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Study to Evaluate the Suitability of Various Solid Waste Management Practices in Indian Cities

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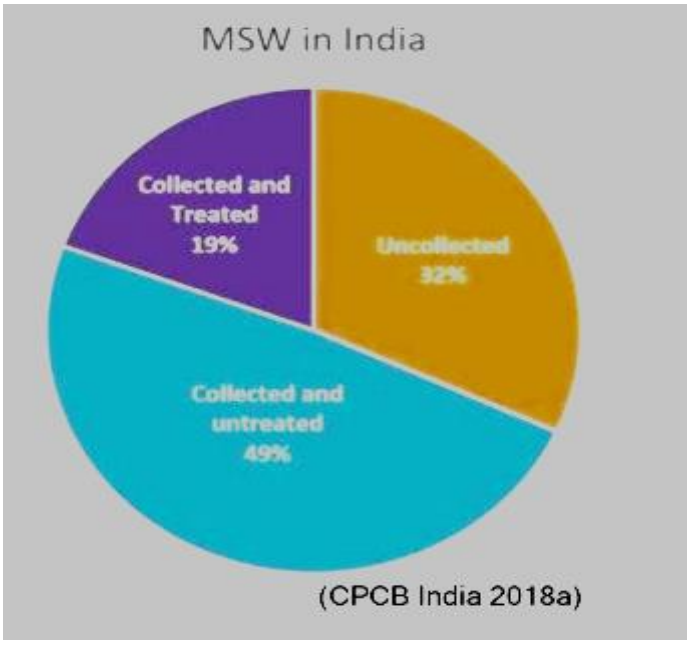
ABSTRACT

This study assesses the suitability of different solid waste management practices in Indian cities. It analyzes factors such as efficiency, environmental impact, and feasibility, aiming to provide insights into effective waste management strategies for diverse urban contexts in India.

KEYWORDS- Solid waste, MSW, DEMATEL, AHP.

1. INTRODUCTION

In India, 80% to 90% of the municipal waste is disposed-off in landfills without proper management practices and open burning, leading to air, water and soil pollution (Ahluwalia & Patel, 2018). Expected urbanization will be 38.2% in 2036, (for population of 152.2 crores). MSW in India Collected and Treated 19% Uncollected 32% Municipal cooperation uses 60% of fund in collection while only 5% in treatment. Collected and untreated 49% (CPCB India 2018a). The per capita waste generation has increased at an exponential rate (0.26 kg/day to 0.85kg/day) (CPCB India, 2018a). Generation of waste is changing with time; metro cities are generating the garbage at a very high rate. (A. Kumar & Agrawal, 2020). Each geographical area offers different evaluation requirements for waste generation and its disposal. (Cervantes et al., 2018) And as the waste generation and content will be different, MSWM also should be designed accordingly.

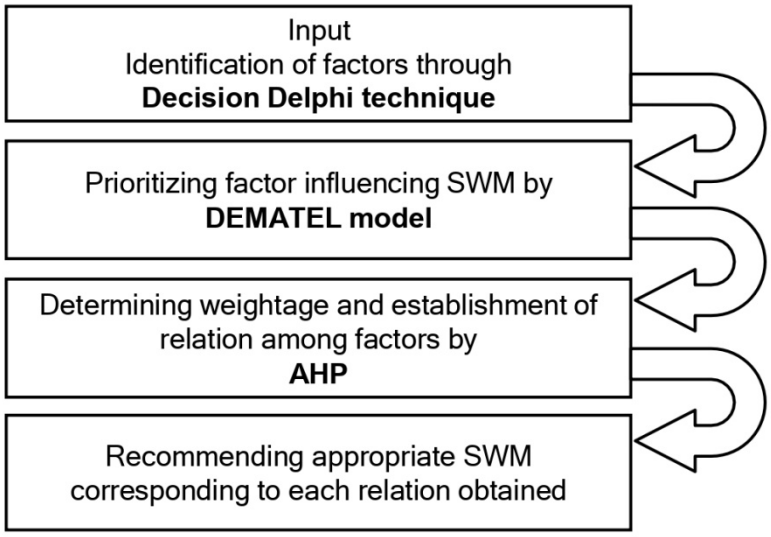


2. OBJECTIVES OF THE STUDY

- To evaluate and analyze the impact of various potential parameters that affect the various process of MSW.
- To evaluate suitability of Decision-making trial and evaluation laboratory (DEMATEL) model for solid waste management practices in India.

- To categorize disposal practices for MSW management in major Indian cities.

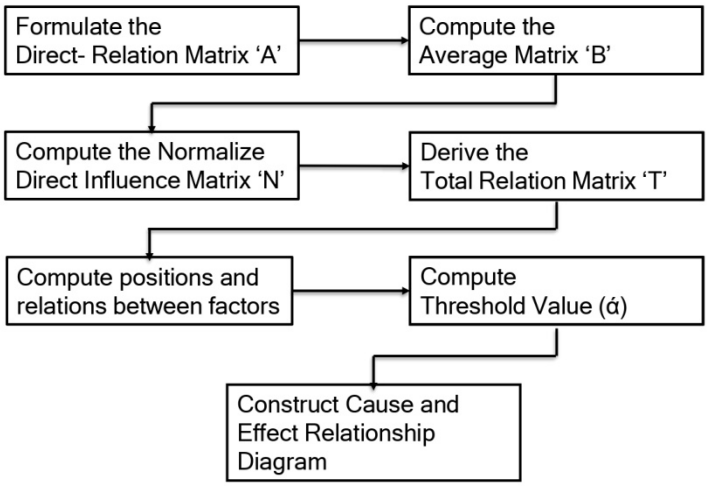
3. METHODOLOGY



There are three steps involved-

1. **Identification of factors -** Decision Delphi technique is There are three steps involved - used. Delphi technique is well suited for consensus-building by multiple iterations on selected data and provides structured alternative anecdotal approach. Firstly, factors and criteria obtained from the literature reviews were presented to the Experts to apply the Decision Delphi technique.
2. **Prioritization of factors -** The DEMATEL method has been applied in 8 steps, formulating Direct Answer Matrix, Original Average Matrix, Normalizing the Direct Influence Matrix, Deriving the Total Relation Matrix and deciding threshold value to get the Cause-and-Effect Relationship diagram.
3. **Evaluation of weightage of factors** - AHP (Analytic Hierarchy Process) is used to establish relationship among factors. Principle of Decomposition, Principle of Comparative Judgment and Principle of Synthesis of Priorities are the three basic principles of AHP.

4. MECHANISM



5. DEMATEL MODEL -

Decision making trial and evaluation laboratory model, it translates human judgements into fuzzy linguistic scales. It is used to solve complex interrelationship problems.

Applications-

- ❖ Can handle interdependent factors characteristics.
- ❖ Multi-criteria decision making (MCMD) method.
- ❖ Establish and analyze causal relationship between factors, cause, and effect factors.
- ❖ Visualize complex relationship as matrices or graphical representation.

Mechanism involved in DEMATEL model -

Direct Relation Matrix 'A' - Matrix incorporate influence of factors over different processes of SWM and over another factors. Matrix formulate using factors given below –

S. No.	Degree of influence	Score
1.	**No Influence**	**0**
2.	**Low Influence**	**1**
3.	**Medium Influence**	**2**
4.	**High Influence**	**3**
5.	**Very High Influence**	**4**

Normalized Direct Influence Matrix 'N' - Divide Direct Relation Matrix with the maximum of sum of individual rows in Direct Relation Matrix.

$$Sum\ of\ all\ the\ values\ in\ a\ row = \sum_{j=1}^{n} a_{ij}$$

$$Normalized\ matrix = k.A = \frac{A}{max_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}}$$

Total Relation Matrix 'T' - Using Normalized Direct - Influence Matrix into model relation.

$$\text{Total Relation Matrix} = T = N\ (I - N)^{-1}$$

Cause-and-Effect Diagram - Plot obtain by mapping all the coordinates of (D+C, D-C).

Where, D = Sum of individual rows of T.

C = Sum of individual column of T.

D+C indicates degree of importance of factor.

While D-C indicates net effect of factor.

6. JUSTIFICATION OF THE STUDY

Attention is not being paid to waste disposal practices by Urban bodies in Indian cities. Open dumping of waste is common in most urban cities. Source segregation, recovery of recyclables, generation of energy during disposal are being avoided. Different cities have different environmental, social, economical and technical parameter. Thus, SWM will also be different based on mentioned parameters. Factors affecting MSW need to be considered while designing solid waste management of the city to generate sustainable solution for Municipal Solid Waste.

High densely populated cities, metropolitan cities generates considerable amount of inorganic waste and paper and cardboard waste that can be recycled and reused instead of landfilled. Decision Delphi Technique is used to identify the factors. Data will be collected and operated into Excel. DEMATEL Model is used to evaluate interdependency of parameters and processes and to prioritize the factors. MATLAB and R language is used to model DEMATEL. AHP used to determine the weightage of factors.

7. STUDY AREA

Cities for study has been selected based tier on classification, population, and geographical location of city. The cities is being selected so as to incorporate most of the Indian conditions.

Tier 1	Tier 2	Tier 3	Tier 4
Metropolitan city	**Urban City**	**Semi Urban City**	**Semi Urban City**
Delhi	**Indore**	**Tirupati**	**Ambala**
Pune	**Warangal**	**Patiala**	**Vellore**
Ahmedabad	**Guwahati**	**Alwar**	**Shimla**
Kolkata	**Dehradun**	**Agartala**	**Port Blair**
	Lucknow		

8.(a) PRELIMINARY RESULT

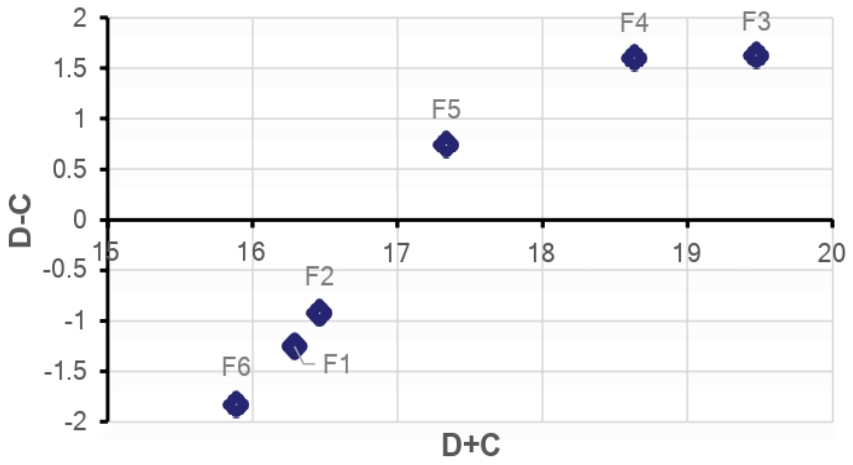
The analysis of Total Relation Matrix and CER diagram shows that Environmental Factor (F3) is the most important factor having the largest (D+C) value i.e., 19.47, whereas Financial Factor (F6) is least important factor having the smallest (D+C) value i.e., 15.88. According to the degree of significance, the magnitude of the factors are recognized as F3>F4>F5>F2>F1>F6.

	F_1	F_2	F_3	F_4	F_5	F_6	D_i	C_i	D_i+C_i	D_i-C_i
F_1	1.18	1.29	1.33	1.24	1.14	1.34	7.52	8.77	16.29	-1.25
F_2	1.24	1.31	1.27	1.34	1.19	1.42	7.77	8.69	16.46	-0.92
F_3	1.69	1.73	1.81	1.75	1.83	1.74	10.55	8.92	19.47	1.63
F_4	1.73	1.68	1.96	1.67	1.51	1.57	10.12	8.51	18.63	1.61
F_5	1.64	1.56	1.34	1.37	1.49	1.64	9.04	8.29	17.33	0.75
F_6	1.29	1.12	1.21	1.14	1.13	1.14	7.03	8.85	15.88	-1.82

8.(b) PRELIMINARY RESULT

The (D-C) values helps to classify the factors into:- (1) Cause Group and (2) Effect Group. Environmental Factor (F3), Hydrology and Hydrogeology Factor (F4), Social, Legal and Political Factors (F5) are fall into the Cause Group, since their (D-C) values are 1.63, 1.61 and 0.75. Transport Factor (F2), Waste Characteristics Factor (F1) and Financial Factor (F6) are fall into the Effect Group, since their (D-C) values are - 0.92, -1.25 and-1.82.

CAUSE-AND-EFFECT DIAGRAM



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