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APPLICATION OF MUTI-CRITERIA DECISION METHOD IN SITE SELECTION FOR SOLID WASTE MANAGEMENT OF KOLHAPUR CITY

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Abstract - Multi-Criteria Decision Making (MCDM) involves a variety of techniques designed to help in finding balanced solutions when multiple criteria are at play. A prime example of a multi-criteria issue is determining the most sustainable approach to solid waste management. This scenario includes conflicting objectives across environmental, economic, social, and technical dimensions. The article reviews several key MCDM methods relevant to evaluating solid waste management systems, including Analytic Hierarchy Process (AHP), Multi-Attribute Utility Theory (MAUT), Outranking Procedures, and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). A notable limitation of these methods is the inherent subjectivity in the criteria chosen by decision makers. To address this, the article recommends combining different methods or developing customized approaches to enhance the optimization of solid waste management.

Key Words: **Multi-Criteria Decision Making (MCDM), Sustainable solution Solid waste management, Analytic Hierarchy Process (AHP), Multi-Attribute Utility Theory (MAUT**)

1.INTRODUCTION

Large volumes of solid waste are produced from residential, industrial, and commercial sources. Proper management of this waste is crucial to reduce environmental impacts, lower economic costs, and prevent adverse social effects. This management process encompasses the generation, collection, transportation, storage, treatment, and disposal of waste. A critical phase in this process is selecting the most effective treatment method. Common treatment options include recycling, anaerobic digestion, composting, incineration, and landfilling. However, the decision-making process can be complex due to the involvement of various stakeholders, each with their own criteria and interests. Multi-Criteria Decision Making (MCDM) provides a framework for navigating such complexities by integrating diverse perspectives and priorities, facilitating a balanced decision when multiple, often conflicting, criteria are involved. Study area The Kolhapur is an energized city on the banks of the Panchganga Stream. It's embraced by the brilliant Sahyadri mountains. You can track down different prominent palaces, great places of refuge, and exceptional castles from the East Royals. This city is truly one of the most shocking spots to ingest the rich history and prominence of India. Tolerating for the time being that you're thinking about, Kolhapur lounges around 387 km away from Mumbai, which is the monetary focal point of India. It's besides prominent for its customary distinguishing strengths, as Kolhapuri Saj (that is nearby adornments) and calfskin shoes that you should get tolerating your visit. A serious need here is the well-known Sri Mahalaxmi Place of refuge. The Bhosle uniquely controlled Kolhapur and were fulfilled relatives of Chhatrapati Shivaji Maharaj. Ace Chhatrapati Shahaji II was really the last top of this past state. The rulers-kept up with theatre wrestling, and countless verbalizations. Nowadays, Kolhapur is mumbling with current life yet at the same time grasps its rich culture. It's a blend of old and new that you won't dismiss Big-hearted! Moreover, try to take a gander at the helper showing India and Maharashtra in Kolhapur city, around 165 tons of solid waste are every single day. Believe it or not, that is an incredible arrangement! this waste moves picked and eliminated every day. Both dry waste and wet waste come from homes and public holders. Then, lining Bazar Kasaba Bavda is totally sent. There, it gets dumped at the Zoom Fertilizer Errand.

1.1 Material and Methods

The composing audit reveals that while GIS and Multi-Principles Appraisal (MCE) are effective gadgets for current site assurance, they much of the time come up short on organized assessment of long stretch reasonability. There is a prerequisite for research that merges future waste age projections and reviews the excessively long sensibility of the site. AHP is the most widely

recognized MCDM strategy to concentrate on most waste administration frameworks, like waste-to-energy frameworks and the board of waste electrical and electronic gear. The Insightful Pecking Order Cycle (AHP) is framed.

The Plan Based on the study, it has been concluded that the Analytical Hierarchy Process method will be used for the solid waste management project. The review shows that 1.2 Acre of land is not accessible inside Kolhapur city. In this manner, the following choice is to investigate elective areas. Five huge towns encompassing Kolhapur city have been considered as expected locales. The loss from Kolhapur city will be shipped to these towns for removal. The following five major villages have been selected for this purpose:

1. Girgaon

2. Kerli

3. Khupire

4. Jaital

5.Kurukali

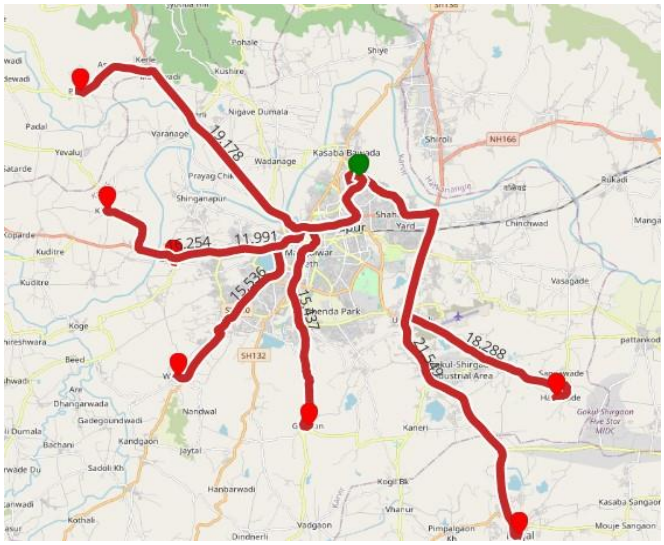

Figure 1. Five villages

The explanation about these factors collectively impacts the efficiency and environmental impact of landfill operations, highlighting the importance of comprehensive management strategies. Using following parameters

1. Transportation

Transportation is a crucial element in solid waste management because it affects the efficiency and effectiveness of waste collection, processing, and disposal. Key aspects include

Collection Efficiency: Proper transportation planning ensures that waste is collected regularly and efficiently from all areas. Inadequate transportation can lead to missed collections, increased litter, and public health issues.

Cost Management: Transportation costs, including fuel, vehicle maintenance, and labor, represent a significant portion of waste management expenses. Efficient routing and vehicle use help to minimize these costs.

Public Health and Safety: Reliable transportation systems help ensure that waste is transported in a sanitary manner, reducing the risk of health hazards associated with waste accumulation.

2. Ground water level –

Ground water levels play a critical role in solid waste management by affecting leachate control, landfill design, site selection, and regulatory compliance. Proper management of these factors is essential to safeguard groundwater resources and ensure the effectiveness of waste management systems. Following table of ground water table

S. R	District	Taluka	Village	Static Water Level (mbgl)
1	**Kolhapur**	**Karver**	**Kurukali**	**1.4**
2	Kolhapur	Karvir	Kogil Bk	2.2
3	**Kolhapur**	**Karvir**	**Jaital**	**1.6**
4	**Kolhapur**	**Karvir**	**Girgaon**	**5.8**
5	Kolhapur	Karvir	Wadipir	3.8
7	**Kolhapur**	**Karvir**	**Khupire**	**1.7**
8	**Kolhapur**	**Karvir**	**Kerli**	**3.7**
9	Kolhapur	Karvir	Shiye	6.9

Table no 1- Static water level

3. Site from residential area

The location of waste management facilities relative to residential areas is important for protecting public health and safety, controlling Odors and noise, preserving property values, and ensuring community acceptance. Keeping waste facilities at a safe distance helps mitigate health risks, reduce nuisances, and comply with regulatory requirements. Scale of deciding site from residential area

Zone 1 - (15KM) Zone 2 - (14KM)

Zone 3 - (13KM) Zone 4 - (12KM)

Zone 5 - (11KM) Zone 6 - (10KM)

4. Distance of surface water from site –

Maintaining a safe distance from surface water is crucial to prevent contamination from leachate, comply with environmental regulations, control erosion, and protect aquatic ecosystems.

1.2 Study of all Paramerters –

Intensity	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective.
3	Weak importance of one over another	Experience and judgement slightly favour one over another.
5	Essential or strong importance	Experience of judgement strongly favour one over another.
7	Very strong or demonstrated importance	An activity fared very strongly over another it demonstrated in practice.
9	Absolute importance	The evidence favouring 1 activity over another is of highest possible order of affirmation.
2,4,6,8	Intermediate value between adjacent scale value	When a compromise in a judgement is needed.

Table no 2 - Choosing scale Source: Adjusted from Saaty (1990)

AHP is a dynamic technique used to assess and focus on numerous rules by separating a mind-boggling issue into a progressive system it includes. Structuring: Disintegrating the issue into a pecking order of models and sub measures.

Pairwise Examination: Assessing the general significance of every rule through pairwise correlations. Scoring: Relegating scores to every choice in light of the rules. Calculation Numerical calculations to compute weighted scores and decide the most ideal choice. AHP helps in making educated, objective choices by efficiently looking at and focusing on various elements following are process –

STEP 1: Fostering a model Here, in this model the objective is to choosing SWM site, with Transportation, Ground level, Site from local location, Distance of surface water from destinations the standards and I have five options for the SWM site

	T. R	G. L	S.R. A	S.W. S
T. R	1	5	4	7
G. L	1/5	1	½	3
S.R. A	1/4	2	1	3
S.W. S	1/7	1/3	1/3	1
Total	1.59	8.33	5.83	14

Table no 3 - Marking scale

Step 2: Refer the properties of weight measures Table Match wise Correlation grid for the determination issue ascribes the qualities got from the Transportation, Ground level, Site from local location, Distance of surface water from destinations should be assessed and their aggregate likewise determined as displayed.

List of Abbreviations

T. R	Transportation	*C.W*	Criteria weight
G. L	Ground level	S. W	Sum weight
S.R. A	Site from residential area	S.W. S	Distance of surface water from site

Finding Criteria weight – Determine the weights of various criteria, and then it transfers them across each level of criteria to calculate overall weightings. From this you can calculate an objective score for each alternative.

	T. R	G. L	S.R. A	S.W. S
T. R	1/1.59	5/8.33	4/5.83	7/14
G. L	0.2/1.59	1/8.33	0.5/5.83	3/14
S.R. A	0.25/1.59	2/8.33	1/5.83	3/14
S.W. S	0.14/1.59	0.33/8.33	0.33/5.83	1/14

Table no 4 - Determination weight

	T. R	G. L	S.R. A	S.W. S	C.W
T. R	0.628	0.600	0.686	0.500	0.603
G. L	0.125	0.120	0.085	0.214	0.136
S.R. A	0.157	0.240	0.171	0.214	0.195
S.W. S	0.089	0.040	0.057	0.071	0.064

Table no 5 - Finding Criteria weight

Sample Calculation –Criteria weights

= 0.638+0.6825+0.7832+0.4522

=2.555/4

=0.603

Step 3: Consistency Check

The consistency apportion ought to be under 0.10, then just the pair wise examination fulfils. Then, at that point, the loads will be taking as the qualities from the framework.
Estimation of Irregularity Consistency record (CI) = (λMax - n)/(n-1), Consistency proportion (CR) = (Consistency record (CI))/ (Radom file (RI))

C.R	3	4	5	6	7	8	9	10
R. I	0.52	0.89	1.11	1.25	1.35	1.4	1.45	1.49

Table no 6- Scale Consistency table

	T. R	G. L	S.R. A	S.W. S	W. S	C.W	S/C
T. R	0.603	0.682	0.783	0.452	2.5217	0.603	4.18
G. L	0.120	0.136	0.097	0.193	0.549	0.136	4.02
S.R. A	0.151	0.237	0.195	0.195	0.813	0.195	4.15
S.W. S	0.08	0.045	0.065	0.064	0.261	0.261	4.04

Table no 7- Finding Sum weights value

n = No of index = 4
Sample calculation –
Criteria Sum weights
= 0.638+0.6825+0.7832+0.4522
= 2.521

λMax
=4.1762+4.0225+4.1553+4.0488
=16.4028/4
= 4.1007
Consistency Index (CI) = (λMax -n)/(n-1)
= 4.1007- 4 /4-1
= 0.1007/3
= 0.03356

CI = 0.03356 RI is 0.90 (From table)

CR = CI/RI = 0.03358/0.90 = 0.03731

CR = 0.03731< 0.10 (Which is standard value)

λ Max=4.1762+4.0225+4.1553+4.0488

To derive overall priorities and final decision weights using the Analytical HierarchyProcess (AHP) –

T. R	0.603
G. L	0.136
S.R. A	0.195
S.W. S	0.064

Table no 8- Final Weight table

Infer generally needs and Official conclusion
Weight Transportation – 0.6038
Weight Ground level - 0.1365;
Weight Site from private region -0.1958;
Weight Distance of surface water from site - 0.0646.

These are the settled loads for the issue and the loads generally speaking aggregate ought to be equivalent to one.

Presently, for the vehicle choice in view of the standards a choice grid should be outlined, as displayed underneath.

V.N	T. R	G. L	S.R. A	S.W. A
Girgaon	15.33	5.80	10	11.9
Kerli	12.67	3.7	12	7.6
Khupire	19.05	1.70	15	11.8
Jaital	19.4	1.60	14	13.9
Kurukali	26.2	1.40	13	21

Table no 8- Parameters And values

Zone 1 - (15KM) Zone 2 - (14KM)

Zone 3 - (13KM) Zone 4-(12KM)

Zone 5 - (11KM) Zone 6 - (10KM)

By and large, the Site is a non-helpful property (bring down the better) the leftover boundaries are valuable credits (higher the better). Need to play out the estimations as displayed here.

Village name	T.R (L)	G. L (H)	S.R. A(L)	S.W. A(H)
Girgaon	12.67/15.33	5.8/5.8	10/10	11.9/21
Kerli	12.67/12.67	3.7/5.8	10/12	7.6/21
Khupire	12.67/19.05	1.70/5.8	10/10	11.8/21
Jaital	12.67/19.4	1.60/5.8	10/14	13.9/21
Kurukali	12.67/26.2	1.40/5.8	10/13	21/21

Table no 10 - Estimate Ranks

The last union of model is displayed here, the loads and the standardized qualities later need to assess the last incentive for positioning.

Step6 - The loads need to duplicate with the relating cost worth and afterward all worth necessities to aggregate to get the last worth,

V.N	T. R	G. L	S.R. A	S. W. A
Girgaon	0.826	1	1	0.566
Kerli	1	0.637	0.833	0.631
Khupire	0.665	0.293	0.666	0.561
Jaital	0.653	0.275	0.714	0.661
Kurukali	0.483	0.275	0.769	1
C.W	0.603	0.136	0.195	0.064

Table no 11 - Ranking Process table

Calculation

0.826x0.6038+1x0.1365+1x0.1958+0.566x0.0648 = 0.8677
At long last, Site 3 is chosen as the best other option. (In light of the great worth)
Rank 1 – Khupire

Rank 2 – Kerli

Rank 3 – Girgaon

Rank 4 – Jaital

Rank 5 – Kurukali

2. RESULT

This part is about conversation of ideal outcome did from AHP strategy with the assistance of result table.
Outcome table following are –
Rank 1 – Khupire
Rank 2 – Kerli
Rank 3 – Girgaon
Rank 4 – Jaital
Rank 5 – Kurukali

3. CONCLUSIONS

This exploration utilized a spatial multi-model assessment approach utilizing Geographic Data Framework (GIS) examination, planning, and prioritization to recognize ideal destinations for strong garbage removal in Kolhapur and the encompassing towns. Using GIS and multimodal' investigation is urgent for deciding reasonable areas for strong garbage removal, which is an imperative part of powerful strong waste administration.

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