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Strategic Prioritization of Service Delivery and User Satisfaction Determinants in Transport Department

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ABSTRACT

Building upon the validated factors identified through Confirmatory Factor Analysis (CFA), this paper focuses on the strategic prioritization of service delivery and user satisfaction determinants within the Transport Department. Following CFA, Hierarchical Clustering was implemented to explore the structural relationships among the confirmed constructs– Licensing and User Accessibility, Process Support and Compliance Services, Safety and Emergency Management, Penalty Management, and Public Awareness. The insights gained from clustering were further integrated with the CRITIC method to enhance the objectivity of priority weighting. Employing Multi-Criteria Decision-Making (MCDM) techniques such as CRITIC, and Entropy, the study evaluates the relative importance of these determinants. Stakeholder judgments and quantitative data are synthesized to rank the constructs based on their impact on service quality and user satisfaction. The integration of hierarchical clustering with the CRITIC and Entropy methods provide a novel perspectives for grouping and weighting interrelated criteria, thereby strengthening the robustness of strategic insights. The findings highlight critical priority areas for policy intervention and resource allocation, offering a data-driven roadmap for improving public service delivery in the transport sector. This contributes to informed decision-making and strategic planning for sustainable, efficient, and user-cantered transport management.

Keywords: Critic method, Multicriteria decision-making, Enttopy method.

INTRODUCTION

In modern governance, the role of public service departments has evolved significantly from merely regulatory bodies to customer-oriented service providers. Among these, the Transport Department holds a unique position, serving as a crucial interface between the government and citizens. It manages a wide spectrum of services such as licensing, vehicle registration, permits, tax collections, road safety enforcement, and penalty administration. As the expectations of citizens continue to rise, there is an urgent need for public agencies to not only improve operational efficiency but also ensure high levels of user satisfaction. However, the challenge lies in the complexity and multifaceted nature of transport services. Multiple service components are often interlinked, and improvements in one area can have cascading effects on others. This complexity calls for a systematic approach to understanding which aspects of service delivery should be prioritized to generate maximum impact. With limited resources and growing demands, it becomes imperative for decision-makers to strategically focus their efforts on the most influential determinants of performance and user satisfaction.

Strategic prioritization involves the identification and ranking of key service factors that significantly contribute to the effectiveness and quality of public service delivery. In the context of transport management, such prioritization supports the development of actionable policies, optimized resource allocation, and targeted interventions. It enables the Transport Department to focus on the most pressing needs of citizens, enhance service accessibility, streamline administrative procedures, reinforce compliance, and promote safety and sustainability on the roads. To achieve these objectives, this paper employs a multi-criteria evaluation framework that integrates quantitative techniques such as Principal Component Analysis (PCA), CRITIC (Criteria Importance Through Intercriteria Correlation), and Entropy-based weighting methods. These techniques are selected for their objectivity and analytical rigor in assessing

the relative importance of diverse service attributes. By extracting insights from structured data and minimizing subjective bias, the prioritization model offers a comprehensive view of which service factors hold the greatest significance in improving user satisfaction and departmental performance.

The analysis focuses on five key constructs that represent the functional and experiential dimensions of transport services: Licensing and user accessibility, Support and compliance services, Safety and Energy Management, Information and financial systems and Penalty management & Public awareness. Each construct encompasses multiple service indicators, and their prioritization is aimed at providing a strategic roadmap for enhancing the overall effectiveness of transport management.

This paper not only contributes to academic discourse on public service prioritization but also offers practical guidance for transport authorities, planners, and policymakers. The resulting insights are intended to support evidence-based decision-making, reinforce accountability, and promote a citizen-centric approach to transport governance. Through the strategic ranking of service determinants, the Transport Department can proactively align its objectives with the evolving needs of the public, ultimately leading to improved trust, satisfaction, and service quality.

LITERATURE REVIEW

The prioritization of service delivery components and user satisfaction indicators within public sector institutions, particularly transport departments, has gained prominence in recent years due to increasing public expectations and administrative complexity. Understanding and addressing the factors that influence citizen satisfaction with transport services requires a multi-dimensional approach that integrates service quality assessment, user behavior analysis, and strategic decision-making frameworks.

The transport sector is often characterized by a wide range of interdependent services including licensing, registration, vehicle taxation, permit issuance, penalty enforcement, and road safety initiatives. According to Parasuraman et al. (1988), the quality of public services can be evaluated through five key dimensions—tangibles, reliability, responsiveness, assurance, and empathy—which have been foundational in the SERVQUAL model. In the transport context, these dimensions translate into timely service, accurate documentation, accessible platforms, and responsive grievance redressal mechanisms (Harrington et al., 2017).

Traditional public administration approaches have long focused on regulatory compliance, cost-efficiency, and administrative control. However, with the advent of New Public Management (NPM), the emphasis has shifted toward citizen-centric service delivery, performance measurement, and accountability (Hood, 1991). The transport sector, as a key public service provider, reflects this transition in its efforts to digitize services, decentralize operations, and engage with stakeholders. Grönroos (1994) emphasized the service logic in public management, underlining the importance of process quality and customer involvement.

Public value theory further highlights the necessity of designing services around societal outcomes and long-term public benefits (Moore, 1995). In this context, transport departments are not just service executors but also enablers of social equity, safety, and economic efficiency.

User satisfaction within public transport services is shaped by a range of functional, emotional, and contextual variables. These include service accessibility, reliability, transparency, safety, and the ease of procedural compliance. Liu et al. (2008) point out that satisfaction is not solely dependent on outcome-based performance but also on the process through which services are delivered. In particular, responsiveness, clarity of information, and fair treatment significantly influence perceptions of quality.

Further, digital transformation has introduced new expectations for real-time service access, automation, and reduced human interaction. According to Dwivedi et al. (2015), e-governance plays a critical role in bridging service delivery gaps and enhancing satisfaction, especially in urban transport systems where efficiency and speed are essential.

User satisfaction is an essential metric for assessing the effectiveness of public sector services. It serves as a feedback mechanism to improve policy design, service mechanisms, and infrastructure planning. Studies by Osborne et al.

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(2013) highlight that citizen satisfaction is not only influenced by service outcomes but also by procedural justice and user engagement. In transport systems, factors such as waiting time, ease of application, transparency, digital accessibility, and safety play crucial roles in shaping perceptions of quality.

Strategic prioritization involves a rational allocation of limited resources to areas with the greatest potential for impact. In the public sector, where competing interests and constraints prevail, prioritization supports evidence-based planning and accountability. It allows departments to set performance targets, measure service gaps, and align actions with strategic goals (Kaplan & Norton, 1996).

The Balanced Scorecard (BSC) framework has been widely used in public sector performance management to link strategic objectives with measurable outcomes. When integrated with transport service delivery, BSC helps in balancing operational goals (e.g., speed of license issuance) with broader outcomes like road safety or environmental sustainability.

The increasing complexity of administrative systems has led to the adoption of Multi-Criteria Decision-Making (MCDM) methods to support evidence-based prioritization. Techniques such as Principal Component Analysis (PCA), CRITIC (Diakoulaki et al., 1995), and Entropy weighting (Zeleny, 1982) allow for objective evaluation of competing service indicators. These methods help reduce subjectivity and ensure that decision-making is based on the intrinsic properties of data. CRITIC, in particular, considers both the contrast intensity and the conflict between criteria, making it well-suited for public service contexts where stakeholder expectations often diverge.

MCDM techniques have emerged as powerful tools for structuring complex decision-making processes in public administration. These methods consider multiple, often conflicting, criteria and provide a ranked output that reflects the relative importance of each factor. Principal Component Analysis (PCA) reduces dimensionality by identifying latent factors that explain maximum variance in the data, enabling policymakers to understand dominant service aspects (Jolliffe, 2002). CRITIC Method objectively derives weights by considering both standard deviation (variability) and correlation among indicators, making it suitable for assessing interrelated transport services (Diakoulaki et al., 1995). Entropy Method quantifies the degree of disorder or uncertainty associated with service indicators, giving more weight to those with higher informational contribution (Zeleny, 1982; Shannon, 1948).

Integrating these techniques allows for more balanced prioritization, considering both internal service dynamics and external stakeholder expectations.

Recent studies emphasize the importance of integrating quantitative techniques with stakeholder perspectives to ensure a holistic evaluation. For instance, Yu et al. (2020) propose combining factor analysis and MCDM to link user feedback with institutional performance. Moreover, frameworks that combine PCA and Entropy are increasingly being used in urban and transport planning to prioritize development goals in alignment with user needs (Kumar & Singh, 2019).

The practical application of MCDM in transport service research is well-documented. For example, Tsamboulas et al. (1999) applied AHP and cost–benefit analysis to prioritize highway projects. More recently, hybrid models combining PCA, Entropy, and CRITIC have been used to prioritize sustainable urban mobility indicators (Kumar & Singh, 2019), assess road safety programs (Motevali et al., 2020), and evaluate transport infrastructure resilience (Gkritza et al., 2017).

In the Indian context, public transport services vary greatly in terms of service quality, efficiency, and user satisfaction. Government initiatives such as the *Parivahan* platform under the Ministry of Road Transport and Highways have attempted to digitize and standardize services nationwide. However, disparities in implementation and public experience highlight the need for prioritization tools that are sensitive to both administrative metrics and citizen feedback.

Empirical applications of these methods in transport departments have shown promise in aligning service delivery with user expectations. For example, Al-Kilidar et al. (2005) examined how customer satisfaction metrics could be embedded into transportation performance dashboards, while Rahman et al. (2021) used Entropy-based approaches to identify critical indicators in smart transport governance.

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2.1 Gaps and Need for Current Study

While numerous studies have examined individual elements of transport service quality, fewer have adopted an integrated prioritization approach that combines statistical validation with decision-making techniques. There is a growing need for frameworks that not only identify key factors but also rank them based on objective analysis and stakeholder relevance. This paper addresses that gap by developing a structured prioritization model using PCA, CRITIC, and Entropy to guide policy interventions and resource optimization in transport management.

PRIORITIZATION METHODS

To prioritize factors CRITIC (Criteria Importance through Intercriteria Correlation) and Entropy methods, the step wise procedure is explained in the following sections.

3.1 Hierarchical Clustering based CRITIC

This section presents an adapted version of the CRITIC (Criteria Importance Through Intercriteria Correlation) method using the distance matrix obtained through hierarchical clustering. The method leverages the correlation-based distance as a measure of conflict or contrast among items, enabling objective prioritization of criteria even when raw item values are unavailable.

Step-1: Consider distance matrix obtained in hierarchical clustering

Step-2: Determine information content (I_j): information content is determined from the following relation. In this case, **correlation coefficient distance** is considered as Conflict degree (c_j).

$$I_j = \mathbf{c_j * \sigma_j}$$

where σ_j of items

Step-3: Determine criteria weights (w_j): The following formula is used to determine the weights

$$w_j = \frac{I_j}{\sum_{j=1,n} I_j}$$

Step-4: Ranking of items: Rank the weights of the items depending on decreasing order of relative weights.

This hybrid method effectively integrates hierarchical clustering and CRITIC, leveraging the distance matrix (correlation coefficient distance) to quantify conflict among criteria. Unlike traditional CRITIC, which computes correlation matrices separately, this approach utilizes the already available output from clustering, thereby reducing computational steps and ensuring methodological consistency. By including both the statistical dispersion (σ_j) and inter-item conflict (c_j), it supports more robust, data-driven prioritization in cases where decision-making must rely on internal structure rather than external performance data.

3.2 Hierarchical Clustering based ENTROPY Method

This section introduces a modified entropy-based prioritization technique where the distance matrix obtained from hierarchical clustering is used as the decision matrix. The method allows for deriving objective weights of criteria (items) based solely on pairwise dissimilarities

Step-1: Obtain decision Matrix (x_{ij}): Consider Distance matrix as decision matrix

Step-2: Normalize the decision matrix: Normalize the decision matrix as discussed in step 2 of section 4.2

Step-3: Calculate of the index's entropy

$$e_j = -k\sum_{i=1}^{n} p_{ij} \ln(p_{ij})$$

where $k = \frac{1}{\ln(n)}$

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Step-4: Calculate degree of diversification d_j from the following relation.

$$\mathbf{d_j = 1 - e_j}$$

Step-5: Compute item weights:

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j}$$

Step-6: Ranking of items: Rank the weights of the items depending on decreasing order of relative weights.

This hybrid method effectively integrates hierarchical clustering and ENTROPY, leveraging the structure uncovered through clustering to guide objective weight assignment. Unlike traditional ENTROPY, which evaluates dispersion across all criteria independently, this approach first organizes criteria into clusters based on similarity (e.g., correlation or Euclidean distance), thereby reducing redundancy and revealing latent structure. By applying the entropy measure within each cluster, it captures the true variability of non-redundant indicators, ensuring that only informative, distinct criteria influence the final weights. This enhances interpretability and reduces computational overhead; while supporting robust, data-driven prioritization in scenarios where external benchmarks are unavailable or internal consistency is paramount.

CASE STUDY

This empirical case study investigates the effectiveness of the Transport Department's service delivery across six core functional areas: licensing, registration, permits, taxation, penalties, and road safety. The evaluation is based on user perceptions collected through a structured questionnaire survey.

A total of 400 questionnaires were distributed to individuals residing in a major city in Andhra Pradesh, selected for its diverse population and high interaction with transport services. Out of the distributed surveys, 377 valid responses were received and considered for analysis, yielding a high response rate and ensuring data reliability.

The questionnaire, provided in **Appendix**, consists of 25 carefully designed statements distributed across the six functional domains of the department. Respondents were asked to evaluate each statement using a 5-point Likert scale, ranging from **1 (Strongly Disagree)** to **5 (Strongly Agree)**, allowing for a nuanced assessment of service quality and user satisfaction.

The data collected through this survey serves as the foundation for subsequent statistical analysis and prioritization, offering a user-driven perspective on the relative importance and performance of various service dimensions within the Transport Department.

4.1 Demographic Profile of Respondents

The survey captured a diverse demographic profile, reflecting the varied stakeholder base of the Transport Department's services. A total of 377 valid responses were analyzed. The breakdown of respondents by age, gender, stakeholder category, and mode of interaction with the department is presented below:

- **Age Groups**

Respondents were classified into three age brackets. The majority (39.8%) were between 18 and 30 years, followed by 34.7% in the 31 to 50 age group. Individuals above 51 years constituted 25.5% of the sample.

  - 18 to 30 years: 150 respondents (39.8%)
  - 31 to 50 years: 131 respondents (34.7%)
  - Above 51 years: 96 respondents (25.5%)

- **Gender**

The gender distribution shows a higher representation of males (57.6%) compared to females (39.8%), with 2.7% preferring not to disclose their gender.

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- Male: 217 respondents (57.6%)
- Female: 150 respondents (39.8%)
- Prefer not to say: 10 respondents (2.7%)

- **Stakeholder Categories**

Respondents were drawn from various stakeholder groups interacting with the Transport Department. Individual applicants made up nearly half the sample (49.9%), followed by transport operators (20.4%), driving school representatives (16.2%), and the general public (13.5%).

- Individual Applicants: 188 respondents (49.9%)
- Transport Operators: 77 respondents (20.4%)
- Driving School Representatives: 61 respondents (16.2%)
- General Public: 51 respondents (13.5%)

- **Mode of Interaction with the Department**

Regarding how respondents typically engaged with the Transport Department, 60% reported using online services, 30% interacted in person, while 10% utilized both modes.

- Online: 226 respondents (60%)
- In-person: 113 respondents (30%)
- Both: 37 respondents (10%)

This demographic distribution provides a representative view of the diverse users of transport services and forms the basis for analysing perceptions of service effectiveness and satisfaction levels.

The following measurement items are considered in the study shown in Table-1.

Table-1: List of measurement items

S.No.	Measurement items
ITEM 1	Clarity of Licensing Procedures
ITEM 2	Timeliness of License Issuance
ITEM 3	Transparency in Testing and Evaluation
ITEM 4	Accessibility of Licensing Sendees
ITEM 5	Ease of Access to Registration Sendees
ITEM 6	User-Friendliness of Online Platforms
ITEM 7	Support from Staff During Registration
ITEM 8	Clarity of Registration Procedures
ITEM 9	Timeliness of Permit Issuance
ITEM 10	Compliance with Legal and Safety Standards
ITEM 11	Support for Permit-Related Queries
ITEM 12	Adequacy of Information Provided on Pennits
ITEM 13	Ease of Payment Process
ITEM 14	Competitive Tax Rates
ITEM 15	Customer Satisfaction Across Borders
ITEM 16	Impact of Tax Incentives on Adoption of Green Initiatives
ITEM 17	User Satisfaction with Penalty Procedures
ITEM 18	Use of Penalty Revenue for Public Benefits
ITEM 19	Digital Integration in Penalty Management
ITEM 20	Educational Campaigns on Penalties
ITEM 21	Road Accident Data Collection and Analysis
ITEM 22	Inspection and Maintenance of Vehicles
ITEM 23	Speed Monitoring and Control

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S.No.	Measurement items
ITEM 24	Collaboration with Other Departments
ITEM 25	Availability of Emergency Response Sendees

Table-2: Data on the measurement items

S.No.	Licensing and User Accessibility						Support and Compliance Services					Safety and Emergency Management					Penalty Management				Public Awareness				
	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24	Item 25
1	2	3	3	2	3	3	2	2	2	2	3	3	3	3	3	3	4	4	4	4	3	3	4	3	3
2	4	4	3	3	3	4	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
5	3	3	3	3	3	3	3	3	3	4	4	3	3	3	3	3	3	4	3	3	3	3	3	3	3
6	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	4	3	4	4	3	4	3	4
7	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3
8	3	4	3	3	4	4	3	3	3	3	3	4	3	4	4	3	4	4	4	4	3	3	3	3	3
9	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	4	4	3	4	3
10	3	3	3	2	2	2	3	3	3	3	3	2	3	3	3	2	4	4	4	4	3	3	3	3	3
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	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24	Item 25
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352	1	2	2	2	1	1	3	2	3	2	2	4	3	3	4	3	3	2	2	2	3	4	3	3	3
353	1	2	3	1	3	3	2	2	1	2	2	2	2	1	1	3	4	3	3	2	2	3	3	2	2
354	3	3	2	2	2	2	3	3	3	3	3	2	2	3	2	3	2	2	3	3	3	3	3	3	3
355	3	3	4	4	5	4	3	4	4	4	3	4	3	3	4	3	3	4	3	3	3	4	4	4	4
356	4	4	5	4	3	3	3	4	3	3	3	1	2	2	2	2	4	2	3	2	3	2	3	2	3
357	3	4	4	3	3	4	2	3	1	2	3	1	1	2	1	2	3	4	4	2	3	3	3	3	3
358	4	4	3	3	3	4	2	2	2	3	3	1	1	1	2	2	3	2	3	3	2	3	2	3	2
359	2	2	2	1	1	1	1	1	1	1	2	1	2	2	1	2	3	3	4	3	1	2	1	1	2
360	3	3	3	3	4	3	4	4	3	4	3	3	3	4	4	4	4	4	2	4	2	1	1	1	1
361	2	3	4	2	3	3	1	1	1	2	2	4	4	3	4	3	4	4	4	3	2	3	3	2	2
362	2	1	3	2	1	2	2	2	2	1	2	4	4	4	4	3	3	4	3	3	3	1	2	3	2
363	2	2	2	2	3	2	2	1	1	1	2	3	3	2	3	2	3	2	3	2	3	2	3	2	2
364	2	3	1	3	2	3	3	3	3	2	3	3	3	4	3	4	3	2	4	4	3	3	2	2	2
365	2	2	2	3	3	3	1	1	1	1	2	1	2	2	2	1	2	3	3	3	1	3	2	1	2

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S.No.	Licensing and User Accessibility						Support and Compliance Services					Safety and Emergency Management					Penalty Management				Public Awareness				
	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24	Item 25
366	4	3	3	4	4	4	1	1	2	2	1	3	4	3	1	2	3	3	4	4	2	3	4	4	2
367	3	3	3	3	4	3	2	2	1	2	2	2	2	2	1	2	3	3	4	3	4	3	3	4	3
368	1	2	1	2	1	1	2	1	2	2	2	1	1	1	1	1	2	2	2	2	3	2	2	2	1
369	1	2	1	2	1	1	2	2	2	1	2	4	4	4	3	3	4	3	4	4	3	4	4	4	4
370	3	4	4	4	4	4	2	2	1	1	1	4	4	3	2	4	2	3	3	3	1	1	2	2	2
371	2	3	3	3	2	3	3	4	4	4	3	1	1	1	2	1	2	2	4	3	3	3	3	3	4
372	2	1	1	1	1	2	3	1	1	1	2	1	1	1	1	1	2	3	3	3	2	2	2	3	2
373	3	3	3	3	3	4	3	2	3	2	3	2	3	3	3	3	3	4	4	2	2	2	2	2	2
374	3	3	4	3	3	3	1	2	2	1	1	5	4	3	4	3	3	3	4	3	1	3	3	3	3
375	3	3	3	4	4	4	2	1	1	1	2	3	3	3	3	3	3	3	2	4	1	1	2	1	1
376	2	2	3	2	3	2	3	4	4	4	3	3	3	2	2	2	2	4	2	3	1	1	1	2	1
377	3	3	4	4	4	3	3	2	4	4	4	3	2	3	3	3	3	3	3	2	4	4	3	3	4

Table-3: Hierarchical cluster analysis

Step No.	Step clusters	Similarity level	Distance level	Clusters joined		New cluster	No. of observations in the new cluster
1	24	85.4601	0.2908	9	10	9	2
2	23	84.5466	0.30907	22	25	22	2
3	22	83.0976	0.33805	21	23	21	2
4	21	82.8629	0.34274	8	9	8	3
5	20	82.6771	0.34646	1	6	1	2
6	19	82.2763	0.35447	14	15	14	2
7	18	82.2708	0.35458	12	16	12	2
8	17	81.5855	0.36829	13	14	13	3
9	16	81.3823	0.37235	12	13	12	5
10	15	81.2818	0.37436	3	5	3	2
11	14	80.8504	0.38299	7	8	7	4
12	13	80.8054	0.38389	2	4	2	2
13	12	80.4828	0.39034	21	24	21	3
14	11	79.9428	0.40114	21	22	21	5
15	10	79.6871	0.40626	7	11	7	5
16	9	79.2115	0.41577	2	3	2	4
17	8	78.8733	0.42253	1	2	1	6
18	7	70.6852	0.5863	18	19	18	2
19	6	68.7633	0.62473	17	18	17	3
20	5	67.4115	0.65177	17	20	17	4
21	4	52.7688	0.94462	17	21	17	9
22	3	51.981	0.96038	12	17	12	14
23	2	51.8187	0.96363	1	7	1	11
24	1	48.7675	1.02465	1	12	1	25

The hierarchical cluster analysis reveals a stepwise merging of clusters based on similarity and distance levels, indicating how closely observations relate to one another. In the early stages (Steps 1 to 17), clusters are joined at high similarity levels (above 78%), suggesting the presence of tightly bound groups with high internal cohesion. For example, in Step-1, clusters 9 and 10 were merged at a similarity level of 85.46%, indicating they are very similar. As clustering progresses, similarity levels gradually decrease, and by Step-17 the similarity drops to 78.87%, still indicating a reasonable degree of homogeneity within the merged groups.

However, from Step-18 onwards, there is a sharp decline in similarity and a corresponding increase in distance levels. For instance, Step 18 shows a drop in similarity to 70.69% (distance 0.5863), and by Step-21, the similarity plummets to 52.77% with a significant distance of 0.9446. These later stages reflect the merging of clusters that are increasingly

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dissimilar, combining more heterogeneous observations. Ultimately, in Step 24, all observations are merged into a single cluster at a similarity level of just 48.77%, indicating that the final merger involves distinctly different groups.

Based on these observations, the optimal number of clusters can be estimated by identifying where large increases in the distance level occur. The significant jumps between Steps 17 and 18, and again between Steps 20 and 21, suggest natural groupings exist before these steps. Therefore, a cut-off at Step 17 would result in eight clusters, while cutting at Step 20 would yield five clusters. These cut points likely represent meaningful groupings within the data and should be considered based on the analysis objective**.** Finally, 5 clusters are formed as shown below.

Cluster 1: Item 1, Item 2, Item 3, item 4, item 5 and Item 6 are grouped under Cluster 1.

Cluster 2: Item 7, Item 8, Item 9, item 10, and Item 11 are grouped under Cluster 2.

Cluster 3: Item 12, Item 13, Item 14, item 15, and Item 16 are grouped under Cluster 3.

Cluster 4: Item 17, Item 18, Item 19 and Item 20 are grouped under Cluster 4.

Cluster 1: Item 21, Item 22, Item 23, item 24 and item 25 are grouped under Cluster 1.

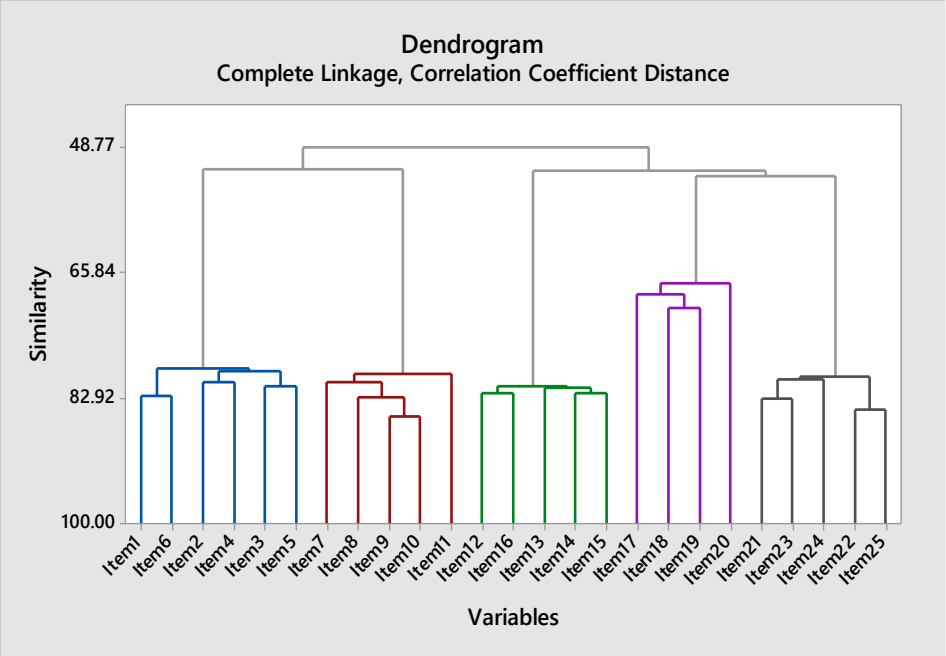

Figure 1: Dendrogram

The dendrogram shows how these items are progressively grouped into clusters based on their correlation. Cutting the dendrogram just above the 48.77% similarity level (near the first large horizontal line at the top) would give you 5 meaningful clusters, consistent with the jump in dissimilarity seen in the hierarchical clustering table (Step-20–21 onward). The dendrogram supports the earlier numerical analysis and confirms that the data naturally groups into five well-defined clusters. Each cluster shows good internal similarity and distinct separation from others, particularly the fifth cluster (Items 20-25), which is notably more distant.

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4.2 Prioritization

In the study, prioritization methods as discussed in section 4 are implemented with the case study to determine relative weights of the criteria

4.3 Hierarchical Clustering with CRITIC Method

4.3.1 Distance matrix

The distance matrix obtained through Hierarchical Clustering is presented in Table-4.

Table-4: Decision matrix

Item 2	Ite m 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22
39557	0.41402	0.4	0.423	0.34646	0.848843	0.854	0.841	0.86	0.866	0.955	0.936	0.878	0.908	0.91	0.879	0.873	0.967	0.869	0.973	1
0	0.41577	0.4	0.393	0.3735	0.894839	0.874	0.919	0.917	0.86	0.931	0.915	0.85	0.94	0.874	0.884	0.883	0.994	0.907	0.914	0.928
41577	0	0.4	0.374	0.34918	0.925566	0.823	0.864	0.866	0.887	0.949	0.908	0.916	0.927	0.94	0.881	0.817	0.963	0.958	1.022	0.969
38389	0.3873	0	0.381	0.39484	0.853945	0.789	0.826	0.864	0.837	0.923	0.851	0.814	0.883	0.94	0.923	0.85	0.965	0.889	0.918	0.891
39298	0.37436	0.4	0	0.35454	0.885936	0.868	0.855	0.837	0.886	0.914	0.895	0.87	0.906	0.878	0.812	0.809	0.906	0.865	0.953	0.936
.3735	0.34918	0.4	0.355	0	0.963298	0.922	0.964	0.959	0.902	0.947	0.962	0.857	0.933	0.883	0.9	0.85	0.919	0.871	0.993	0.988
89484	0.92557	0.9	0.886	0.9633	0	0.383	0.327	0.36	0.386	0.959	0.993	0.96	0.822	0.893	0.869	0.797	0.941	0.941	0.9	0.919
87425	0.82347	0.8	0.868	0.92184	0.382993	0	0.329	0.343	0.399	1.025	1.003	0.995	0.88	0.925	0.86	0.803	0.884	0.88	0.852	0.875
91899	0.86394	0.8	0.855	0.96363	0.327463	0.329	0	0.291	0.406	0.945	0.965	0.912	0.816	0.935	0.916	0.875	0.937	0.931	0.864	0.848
.9171	0.86604	0.9	0.837	0.95896	0.360266	0.343	0.291	0	0.396	0.971	1.017	0.955	0.839	0.886	0.94	0.87	0.969	0.975	0.894	0.914
85961	0.88667	0.8	0.886	0.90158	0.3857	0.399	0.406	0.396	0	0.991	0.969	0.897	0.805	0.87	0.867	0.826	0.898	0.889	0.815	0.883
93059	0.94949	0.9	0.914	0.94657	0.959216	1.025	0.945	0.971	0.991	0	0.369	0.372	0.357	0.355	0.914	0.912	0.901	0.911	0.923	0.911
91479	0.90809	0.9	0.895	0.96191	0.993077	1.003	0.965	1.017	0.969	0.369	0	0.368	0.362	0.367	0.913	0.892	0.911	0.917	0.876	0.878
84993	0.91649	0.8	0.87	0.85713	0.959614	0.995	0.912	0.955	0.897	0.372	0.368	0	0.354	0.36	0.904	0.915	0.864	0.821	0.808	0.793
93959	0.92694	0.9	0.906	0.93338	0.822009	0.88	0.816	0.839	0.805	0.357	0.362	0.354	0	0.359	0.914	0.948	0.951	0.899	0.84	0.797
87396	0.94	0.9	0.878	0.88285	0.893282	0.925	0.935	0.886	0.87	0.355	0.367	0.36	0.359	0	0.904	0.946	0.942	0.881	0.889	0.858
88444	0.8809	0.9	0.812	0.90039	0.868504	0.86	0.916	0.94	0.867	0.914	0.913	0.904	0.914	0.904	0	0.593	0.625	0.652	0.755	0.791
88266	0.81669	0.9	0.809	0.84996	0.796595	0.803	0.875	0.87	0.826	0.912	0.892	0.915	0.948	0.946	0.593	0	0.586	0.616	0.897	0.945
99404	0.9627	1	0.906	0.91907	0.941021	0.884	0.937	0.969	0.898	0.901	0.911	0.864	0.951	0.942	0.625	0.586	0	0.628	0.94	0.935
90665	0.95753	0.9	0.865	0.87081	0.941204	0.88	0.931	0.975	0.889	0.911	0.917	0.821	0.899	0.881	0.652	0.616	0.628	0	0.837	0.83
91366	1.02167	0.9	0.953	0.99251	0.899808	0.852	0.864	0.894	0.815	0.923	0.876	0.808	0.84	0.889	0.755	0.897	0.94	0.837	0	0.398
92844	0.96922	0.9	0.936	0.98755	0.918924	0.875	0.848	0.914	0.883	0.911	0.878	0.793	0.797	0.858	0.791	0.945	0.935	0.83	0.398	0
90394	0.97063	0.9	0.907	0.90068	0.986465	0.887	0.879	0.929	0.905	0.884	0.893	0.829	0.913	0.96	0.804	0.912	0.877	0.849	0.338	0.366
91667	0.94774	0.9	0.923	0.88856	0.907874	0.88	0.834	0.939	0.904	0.882	0.849	0.801	0.868	0.909	0.834	0.824	0.822	0.842	0.39	0.375
91313	0.96834	0.9	0.941	0.96955	0.994601	0.916	0.905	0.971	0.934	0.923	0.881	0.793	0.878	0.895	0.823	0.925	0.944	0.799	0.333	0.309

Table-5: Measure of conflict, relative weights, ranking

Items	Sum of Membership	Std of Items	Measure of Conflict	RW_Item	Rank	Dimensions	Relative Wt. of Dimension
Item l	19.3032	0.6838	13.1992	0.0394	16	Licensing and User Accessibility	0.2386
Item 2	19.1790	0.6988	13.4030	0.0400	12		
Item 3	19.4428	0.7264	14.1228	0.0421	4		
Item 4	18.6733	0.7076	13.2133	0.0394	15		
Item 5	18.7726	0.6901	12.9554	0.0387	21		
Item 6	19.3887	0.6733	13.0544	0.0390	18		
Item 7	19.7110	0.7017	13.8314	0.0413	6	Support and Compliance Services	0.2086
Item 8	19.2487	0.7142	13.7479	0.0410	8		
Item 9	19.1829	0.7475	14.3395	0.0428	2		
Item 10	19.7602	0.7325	14.4751	0.0432	1		
Item 11	19.2743	0.7004	13.4997	0.0403	11		
Item 12	20.1222	0.7104	14.2952	0.0427	3	Safety and Emergency Management	0.2002
Item 13	19.8888	0.6926	13.7758	0.0411	7		
Item 14	18.8865	0.6704	12.6611	0.0378	23		
Item 15	19.1001	0.6978	13.3278	0.0398	13		
Item 16	19.5569	0.6666	13.0366	0.0389	19		
Item 17	20.1547	0.6113	12.3212	0.0368	24		0.1506

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Item 18	20.1633	0.6398	12.9008	0.0385	22	Penalty Management	
Item 19	21.2666	0.6160	13.1009	0.0391	17		
Item 20	20.4550	0.5937	12.1436	0.0362	25		
Item 21	19.3192	0.7054	13.6277	0.0407	10	Public Aware ness	0.2021
Item 22	19.3364	0.6844	13.2329	0.0395	14		
Item 23	19.4820	0.7049	13.7329	0.0410	9		
Item 24	19.1563	0.6798	13.0215	0.0389	20		
Item 25	19.6188	0.7188	14.1013	0.0421	5		

The CRITIC method analysis highlights “Licensing and User Accessibility” as the most influential dimension, contributing 23.86% of the total weight, followed by “Support and Compliance Services” (20.86%) and “Public Awareness” (20.21%). “Penalty Management” is the least impactful at 15.06%. Among the 25 items, Item10 (RW = 0.0432) ranks first in terms of importance, indicating high variability and low correlation with others. Items 9, 12, 3, and 25 also rank within the top five, reinforcing their informational significance. Conversely, Item20 and Item17 fall at the bottom, contributing minimally to overall differentiation. This analysis underscores the value of certain dimensions and items in guiding focused improvements or decision-making priorities.

4.4 Hierarchical Clustering Based Entropy

Table-6: Normalized matrix

Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Ite 2
0.0223	0.0225	0.0179	0.0431	0.0444	0.0438	0.0435	0.0449	0.0474	0.0471	0.0465	0.0476	0.0465	0.0436	0.0433	0.0455	0.0425	0.0503	0.0517	
0.0206	0.0209	0.0193	0.0454	0.0454	0.0479	0.0464	0.0446	0.0462	0.0460	0.0450	0.0492	0.0447	0.0439	0.0438	0.0467	0.0443	0.0473	0.0480	
0.0207	0.0199	0.0180	0.0470	0.0428	0.0450	0.0438	0.0460	0.0472	0.0457	0.0485	0.0485	0.0481	0.0437	0.0405	0.0453	0.0468	0.0529	0.0501	
0.0000	0.0203	0.0204	0.0433	0.0410	0.0430	0.0437	0.0434	0.0459	0.0428	0.0431	0.0462	0.0481	0.0458	0.0422	0.0454	0.0435	0.0475	0.0461	
0.0204	0.0000	0.0183	0.0449	0.0451	0.0446	0.0424	0.0460	0.0454	0.0450	0.0461	0.0474	0.0449	0.0403	0.0401	0.0426	0.0423	0.0493	0.0484	
0.0211	0.0189	0.0000	0.0489	0.0479	0.0502	0.0485	0.0468	0.0470	0.0484	0.0454	0.0489	0.0451	0.0447	0.0422	0.0432	0.0426	0.0514	0.0511	
0.0457	0.0472	0.0497	0.0000	0.0199	0.0171	0.0182	0.0200	0.0477	0.0499	0.0508	0.0430	0.0457	0.0431	0.0395	0.0442	0.0460	0.0466	0.0475	
0.0422	0.0462	0.0475	0.0194	0.0000	0.0172	0.0173	0.0207	0.0509	0.0504	0.0527	0.0461	0.0473	0.0426	0.0398	0.0416	0.0430	0.0441	0.0453	
0.0442	0.0455	0.0497	0.0166	0.0171	0.0000	0.0147	0.0211	0.0470	0.0485	0.0483	0.0427	0.0478	0.0454	0.0434	0.0441	0.0455	0.0447	0.0439	
0.0463	0.0446	0.0495	0.0183	0.0178	0.0152	0.0000	0.0205	0.0482	0.0511	0.0505	0.0439	0.0453	0.0466	0.0431	0.0456	0.0477	0.0463	0.0473	
0.0448	0.0472	0.0465	0.0196	0.0207	0.0212	0.0200	0.0000	0.0493	0.0487	0.0475	0.0422	0.0445	0.0430	0.0410	0.0422	0.0434	0.0422	0.0456	
0.0494	0.0487	0.0488	0.0487	0.0532	0.0493	0.0491	0.0514	0.0000	0.0185	0.0197	0.0187	0.0181	0.0453	0.0452	0.0424	0.0445	0.0478	0.0471	
0.0456	0.0477	0.0496	0.0504	0.0521	0.0503	0.0515	0.0503	0.0183	0.0000	0.0195	0.0190	0.0188	0.0453	0.0442	0.0428	0.0448	0.0453	0.0454	
0.0436	0.0464	0.0442	0.0487	0.0517	0.0475	0.0483	0.0465	0.0185	0.0185	0.0000	0.0186	0.0184	0.0449	0.0454	0.0406	0.0401	0.0418	0.0410	
0.0473	0.0482	0.0481	0.0417	0.0457	0.0425	0.0425	0.0418	0.0177	0.0182	0.0188	0.0000	0.0184	0.0454	0.0470	0.0447	0.0439	0.0435	0.0412	
0.0503	0.0468	0.0455	0.0453	0.0480	0.0487	0.0448	0.0452	0.0176	0.0184	0.0191	0.0188	0.0000	0.0448	0.0469	0.0443	0.0430	0.0460	0.0444	
0.0494	0.0433	0.0464	0.0441	0.0447	0.0477	0.0476	0.0450	0.0454	0.0459	0.0479	0.0479	0.0462	0.0000	0.0294	0.0294	0.0319	0.0391	0.0409	
0.0455	0.0431	0.0438	0.0404	0.0417	0.0456	0.0440	0.0429	0.0453	0.0448	0.0484	0.0496	0.0484	0.0294	0.0000	0.0276	0.0301	0.0464	0.0489	
0.0517	0.0483	0.0474	0.0477	0.0459	0.0489	0.0490	0.0466	0.0448	0.0458	0.0458	0.0498	0.0482	0.0310	0.0291	0.0000	0.0307	0.0487	0.0483	
0.0476	0.0461	0.0449	0.0478	0.0457	0.0485	0.0493	0.0461	0.0453	0.0461	0.0435	0.0471	0.0450	0.0323	0.0306	0.0295	0.0000	0.0433	0.0429	
0.0492	0.0507	0.0512	0.0456	0.0443	0.0450	0.0453	0.0423	0.0459	0.0440	0.0428	0.0440	0.0454	0.0375	0.0445	0.0442	0.0409	0.0000	0.0206	
0.0477	0.0499	0.0509	0.0466	0.0455	0.0442	0.0462	0.0458	0.0453	0.0441	0.0420	0.0417	0.0439	0.0392	0.0468	0.0440	0.0406	0.0206	0.0000	
0.0471	0.0483	0.0465	0.0500	0.0461	0.0458	0.0470	0.0469	0.0439	0.0449	0.0439	0.0478	0.0491	0.0399	0.0452	0.0412	0.0415	0.0175	0.0189	
0.0490	0.0492	0.0458	0.0461	0.0457	0.0435	0.0475	0.0469	0.0439	0.0427	0.0424	0.0454	0.0465	0.0414	0.0409	0.0386	0.0412	0.0202	0.0194	
0.0480	0.0501	0.0500	0.0505	0.0476	0.0472	0.0491	0.0484	0.0459	0.0443	0.0420	0.0460	0.0458	0.0408	0.0459	0.0444	0.0390	0.0172	0.0160	

Table-7: Shannon’s entropy component

Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24	Item 25
0.0000	-0.0801	-0.0820	-0.0849	-0.0854	-0.0719	-0.1354	-0.1382	-0.1371	-0.1365	-0.1394	-0.1446	-0.1438	-0.1427	-0.1448	-0.1427	-0.1366	-0.1359	-0.1405	-0.1341	-0.1505	-0.1532	-0.1522	-0.1471	-0.1478
-0.0797	0.0000	-0.0822	-0.0799	-0.0809	-0.0761	-0.1404	-0.1404	-0.1456	-0.1425	-0.1387	-0.1422	-0.1416	-0.1396	-0.1382	-0.1389	-0.1372	-0.1370	-0.1432	-0.1381	-0.1443	-0.1458	-0.1425	-0.1455	-0.1428

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-0.0824	-0.0831	0.0000	-0.0804	-0.0781	-0.0723	-0.1436	-0.1348	-0.1396	-0.1371	-0.1416	-0.1441	-0.1409	-0.1468	-0.1468	-0.1459	-0.1368	-0.1299	-0.1401	-0.1433	-0.1555	-0.1500	-0.1494	-0.1487	-0.1485
-0.0828	-0.0783	-0.0780	0.0000	-0.0791	-0.0793	-0.1360	-0.1309	-0.1354	-0.1368	-0.1362	-0.1414	-0.1349	-0.1355	-0.1421	-0.1459	-0.1412	-0.1335	-0.1403	-0.1363	-0.1448	-0.1418	-0.1399	-0.1453	-0.1411
-0.0837	-0.0797	-0.0761	-0.0794	0.0000	-0.0732	-0.1394	-0.1397	-0.1386	-0.1340	-0.1415	-0.1404	-0.1395	-0.1418	-0.1446	-0.1393	-0.1294	-0.1290	-0.1345	-0.1338	-0.1484	-0.1466	-0.1428	-0.1462	-0.1457
-0.0722	-0.0767	-0.0722	-0.0815	-0.0750	0.0000	-0.1475	-0.1455	-0.1503	-0.1468	-0.1432	-0.1438	-0.1465	-0.1404	-0.1475	-0.1398	-0.1389	-0.1335	-0.1358	-0.1344	-0.1525	-0.1519	-0.1421	-0.1424	-0.1486
-0.1374	-0.1430	-0.1449	-0.1411	-0.1441	-0.1492	0.0000	-0.0779	-0.0695	-0.0730	-0.0783	-0.1451	-0.1497	-0.1514	-0.1354	-0.1410	-0.1355	-0.1277	-0.1380	-0.1417	-0.1428	-0.1448	-0.1510	-0.1445	-0.1512
-0.1380	-0.1408	-0.1339	-0.1337	-0.1421	-0.1448	-0.0766	0.0000	-0.0698	-0.0703	-0.0802	-0.1516	-0.1506	-0.1550	-0.1418	-0.1443	-0.1345	-0.1283	-0.1322	-0.1354	-0.1377	-0.1401	-0.1406	-0.1416	-0.1431
-0.1365	-0.1456	-0.1384	-0.1379	-0.1407	-0.1492	-0.0681	-0.0696	0.0000	-0.0621	-0.0814	-0.1436	-0.1468	-0.1464	-0.1347	-0.1454	-0.1404	-0.1361	-0.1376	-0.1406	-0.1390	-0.1372	-0.1398	-0.1364	-0.1419
-0.1386	-0.1454	-0.1386	-0.1422	-0.1387	-0.1487	-0.1431	-0.1417	-0.1435	0.0000	-0.0798	-0.1462	-0.1520	-0.1509	-0.1373	-0.1402	-0.1430	-0.1356	-0.1407	-0.1451	-0.1423	-0.1442	-0.1451	-0.1479	-0.1488
-0.1393	-0.1392	-0.1408	-0.1392	-0.1441	-0.1427	-0.1470	-0.1403	-0.1416	-0.1483	0.0000	-0.1483	-0.1472	-0.1447	-0.1335	-0.1385	-0.1353	-0.1309	-0.1336	-0.1362	-0.1336	-0.1409	-0.1425	-0.1441	-0.1449
-0.1487	-0.1468	-0.1474	-0.1486	-0.1471	-0.1474	-0.1471	-0.1561	-0.1483	-0.1480	-0.1526	0.0000	-0.1539	-0.1507	-0.1443	-0.1427	-0.1403	-0.1401	-0.1339	-0.1386	-0.1453	-0.1439	-0.1403	-0.1418	-0.1438
-0.1467	-0.1451	-0.1431	-0.1408	-0.1451	-0.1490	-0.1505	-0.1540	-0.1504	-0.1527	-0.1503	-0.1533	0.0000	-0.1468	-0.1452	-0.1446	-0.1402	-0.1379	-0.1350	-0.1392	-0.1402	-0.1404	-0.1413	-0.1381	-0.1394
-0.1406	-0.1381	-0.1440	-0.1366	-0.1424	-0.1379	-0.1471	-0.1531	-0.1448	-0.1464	-0.1427	-0.1438	-0.1468	0.0000	-0.1440	-0.1435	-0.1392	-0.1403	-0.1302	-0.1290	-0.1327	-0.1310	-0.1343	-0.1328	-0.1297
-0.1438	-0.1478	-0.1451	-0.1443	-0.1463	-0.1460	-0.1325	-0.1411	-0.1343	-0.1341	-0.1327	-0.1507	-0.1529	-0.1546	0.0000	-0.1534	-0.1403	-0.1438	-0.1389	-0.1373	-0.1363	-0.1315	-0.1435	-0.1402	-0.1391
-0.1440	-0.1407	-0.1465	-0.1504	-0.1433	-0.1407	-0.1402	-0.1458	-0.1473	-0.1392	-0.1399	-0.1512	-0.1536	-0.1555	-0.1547	0.0000	-0.1392	-0.1435	-0.1380	-0.1354	-0.1416	-0.1382	-0.1484	-0.1446	-0.1408
-0.1406	-0.1419	-0.1402	-0.1487	-0.1359	-0.1425	-0.1376	-0.1388	-0.1452	-0.1449	-0.1395	-0.1404	-0.1414	-0.1455	-0.1455	-0.1421	0.0000	-0.1038	-0.1036	-0.1098	-0.1267	-0.1307	-0.1315	-0.1364	-0.1330
-0.1400	-0.1417	-0.1332	-0.1407	-0.1355	-0.1371	-0.1297	-0.1325	-0.1408	-0.1374	-0.1350	-0.1403	-0.1392	-0.1466	-0.1491	-0.1465	-0.1038	0.0000	-0.0990	-0.1055	-0.1426	-0.1475	-0.1434	-0.1354	-0.1440
-0.1500	-0.1534	-0.1488	-0.1531	-0.1463	-0.1445	-0.1452	-0.1415	-0.1475	-0.1478	-0.1428	-0.1391	-0.1412	-0.1411	-0.1493	-0.1461	-0.1077	-0.1029	0.0000	-0.1070	-0.1471	-0.1464	-0.1395	-0.1351	-0.1460
-0.1395	-0.1443	-0.1483	-0.1450	-0.1418	-0.1394	-0.1452	-0.1411	-0.1468	-0.1485	-0.1419	-0.1401	-0.1418	-0.1363	-0.1438	-0.1396	-0.1110	-0.1066	-0.1040	0.0000	-0.1360	-0.1352	-0.1365	-0.1373	-0.1303
-0.1505	-0.1450	-0.1548	-0.1481	-0.1513	-0.1521	-0.1409	-0.1380	-0.1396	-0.1401	-0.1338	-0.1414	-0.1375	-0.1348	-0.1373	-0.1405	-0.1231	-0.1385	-0.1379	-0.1308	0.0000	-0.0799	-0.0703	-0.0793	-0.0691
-0.1534	-0.1466	-0.1495	-0.1452	-0.1495	-0.1516	-0.1429	-0.1405	-0.1379	-0.1421	-0.1412	-0.1401	-0.1377	-0.1331	-0.1326	-0.1371	-0.1270	-0.1434	-0.1373	-0.1301	-0.0799	0.0000	-0.0746	-0.0771	-0.0654
-0.1531	-0.1440	-0.1496	-0.1439	-0.1464	-0.1426	-0.1499	-0.1418	-0.1413	-0.1437	-0.1436	-0.1373	-0.1393	-0.1372	-0.1454	-0.1480	-0.1285	-0.1401	-0.1314	-0.1320	-0.1708	-0.0750	0.0000	-0.0761	-0.0708

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-0.1464	-0.1453	-0.1473	-0.1478	-0.1481	-0.1413	-0.1418	-0.1411	-0.1363	-0.1448	-0.1435	-0.1371	-0.1346	-0.1340	-0.1405	-0.1426	-0.1317	-0.1307	-0.1257	-0.1313	-0.0788	-0.0765	-0.0752	0.0000	-0.0795
-0.1494	-0.1450	-0.1494	-0.1458	-0.1501	-0.1498	-0.1507	-0.1449	-0.1440	-0.1481	-0.1467	-0.1414	-0.1381	-0.1331	-0.1416	-0.1411	-0.1306	-0.1414	-0.1382	-0.1266	-0.0700	-0.0661	-0.0712	-0.0810	0.0000

Table-8: Relative weights through hierarchical cluster-based entropy method

Items	Entropy Index	Degree of Diversification	RW_Item	Rank	Dimensions	Relative Wt. of Dimension
Item l	0.9746	0.0254	0.0433	7	Licensing and User Accessibility	0.2386
Item 2	0.9747	0.0253	0.0432	8		
Item 3	0.9737	0.0263	0.0449	2		
Item 4	0.9752	0.0248	0.0423	14		
Item 5	0.9746	0.0254	0.0434	6		
Item 6	0.9722	0.0278	0.0475	1		
Item 7	0.9750	0.0250	0.0426	11	Support and Compliance Services	0.2086
Item 8	0.9754	0.0246	0.0421	16		
Item 9	0.9741	0.0259	0.0442	5		
Item 10	0.9740	0.0260	0.0444	3		
Item 11	0.9775	0.0225	0.0384	21		
Item 12	0.9749	0.0251	0.0428	10	Safety and Emergency Management	0.2002
Item 13	0.9752	0.0248	0.0424	13		
Item 14	0.9759	0.0241	0.0412	19		
Item 15	0.9755	0.0245	0.0418	18		
Item 16	0.9754	0.0246	0.0420	17		
Item 17	0.9852	0.0148	0.0252	24	Penalty Management	0.1506
Item 18	0.9849	0.0151	0.0258	23		
Item 19	0.9847	0.0153	0.0261	22		
Item 20	0.9853	0.0147	0.0250	25		
Item 21	0.9753	0.0247	0.0422	15	Public Awareness	0.2021
Item 22	0.9751	0.0249	0.0424	12		
Item 23	0.9749	0.0251	0.0429	9		
Item 24	0.9770	0.0230	0.0393	20		
Item 25	0.9740	0.0260	0.0443	4		

The hierarchical clustering based on the Entropy Method reveals that “Licensing and User Accessibility” remains the most influential dimension with a relative weight of 23.86%, followed by “Support and Compliance Services” and “Public Awareness.” “Penalty Management” contributes the least at 15.06% due to high entropy values, indicating low variability. Item6 emerged as the most informative (RW = 0.0475), followed by Items 3, 10, 25, and 9. Conversely, Items 17 through 20, associated with Penalty Management, show minimal differentiation and carry the lowest weights. This entropy-based approach emphasizes items and dimensions that provide greater diversity in data, ensuring more meaningful and impactful clustering.

4.5 Comparison of Methods

In the study, relative weights of the criteria are determined through hierarchical cluster-based CRITIC and ENTROPY methods.

Table-9: Relative weights comparison

Items	Description	CRITIC		ENTROPY	
		RW_Item	Rank	RW_Item	Rank
Item l	Clarity of Licensing Procedures	0.0394	16	0.0433	7
Item 2	Timeliness of License Issuance	0.0400	12	0.0432	8
Item 3	Transparency in Testing and Evaluation	0.0421	4	0.0449	2
Item 4	Accessibility of Licensing Services	0.0394	15	0.0423	14
Item 5	Ease of Access to Registration Sendees	0.0387	21	0.0434	6
Item 6	User-Friendliness of Online Platforms	0.0390	18	0.0475	1

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Items	Description	CRITIC		ENTROPY	
		RW_Item	Rank	RW_Item	Rank
Item 7	Support from Staff Dining Registration	0.0413	6	0.0426	11
Item 8	Clarity of Registration Procedures	0.0410	8	0.0421	16
Item 9	Timeliness of Peimit Issuance	0.0428	2	0.0442	5
Item 10	Compliance wiii Legal and Safety Standards	0.0432	1	0.0444	3
Item11	Support for Permit-Related Queries	0.0403	11	0.0384	21
Item 12	Adequacy of Information Provided on Permits	0.0427	3	0.0428	10
Item 13	Ease of Payment Process	0.0411	7	0.0424	13
Item 14	Competitive Tax Rates	0.0378	23	0.0412	19
Item 15	Customer Satisfaction Across Borders	0.0398	13	0.0418	18
Item 16	Intact of Tax Incentives on Adoption of Green Initiatives	0.0389	19	0.0420	17
Item 17	User Satisfaction with Penalty Procedures	0.0368	24	0.0252	24
Item 18	Use of Penalty Revenue for Public Benefits	0.0385	22	0.0258	23
Item 19	Digital Integration in Penalty Management	0.0391	17	0.0261	22
Item 20	Educational Campaigns on Penalties	0.0362	25	0.0250	25
Item 21	Road Accident Data Collection and Analysis	0.0407	10	0.0422	15
Item 22	Inspection and Maintenance of Vehicles	0.0395	14	0.0424	12
Item 23	Speed Monitoring and Control	0.0410	9	0.0429	9
Item 24	Collaboration with Other Departments	0.0389	20	0.0393	20
Item 25	Availability of Emergency Response Sendees	0.0421	5	0.0443	4

Correlation of the relative weights of items are determined through correlation and the results are presented in Table–10.

Table-10. Correlation of methods

Method	Hierarchical based CRITIC	Hierarchical based ENTROPY
Hierarchical Custer based CRITIC	1.000	0.627
Hierarchical cluster-based ENTROPY	0.627	1.000

The correlation coefficient of 0.627 between hierarchical clustering results using CRITIC and Entropy methods indicates a moderate degree of agreement. This suggests that while both approaches lead to somewhat similar item groupings, their underlying weighting philosophies cause noticeable differences in the final cluster structures. CRITIC emphasizes criteria with high contrast and low redundancy, whereas Entropy values diversity in the data without accounting for inter-criteria relationships. As a result, certain items may shift clusters depending on the method used, highlighting the influence of weighting schemes in multi-criteria clustering analyses.

Since, the relative weights of the items of service delivery and user satisfaction in transport department are significantly correlated, the expected weight is calculated through three-point estimate and presented in the following Table-11.

Table-11: Expected weights of the determinants

Items	RW_Item of CRITIC	RW_Item of Entropy	Ensembling Weight	Expected Weight
Item l	0.0394	0.0433	0.0414	0.0414
Item 2	0.0400	0.0432	0.0416	0.0416
Item 3	0.0421	0.0449	0.0435	0.0435
Item 4	0.0394	0.0423	0.0409	0.0409
Item 5	0.0387	0.0434	0.0411	0.0410
Item 6	0.0390	0.0475	0.0433	0.0432
Item 7	0.0413	0.0426	0.0420	0.0419
Item 8	0.0410	0.0421	0.0416	0.0415
Item 9	0.0428	0.0442	0.0435	0.0435

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Items	RW_Item of CRITIC	RW_Item of Entropy	Ensembling Weight	Expected Weight
Item 10	0.0432	0.0444	0.0438	0.0438
Item11	0.0403	0.0384	0.0394	0.0394
Item 12	0.0427	0.0428	0.0428	0.0427
Item 13	0.0411	0.0424	0.0418	0.0417
Item 14	0.0378	0.0412	0.0395	0.0395
Item 15	0.0398	0.0418	0.0408	0.0408
Item 16	0.0389	0.0420	0.0405	0.0404
Item 17	0.0368	0.0252	0.0310	0.0310
Item 18	0.0385	0.0258	0.0322	0.0322
Item 19	0.0391	0.0261	0.0326	0.0326
Item 20	0.0362	0.0250	0.0306	0.0306
Item 21	0.0407	0.0422	0.0415	0.0415
Item 22	0.0395	0.0424	0.0410	0.0410
Item 23	0.0410	0.0429	0.0420	0.0420
Item 24	0.0389	0.0393	0.0391	0.0391
Item 25	0.0421	0.0443	0.0432	0.0432

4.5.1 Analysis of variance

ANOVA is implemented using Minitab to know the significance of the methods and criteria. The results are presented below.

Table-12: ANOVA results

Source	DF	Adj	SS	Adj	MS	F-Value	P-Value
Method	2	0	0	0	1	0.000	1.000
Error	72	0.001523	2E-05				
Total	74	0.001523					

There is no statistically significant difference between the methods under comparison. The ANOVA results clearly show that the variation due to different methods is negligible.

CONCLUDING REMARKS

This study systematically identified and prioritized key service delivery and user satisfaction determinants in the Transport Department by integrating Hierarchical Clustering, and Multi-Criteria Decision-Making (MCDM) methods, particularly CRITIC and Entropy. The clustering results revealed meaningful groupings of related constructs, while the application of CRITIC and Entropy provided objective and complementary weighting strategies. The moderate correlation between CRITIC-based and Entropy-based clustering indicates consistency in overall trends but also highlights methodological sensitivity in prioritization outcomes. Furthermore, the ANOVA and model summary results suggest no significant statistical difference between the outputs of the methods, supporting the validity and robustness of the prioritization framework. Overall, this integrative approach offers a data-driven foundation for strategic planning, with the Licensing and User Accessibility dimension emerging as a top priority, followed by Support and Compliance Services and Public Awareness. These insights are crucial for evidence-based policy decisions, enabling the department to allocate resources more effectively and enhance user satisfaction through targeted interventions.

Inclusion of Fuzzy Logic or Hybrid MCDM Models: To handle uncertainty and imprecision in stakeholder judgments, fuzzy MCDM techniques or hybrid models combining AHP, DEMATEL, and TOPSIS can be explored. Linking the prioritized factors with key performance indicators (KPIs) could further validate their real-world impact and support outcome-based governance.

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APPENDIX

QUESTIONNAIRE

Section 1: Please rate the following statements based on your experience with licensing services, using the scale below:

Scale: 1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

1. Clarity of Licensing Procedures:
    - "The licensing procedures of the transport department are clear and easy to understand."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

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2. Timeliness of License Issuance:
    - "The transport department processes and issues licenses within the promised time frame."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
3. Transparency in Testing and Evaluation:
    - "The driving tests and evaluations for obtaining a license are conducted fairly and transparently."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
4. Accessibility of Licensing Services:
    - "The licensing services of the transport department are easily accessible through multiple channels."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
5. Ease of Access to Registration Services:
    - "The vehicle registration services are easily accessible through online platforms or physical offices."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
6. User-Friendliness of Online Platforms:
    - "The online platform for vehicle registration is user-friendly and efficient."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
7. Support from Staff During Registration:
    - "The staff at the transport department are helpful and responsive during the vehicle registration process."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
8. Clarity of Registration Procedures:
    - "The steps and documentation required for vehicle registration are clearly communicated and easy to understand."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
9. Timeliness of Permit Issuance:
    - "The transport department issues permits within the promised time frame."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10. Compliance with Legal and Safety Standards:
    - "The permits issued by the transport department comply with all legal and safety standards."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
11. Support for Permit-Related Queries:
    - "The transport department provides prompt and helpful responses to permit-related queries."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
12. Adequacy of Information Provided on Permits:
    - "The permits issued include all necessary information, such as terms, validity, and conditions."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

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13. Ease of Payment Process:
    - "The tax payment process is user-friendly and efficient."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
14. Competitive Tax Rates:
    - "The transport department's tax rates are fair and comparable to those in other states."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
15. Customer Satisfaction Across Borders:
    - "The transport department's tax-related services are convenient for users dealing with interstate vehicles."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
16. Impact of Tax Incentives on Adoption of Green Initiatives:
    - "The tax incentives provided by the transport department encourage the adoption of environmentally friendly practices, like using electric vehicles."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
17. User Satisfaction with Penalty Procedures:
    - "I am satisfied with the penalty procedures implemented by the transport department."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
18. Use of Penalty Revenue for Public Benefits:
    - "The penalty revenues collected by the transport department are used effectively for public benefits, such as road safety."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
19. Digital Integration in Penalty Management:
    - "The transport department provides a reliable and efficient online platform for managing penalties."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
20. Educational Campaigns on Penalties:
    - "The transport department organizes effective campaigns to raise awareness about penalties and legal compliance."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
21. Road Accident Data Collection and Analysis:
    - "The transport department uses road accident data effectively to improve road safety measures."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
22. Inspection and Maintenance of Vehicles:
    - "The transport department enforces regular vehicle inspections to ensure road safety."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
23. Speed Monitoring and Control:
    - "The transport department effectively monitors and controls speeding to improve road safety."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
24. Collaboration with Other Departments:

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- "The transport department collaborates effectively with other departments (e.g., police, health) to improve road safety."
  ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

25. Availability of Emergency Response Services:
    - "The transport department ensures quick and effective emergency response services for road accidents."
      ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Section 2: Demographics

1. Age Group:
    - ☐ Under 18
    - ☐ 18–30
    - ☐ 31–50
    - ☐ Above 50
2. Gender:
    - ☐ Male
    - ☐ Female
    - ☐ Prefer not to say
3. Stakeholder Category:
    - ☐ Individual Applicant (e.g., first-time license seeker, renewal)
    - ☐ Driving School Representative
    - ☐ Transport Operators
    - ☐ General Public
    - ☐ Other (please specify): _____
4. Mode of Interaction with Licensing Services:
    - ☐ Online services
    - ☐ In-person services
    - ☐ Both