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Analysis of Transport Department Services: Insights from Exploratory and Confirmatory Factor Analysis

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Abstract:

This work presents a comprehensive analysis of transport services using both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) to identify and validate key dimensions influencing service efficiency and user satisfaction. Data was collected on 25 measurement items across six constructs, including Licensing, Registration, Permits, Taxes, Penalties, and Road Safety. EFA was employed to explore the underlying structure of the data and to group related items under cohesive factors. The results identified five distinct factors, namely Service Access, Process Support, Safety Operations, Eco Efficiency, and Penalty Awareness. CFA was then utilized to validate the factor structure and assess the model's fit to the observed data. The findings highlight critical areas for improvement in transport services, such as streamlining processes, enhancing accessibility, ensuring compliance, and promoting road safety initiatives. This study offers actionable insights for policymakers and stakeholders to optimize service delivery and enhance user satisfaction in transport management systems.

Keywords:CFA, Transport management systems, Confirmatory factor analysis

1. Introduction

Transport services play a pivotal role in facilitating mobility, ensuring compliance with regulatory frameworks, and promoting road safety. Effective management of transport-related activities, such as licensing, vehicle registration, permits, tax collection, penalty enforcement, and road safety measures, is essential for enhancing user satisfaction and operational efficiency. The increasing complexity of these services, driven by technological advancements and growing user expectations, necessitates a structured approach to evaluate and improve their performance.

Evaluating the performance of road transport departments, which are responsible for enforcing transport-related regulations, is crucial for ensuring effective governance and public satisfaction. This literature review examines methodologies and frameworks pertinent to assessing such public sector transport enforcement agencies.

The Department for Transport needs to establish comprehensive strategies for monitoring and evaluating transport services. Monitoring and Evaluation Strategy outlines a framework aimed at integrating high-quality evidence into departmental decision-making processes. This strategy

emphasizes the importance of systematic learning from past and current activities to enhance future transport initiatives.

The International Road Assessment Programme (iRAP) provides a framework for assessing road infrastructure safety, which can indirectly reflect the performance of transport departments responsible for road safety enforcement. iRAP focuses on identifying high-risk roads and recommending safety improvements, thereby contributing to the overall assessment of transport service quality.

Monitoring and evaluation in the public sector, particularly within transport agencies, present several challenges. These include resource constraints, data collection difficulties, and the need for specialized expertise. Addressing these challenges is essential for developing effective monitoring and evaluation systems that can inform policy decisions and improve service delivery.

Implementing robust monitoring and evaluation frameworks enables transport departments to identify areas requiring improvement, allocate resources efficiently, and enhance overall performance. By adopting best practices from established frameworks

This chapter investigates the key dimensions of transport services through the application of both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). EFA is employed to uncover the latent structure of the data, grouping related items into cohesive factors that represent distinct dimensions of service efficiency and user experience. CFA is then used to validate these factors, ensuring their alignment with theoretical constructs and assessing the model's goodness-of-fit.

The study focuses on six critical constructs of transport services: Licensing, Registration, Permits, Taxes, Penalties, and Road Safety. Data was collected on 25 measurement items, each designed to capture specific aspects of these constructs, such as clarity, accessibility, timeliness, compliance, and user satisfaction. The analysis revealed five key factors—Service Access, Process Support, Safety Operations, Ecoefficiency, and Penalty Awareness—that encapsulate the core dimensions of transport service delivery.

Efficient transport service management is crucial for urban development, directly influencing user satisfaction, regulatory compliance, and safety outcomes. Research in this domain often emphasizes service quality dimensions such as accessibility, clarity, timeliness, and technological integration.

Licensing and Registration Services

Studies highlight the importance of clear procedures and user-friendly platforms in licensing and registration processes. Digital transformation in these areas significantly enhances user satisfaction and reduces delays.

Permit Management

The role of compliance with legal standards is vital in building trust among users. Providing timely and detailed permit information fosters a transparent and efficient service environment.

Tax Efficiency and Incentives

The impact of tax-related services on user satisfaction focuses on the ease of payment systems and the fairness of tax rates. Research also investigates the role of eco-friendly tax incentives in promoting sustainable practices, such as the adoption of electric vehicles.

Penalty Management

Digital integration in penalty management, such as online systems for penalty payments and disputes, improves user convenience. Public awareness campaigns are effective in promoting compliance and fostering positive perceptions of penalty enforcement.

Road Safety Initiatives

Data-driven approaches to accident analysis are essential for implementing integrated road safety measures. Collaborative efforts between transport departments and other agencies enhance the effectiveness of these initiatives.

1.1 Factor Analysis in Transport Research

Factor analysis is widely applied in transport research to identify and validate key service dimensions. Exploratory Factor Analysis (EFA) uncovers latent constructs, while Confirmatory Factor Analysis (CFA) ensures the reliability and validity of measurement models.

This chapter not only provides insights into the structural relationships among the various aspects of transport services but also highlights areas for improvement to enhance efficiency and user satisfaction. By integrating EFA and CFA methodologies, the study offers a robust framework for evaluating and optimizing transport service management systems.

2. Literature Review

Efficient transport service management is crucial for urban development, directly influencing user satisfaction, regulatory compliance, and safety outcomes. Research in this domain often emphasizes service quality dimensions such as accessibility, clarity, timeliness, and technological integration.

Parasuraman et al (1988) introduced SERVQUAL, a widely used model to measure service quality using factor analysis. The methodology can be adapted to transport services to evaluate efficiency and satisfaction.

Pullen (1993) explored approaches to defining and assessing quality management processes in local public transportation. The research analyzed various evaluation methods, such as passenger waiting times, lost mileage, and an expanded range of performance measures and indices.

Tyrinopoulos, Y., and Antoniou, C. (2008) examined public transport user satisfaction using factor analysis, identifying factors that affect transit service performance.

Blanquart and Burmeister (2009) developed an alternative framework for evaluating freight transport performance, emphasizing diverse service configurations, each with unique performance indicators, rather than relying solely on traditional productivity measures

Fabrigar and Wegener (2011) employed Exploratory and Confirmatory Factor Analyses on the Teacher's Evaluation of Student's Conduct Questionnaire (TESC). Chen, C., and Lai, W. T. (2011) used factor analysis and SEM to examine how different dimensions of service quality impact user satisfaction in public transport. Andrews, R., Boyne, G. A., and Walker, R. M. (2011) Used factor analysis to develop an empirical model of public service efficiency.

Bachok, S., Osman, M. M., and Ponrahono, Z. (2014) used factor analysis to identify key determinants of public transport service quality, offering policy recommendations

Yaya et al (2015) identified functional, convenience, and physical environment quality as key dimensions of public transport service quality, influenced by demographic factors like age, education, and license ownership. Younger commuters perceive lower service quality, while educated individuals are more responsive to quality-focused appeals.

de Oña, J., & de Oña, R. (2015) reviewed different methodological approaches, including factor analysis, SEM, and CFA, used to assess public transport service quality.

Ugo, F., & Usman, U. M. (2016) applied factor analysis to assess the efficiency of road transport services in Nigeria, highlighting factors influencing user satisfaction.

The study made by Abenoza et al (2017) analysed nearly half a million records to identify key determinants of public transport satisfaction among five traveller segments in Sweden, emphasizing the importance of customer interface, operations, and network attributes, with tailored recommendations for each group

Javid, M. A., & Sayed, T. (2018) Explored road safety performance evaluation through factor analysis. Kral et al (2018) identified key factors influencing public transport satisfaction and decision-making using statistical methods, offering insights for improving service management and customer retention.

Yu, J., and Lee, H. (2019) examined transport policy effectiveness and public satisfaction using CFA and SEM techniques.

Kilibarda et al (2020) made a systematic literature review of 98 papers across 56 journals identifies three primary research focuses in Logistics Service Quality (LSQ), analyzing commonly used dimensions and measurement approaches. Findings indicate a predominance of empirical studies reporting low LSQ levels, providing a foundation for future research and practical applications in transport and logistics.

Public transport performance assessment methods include: (1) evaluating operational variables; (2) assessing user perceptions of service quality; and (3) integrating both approaches with outcome-oriented variables (Verma and Rastogi, 2022). A generalized methodology suitable for evaluating transit performance is also presented, with a focus on the approaches prevalent in India

Sogbe et al (2024) made a systematic review of 104 papers published since 2000 identifies safety, security, comfort, reliability, and accessibility as key determinants influencing bus transport usage. The study highlights challenges in first mile and last-mile connectivity, particularly in developing countries, and suggests further research to address these issues.

3. Transport Department

The Transport Department operates under the provisions of Sections of the Motor Vehicle Act. It is primarily tasked with enforcing the Motor Vehicle Act, and the associated rules and regulations. Among the various modes of transport, road transport stands out as the most effective for relatively short distances, particularly for connecting rural areas with towns and cities, where other forms of transport are less feasible.

In this context, the Transport Department collaborates with other organizations to enhance transport infrastructure and strives to ensure the provision of efficient, adequate, and economical road transport services for passengers and goods. In fulfilling its statutory responsibilities, the department has evolved into a significant revenue-generating entity for the government through the collection of motor vehicle taxes. Various functions of the department are presented below.

Licensing: The Licensing function of the transport department focuses on ensuring clarity in licensing procedures by simplifying the process and making it easy to understand. It emphasizes timely issuance of licenses by processing applications within the promised timeframe. Transparency is a key aspect, as driving tests and evaluations are conducted fairly and objectively. Additionally, the department ensures that licensing services are accessible through multiple channels, including both online platforms and physical offices.

Registration: The Registration function streamlines the vehicle registration process to make it accessible and convenient for users. Services are offered through online platforms and physical offices, with an emphasis on user-friendly systems. The department provides clear guidelines and documentation requirements to prevent confusion and ensures staff are supportive and responsive during the registration process.

Permits: The Permits function ensures timely issuance of permits while adhering to legal and safety standards. The department is responsive to permit-related queries and provides complete and clear information regarding terms, validity, and conditions associated with permits. This transparency helps users navigate the permit process effectively.

Taxes: The Taxes function prioritizes ease of payment by offering efficient systems for both online and in-person tax payments. It ensures that tax rates are fair and competitive compared to other states, fostering compliance. Services are also tailored to facilitate interstate vehicle registrations and tax payments, enhancing customer satisfaction. Furthermore, the department promotes eco-friendly practices by providing tax incentives for adopting electric and hybrid vehicles.

Penalties: The Penalties function focuses on fairness and efficiency in managing penalties, ensuring users are satisfied with the procedures. Revenue from penalties is utilized effectively for public benefits, such as improving road safety or transport infrastructure. The department provides a digital platform for users to check, pay, or dispute penalties conveniently and organizes educational campaigns to raise awareness about legal compliance and the consequences of violations.

Road Safety: The Road Safety function plays a crucial role in improving safety measures. The department collects and analyses road accident data to implement preventive strategies. It ensures vehicle fitness through regular inspections and enforces speed monitoring systems to reduce speeding. Collaboration with police, health, and other departments enhances the effectiveness of integrated road safety initiatives. Additionally, the department ensures the availability of emergency response services to provide quick assistance during road accidents.

4. Research Methodology

The research methodology followed in this study consists of “identification of model variables with a comprehensive literature review, validation of literature review results with illustrative case study,

and questionnaire survey to construct model, analysis of data, and model creation with Factor Analysis and Validation through Confirmatory factor analysis. In this study, two research methods were used. Firstly, Factor Analysis used as a data reduction technique to simplify large datasets by identifying a smaller set of underlying dimensions (factors) that capture most of the variance in the observed variables. Then The factors identified through Factor Analysis (FA), which reveal the underlying structure of the data, are subsequently validated using Confirmatory Factor Analysis (CFA) to confirm the hypothesized relationships and ensure the robustness, reliability, and validity of the measurement model. The methodology is explained in the following steps.

Step 1: Identification of model variables: The selection of variables should be grounded in existing literature, theories, or prior research to ensure a sound conceptual basis.

Step 2: Design the Questionnaire survey: After identifying model variables, is designing a **questionnaire survey** to collect data. A well-designed questionnaire ensures that the observed variables accurately capture the underlying constructs, facilitating reliable and valid results in subsequent analyses.

Step 3: Data Collection: The questionnaire survey designed in the previous step is administered to gather responses from participants. This step is critical as the quality, accuracy, and representativeness of the collected data directly impact the validity and reliability of the subsequent analyses

Step 4: Conduct the Factor analysis: At the end of this step, the factors are identified, labelled, and validated, providing a clear understanding of the latent constructs in the data. The identified factors can now be used in subsequent analyses, such as Confirmatory Factor Analysis (CFA), to test and validate the measurement model. Factor analysis is conducted using SPSS 20.0

Step 5: Analyse the results of FA: The results of the factor analysis are interpreted, validated, and aligned with the research objectives. The finalized factor structure provides a simplified, meaningful representation of the dataset, ready for further validation or integration into more advanced analyses

Step 6: Conduct Confirmatory Factor analysis: After identifying and interpreting factors through Factor Analysis (FA), the next step is to perform Confirmatory Factor Analysis (CFA) to validate the factor structure. CFA is a hypothesis-driven technique used to confirm whether the observed variables reliably measure the latent constructs identified in FA. This step ensures the robustness, reliability, and validity of the measurement model, aligning it with theoretical expectations.

Step 7: Analyse the results of CFA: The results of the CFA are thoroughly analysed, and the validated measurement model is finalized. The findings confirm that the constructs are reliable, valid, and appropriately measured by their observed variables.

Step 8: Report Findings: Concise summary of the factor analysis (FA) and confirmatory factor analysis (CFA) findings is needed to highlight the factors retained, their reliability, validity, and the fit of the final model. Also, findings contribute to the existing body of knowledge? and how can the results be applied in real-world contexts (e.g., policymaking, organizational improvement)?

5. Case Study

This empirical case study evaluates the effectiveness of the Transport Department's services across licensing, registration, permits, taxes, penalties, and road safety based on user feedback. Questionnaire is distributed to 400 persons out of which 377 usable surveys are received. The survey is conducted in a major city in Andhra Pradesh. The questionnaire is presented in Appendix3.1. There are 25 statements under 6 functions of the department. To measure these functions, indicators were evaluated by respondents according to a 1 to 5-point Likert scale. Demographics are presented in table 1

Table 1: Demographics

Category	Sub-Category	Number of Respondents	Percentage (%)
Age Groups (years)	18 to 30	150	39.8
	31 to 50	131	34.7
	Above 51	96	25.5
Gender	Male	217	57.6
	Female	150	39.8
	Prefer not to say	10	2.7
Stakeholder Categories	Individual Applicants	188	49.9
	Transport Operators	77	20.4
	Driving School Representatives	61	16.2
	General Public	51	13.5
Mode of Interaction	Online	226	60
	In-person	113	30
	Both	37	10

5.1 Data on the model variables: In the Study, items under 6 functions are considered and presented in table 2.

Table 2: 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 Sen· ices
ITEM 5	Ease of Access to Registration Services
ITEM 6	User-Friendliness of Online Platforms
ITEM 7	Support from Staff Dining 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 Permits
ITEM 13	Ease of Payment Process
ITEM 14	Competitive Tax Rates
ITEM 15	Customer Satisfaction Across Borders

S. No.	Measurement items
ITEM 16	Intact 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
ITEM 24	Collaboration with Ollier Departments
ITEM 25	Availability of Emergency Response Services

Data on the measurement items collected from the survey are presented in appendix A.2. Basic statics of the items are presented in table 3.3

5.1.1 Explanatory Factor Analysis (EFA)

Tabachnick and Fidell (2001) propose a general guideline that a minimum of 300 cases is required for factor analysis. Hair et al. (1995) recommend a sample size of at least 100. Comrey (1973) offers a more detailed classification, rating sample sizes as follows: 100 as poor, 200 as fair, 300 as good, 500 as very good, and 1000 or more as excellent. In this study 377 samples are considered. Basic statistics of the survey is presented in table 3.

Table 3: Basic Statistics of the Survey

Variable	N	Mean	Std.dev	Minimum	Q1	Median	Q3	Maximum
Item 1	377	2.8355	0.6838	1	3	3	3	5
Item 2	377	2.8806	0.6988	1	3	3	3	5
Item 3	377	2.878	0.7264	1	3	3	3	5
Item 4	377	2.8568	0.7076	1	3	3	3	5
Item 5	377	2.8462	0.6901	1	3	3	3	5
Item 6	377	2.8408	0.6733	1	3	3	3	4
Item 7	377	2.8223	0.6863	1	3	3	3	4
Item 8	377	2.8408	0.6733	1	3	3	3	4
Item 9	377	2.8833	0.7595	1	3	3	3	5
Item 10	377	2.8435	0.7325	1	3	3	3	5
Item 11	377	2.8408	0.7004	1	3	3	3	4
Item 12	377	2.8515	0.7816	1	3	3	3	5
Item 13	377	2.878	0.6926	1	3	3	3	4
Item 14	377	2.8541	0.6704	1	3	3	3	5
Item 15	377	2.8462	0.6978	1	3	3	3	5
Item 16	377	2.8462	0.6666	1	3	3	3	5
Item 17	377	3.2812	0.6688	1	3	3	4	5
Item 18	377	3.305	0.6398	2	3	3	4	5
Item 19	377	3.3103	0.616	2	3	3	4	4
Item 20	377	3.3236	0.5937	2	3	3	4	4
Item 21	377	2.8223	0.7054	1	3	3	3	4

Item 22	377	2.8859	0.6844	1	3	3	3	5
Item 23	377	2.8621	0.7049	1	3	3	3	5
Item 24	377	2.8196	0.6798	1	3	3	3	4
Item 25	377	2.809	0.7188	1	3	3	3	5

Varimax rotation which was developed by (Thompson 2004) is the most common form of rotational methods for exploratory factor analysis and will often provide a simple structure that produces a more interpretable and simplified solution

6. Results and Discussion

EFA was performed using SPSS (IBM Corp, 2020) statistical software packages. To evaluate the appropriateness of the data for factor analysis, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity were applied. Initially, Exploratory Factor Analysis (EFA) was conducted without rotation, utilizing maximum likelihood extraction and retaining factors with eigenvalues greater than 1. Furthermore, EFA was also performed using varimax rotation.

The results so obtained are discussed below.

Table 4: KMO and Bartlett's test Results

KMO measure		0.867
Bartlett's Test of Sphericity	Approx. Chi-Square	5052.67
	Degrees of freedom	300
	Significance	0

The KMO measure serves as an index that evaluates how well each variable in a dataset is predicted by the other variables without error. A value closer to 1 signifies a greater proportion of variance that may be attributed to common variance, indicating suitability for factor analysis. A KMO value of 0.867 is regarded as excellent, suggesting that a significant portion of the variance in the variables can be accounted for by underlying factors, making factor analysis an appropriate method for the data.

Bartlett's Test of Sphericity assesses whether the correlation matrix is an identity matrix, indicating unrelated variables unsuitable for factor analysis. A significant p-value (< 0.05) rejects this null hypothesis. In this case, the p-value is 0, confirming significant relationships among variables and supporting the suitability of factor analysis.

Table 5: Communalities

Factor	Extraction
F1	0.658
F2	0.673
F3	0.680
F4	0.674
F5	0.683
F6	0.731
F7	0.715
F8	0.712

Factor	Extraction
F9	0.754
F10	0.745
F11	0.648
F12	0.716
F13	0.708
F14	0.718
F15	0.739
F16	0.718
F17	0.516
F18	0.592
F19	0.582
F20	0.498
F21	0.712
F22	0.717
F23	0.727
F24	0.661
F25	0.746

Above table shows the communalities from an exploratory factor analysis (EFA) it is suggested that these variables correlate well with the factors extracted and are satisfactorily represented within the factor structure.

Table 6: Eigen Values and Loadings

	Initial Eigenvalues			Loadings			Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.545	22.180	22.180	5.545	22.180	22.180	4.086	16.343	16.343
2	3.596	14.384	36.564	3.596	14.384	36.564	3.607	14.427	30.771
3	3.173	12.691	49.255	3.173	12.691	49.255	3.591	14.365	45.135
4	2.860	11.438	60.694	2.860	11.438	60.694	3.554	14.215	59.350
5	1.849	7.396	68.090	1.849	7.396	68.090	2.185	8.740	68.090

Above table shows the components having eigen values >1.0. The results support retaining five factors, as each contributes significantly to explaining the variance in the dataset, with a cumulative total of over 68% variance explained. Each factor likely represents a distinct underlying construct. The factor loadings for each variable on these factors to interpret what each factor represents need to be examined.

Table 7: Rotated Component Matrix

	Component				
	1	2	3	4	5
Item l	0.801				
Item 2	0.814				
Item 3	0.819				
Item 4	0.804				

	Component				
	1	**2**	**3**	**4**	**5**
Item 5	0.810				
Item 6	0.850				
Item 7		0.839			
Item 8		0.825			
Item 9		0.858			
item 10		0.859			
Item 11		0.789			
Item 12				0.843	
Item 13				0.833	
Item 14				0.821	
Item 15				0.837	
Item 16				0.841	
Item 17					0.687
Item 18					0.744
Item 19					0.760
Item 20					0.683
Item 21			0.829		
Item 22			0.835		
Item 23			0.846		
Item 24			0.793		
Item 25			0.858		

The Rotated Component Matrix indicates how each question (item 1 through item 25) loads on five distinct components, following a factor rotation. This matrix is essential in identifying which questions share common underlying factors and how they group together.

Factor 1: Licensing and User Accessibility (Items 1 to 6)

This factor focuses on ensuring efficient and user-friendly licensing and registration processes. It includes the clarity of licensing procedures, timeliness of license issuance, transparency in testing and evaluation, accessibility of licensing services, ease of access to registration services, and user-friendliness of online platforms. The emphasis is on providing accessible and efficient systems for users to navigate licensing and registration processes.

Factor 2: Support and Compliance Services (Items 7 to 11)

This factor emphasizes the quality of support services and adherence to legal and safety standards. It includes support from staff during registration, clarity of registration procedures, timeliness of permit issuance, compliance with legal and safety standards, and support for permit-related queries. The focus is on ensuring user satisfaction while maintaining compliance and addressing user concerns effectively.

Factor 3: Information and Financial Systems (Items 12 to 16)

This factor deals with the adequacy and efficiency of information and financial systems. It includes the adequacy of information provided on permits, ease of payment processes, competitive tax rates,

customer satisfaction across borders, and the impact of tax incentives on green initiatives. The focus is on ensuring reliable information systems and financial processes to support customer satisfaction and encourage sustainable practices.

Factor 4: Penalty Management and Public Awareness (Items 17 to 20)

This factor focuses on effective penalty administration and increasing public awareness. It includes user satisfaction with penalty procedures, the use of penalty revenue for public benefits, digital integration in penalty management, and educational campaigns on penalties. The aim is to ensure fair and transparent penalty management while promoting public understanding and acceptance of the system.

Factor 5: Safety and Emergency Management (Items 21 to 25)

This factor highlights the importance of safety measures and emergency response systems. It includes road accident data collection and analysis, inspection and maintenance of vehicles, speed monitoring and control, collaboration with other departments, and availability of emergency response services. The aim is to enhance safety standards and preparedness for emergencies through systematic management.

6.1. Confirmatory Factor Analysis (CFA)

Integrating EFA with CFA is beneficial as EFA provides data-driven insights into the underlying structure of the variables, while CFA validates this structure within a hypothesis-driven framework. In this study, CFA is employed to confirm and validate the factor structure identified through EFA. Specifically, CFA tests whether the data aligns with a hypothesized factor model derived from theoretical foundations or prior analyses, such as those from EFA. To conduct CFA, the following hypotheses are developed.

Licensing and User Accessibility H1: Items 1-6 are expected to load on the latent factor "Licensing and user accessibility."

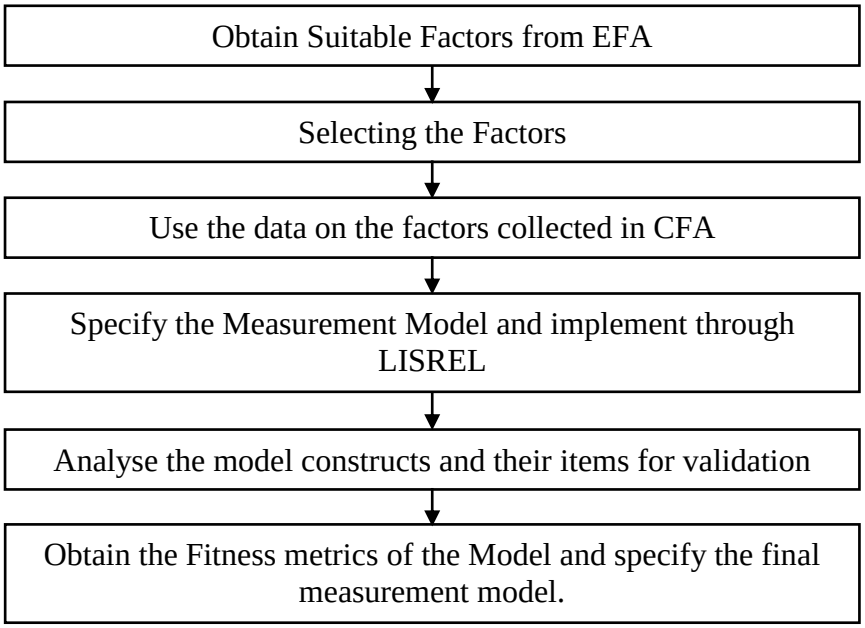
Support and Compliance Services H2: Items 7-11 are expected to load on the latent factor will load significantly on a latent factor representing "Support and Compliance Services."

Information and Financial Systems H3: Items 12-16 are expected to load on the latent factor will load significantly on a latent factor representing "Information and Financial Systems".

Penalty Management and Public Awareness H4: Items 17-20 are expected to load on the latent factor will load significantly on a latent factor representing "Penalty management and Public Awareness".

Safety and Emergency Management H5: Items 20-25 are expected to load on the latent factor will load significantly on a latent factor representing "Safety and Emergency management".

In this chapter, Confirmatory Factor Analysis is employed to assess the critical factors for evaluating performance Transportation department. This approach aims to provide valuable insights for these better functioning of the department. The proposed methodology is outlined in the following steps.



Selection of Variables. The variables identified based on the EFA are utilized for CFA. LISREL 8.8 software is used to conduct confirmatory factor analysis. The results obtained are discussed below.

Table 8: Measurements Items and Result of Reliability Test

S.No.	Latent Construct	Cronbach's Alpha	Measurement Items	Cronbach's Alpha
1	Licensing and User Accessibility	0.9046	Clarity of Licensing Procedures	0.8902
			Timeliness of License Issuance	0.8888
			Transparency· in Testing and Evaluation	0.8880
			Accessibility· of Licensing Services	0.8888
			Ease of Access to Registration Services	0.8872
			User-Friendliness of Online Platforms	0.8830
2	Support and Compliance Services	0.7031	Support from Staff During Registration	0.6859
			Clarity of Registration Procedures	0.6847
			Timeliness of Permit Issuance	0.6382
			Compliance with Legal and Safety Standards	0.6279
			Support for Permit-Related Queries	0.6286
3	Safety and Emergency Management	0.7663	Adequacy of Information Provided on Permits	0.8757
			Ease of Payment Process	0.6818
			Competitive Tax Rates	0.6751
			Customer Satisfaction Across Borders	0.6549
			Impact of Tax Incentives on Adoption of Green Initiatives	0.6804
4	Information and Financial Systems	0.7805	User Satisfaction with Penalty Procedures	0.6570

S.No.	Latent Construct	Cronbach's Alpha	Measurement Items	Cronbach's Alpha
			Use of Penalty Revenue for Public Benefits	0.6240
			Digital Integration in Penalty Management	0.7918
			Educational Campaigns on Penalties	0.7979
5	Penalty· Management and Public Awareness	0.8980	Road Accident Data Collection and Analysis	0.8763
			Inspection and Maintenance of Vehicles	0.8756
			Speed Monitoring and Control	0.8731
			Collaboration with Oilier Departments	0.8824
			Availability of Emergency Response Services	0.8707

High Cronbach's Alpha values indicate that the scale is reliable and consistently measures whatever construct it is intended to. Composite reliability, average variance extracted of the latent constructs and measurement items are presented in table 9.

Table 9: Composite Reliability and Average Variance Extracted

Transport Dept. Function	Measurement Item	Loadings	Error	AXE	CR
Licensing and User Accessibility	Clarity of Licensing Procedure s	0.77	0.41	0.6146	0.9053
	Timeliness of License Issuance	0.77	0.4		
	Transparency in Testing and Evaluation	0.78	0.39		
	Accessibility of Licensing Services	0.77	0.4		
	Ease of Access to Registration Services	0.79	0.38		
	User-Friendliness of Online Platforms	0.82	0.33		
Support and Compliance Services	Support from Staff During Registration	0.79	0.37	0.6405	0.8989
	Clarity of Registration Procedure s	0.8	0.36		
	Timeliness of Permit Issuance	0.84	0.29		
	Compliance with Legal and Safety Standards	0.82	0.32		
	Support for Permit-Related Queries	0.74	0.45		
Information and Financial Systems	Adequacy of Information Provided on Permits	0.79	0.37	0.6376	0.8979
	Ease of Payment Process	0.79	0.37		
	Competitive Tax Rates	0.8	0.36		
	Customer Satisfaction Across Borders	0.81	0.35		
	Impact of Tax Incentives on Adoption of Green Initiatives	0.8	0.36		
Penalty Management and Public Awareness	User Satisfaction with Penalty Procedures	0.62	0.62	0.4734	0.7821
	Use of Penalty Revenue for Public Benefits	0.66	0.37		
	Digital Integration in Penalty Management	0.6	0.36		
	Educational Campaigns on Penalties	0.59	0.35		

Transport Dept. Function	Measurement Item	Loadings	Error	AXE	CR
Safety and Emergency Management	Road Accident Data Collection and Analysis	0.8	0.37	0.6364	0.8974
	Inspection and Maintenance of Vehicles	0.8	0.36		
	Speed Monitoring and Control	0.81	0.35		
	Collaboration with Other Departments	0.76	0.42		
	Availability of Emergency Response Services	0.82	0.32		

Item loadings on their respective constructs range from 0.59 to 0.82, indicating a moderate relationship with their latent variables. This confirms their suitability as indicators of the intended constructs.

The AVE assesses the variance a construct captures from its items relative to measurement error. A value above 0.5 is preferred, indicating the construct explains over half of the item variance. For the latent constructs, AVE exceeds 0.6, except for penalty management and public awareness.

CR evaluates the reliability of a latent construct, offering a more precise measure than Cronbach's alpha by considering factor loadings. A CR above 0.7 is acceptable, above 0.8 is good, and above 0.9 is excellent. In this study, CR values exceed 0.78, indicating a well-specified model.

The strong loadings and generally high AVE and CR values suggest that your model is well-specified and the constructs are measured reliably. These results can be confidently used for further analysis, such as examining the relationships between these constructs and other variables or outcomes.

Model Evaluation Criteria

The model fitting process involves determining the goodness-of fit between the hypothesized model and the sample data. Given below is a description of the goodness-of–fit indicators used to evaluate model fitness in (CFA)

Table 10: Fit Indices

Model fit indices	Values
Chi-square or degree of freedom (df)	(388.71/265) =1.467
Goodness of fit index (GFI)	0.9236
Adjusted goodness of fit index (AGFI)	0.9063
Normed fit index (NFI)	0.9508
Comparative fit index (CFI)	0.9823
Incremental fit index (IFI)	0.9823
Relative fit index (RFI)	0.9443
Root mean square error of approximation (RMSEA)	0.035
Standardized RMR	0.019

The model fitting process assesses the goodness-of-fit between the hypothesized model and the sample data. Below is a summary of the fit indicators used to evaluate model fitness in CFA.

Chi Square Goodness of Fit (χ^2/d.f)

The Chi-square goodness-of-fit metric evaluates the alignment between theoretical specifications and empirical data in CFA. A higher Chi-square value indicates a poorer fit. In this study, χ^2/d.f = 1.467, indicating a good fit.

Goodness-of-fit Index

The Chi-square test assesses model fit in CFA, with higher values indicating poorer fit. In this study, χ^2/d.f = 1.467, confirming a good fit.

Adjusted goodness-of-fit index

The AGFI adjusts the GFI for degrees of freedom. In this study, AGFI = 0.9063, indicating a good fit.

Normed Fit Index (NFI)

It ranges between zero to one. A Normed fit index of one indicates perfect fit. In this study, NFI = 0.9508 indicates good fit.

Incremental fit index (IFI)

It ranges between zero to one. An incremental index of one indicates perfect fit. In this study, IFI = 0.9823 indicates good fit.

Relative Fit Index (RFI)

RFI coefficient values range from zero to one with values close to one indicating superior fit. In this study, RFI = 0.9443 indicates good fit.

Comparative Fit Index (CFI)

CFI ranges from 0 to 1, with higher values indicating better fit. A CFI above 0.90 suggests a well-fitting model. In this study, CFI = 0.9823, confirming a good fit.

Root Mean Square Error of Approximation (RMSEA)

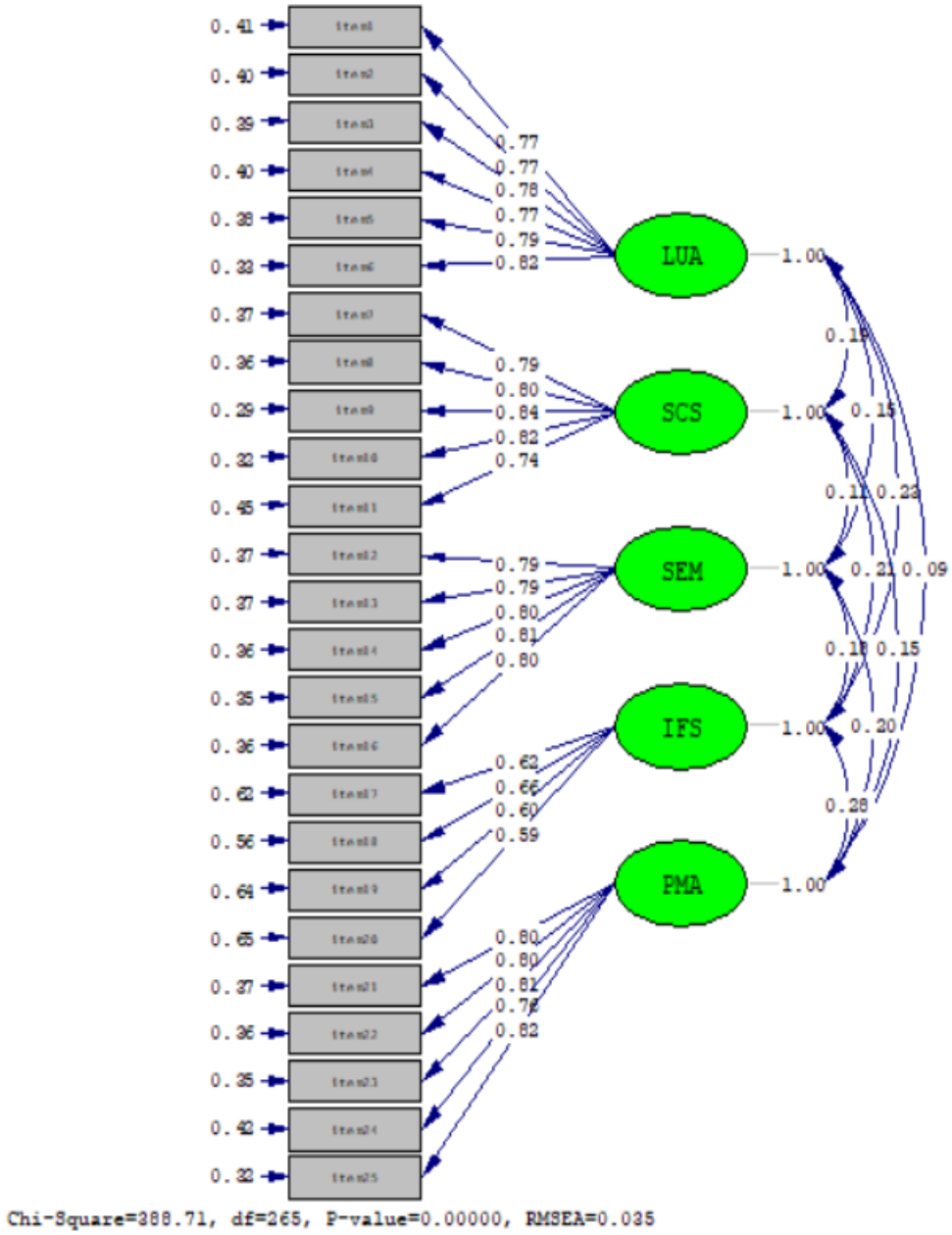
RMSEA measures model fit for the population, not just the sample. Lower values indicate better fit, with <0.08 considered good. In this study, RMSEA = 0.035, confirming a good fit.

Standardized RMR (SRMR)

SRMR is the square root of the mean standardized residuals, with lower values indicating better fit. An SRMR < 0.05 is recommended. In this study, SRMR = 0.0019, confirming a good fit.

Overall Measurement Model Fitness

The chi-square statistic appears satisfactory; however, the χ^2/df ratio provides a more reliable model fit assessment. A lower χ^2/df value generally indicates a better fit. If most fit indices meet acceptable thresholds, the model can be considered a good fit. The CFA path diagram is presented below.



6.2. Discussion

Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) serve distinct yet complementary roles in validating the structure of latent constructs within a dataset. In the case of the analysis of transport department services, EFA was used to uncover the underlying factor structure from empirical data, while CFA was employed to confirm and validate the identified factors.

The integration of EFA and CFA ensures that the factors derived from the data are both statistically sound and theoretically meaningful. This discussion elaborates on the alignment of EFA and CFA results, the methodological consistency, and the implications of the findings.

Alignment between EFA and CFA Results

1. Factor Structure Retention:
    - EFA identified five factors—Licensing and User Accessibility, Support and Compliance Services, Information and Financial Systems, Penalty Management and Public Awareness, and Safety and Emergency Management—which encapsulated key dimensions of transport services.
    - CFA validated the structure by confirming that these five factors fit the measurement model well, with high factor loadings and acceptable goodness-of-fit indices.
2. Reliability and Validity:
    - Internal Consistency: High Cronbach's alpha and Composite Reliability (CR) values (>0.78) indicated strong reliability across the identified factors.
    - Convergent Validity: The Average Variance Extracted (AVE) values were above 0.6 for most constructs, except for the "Penalty Management and Public Awareness" factor, suggesting a strong relationship between items and their respective latent constructs.
    - Discriminant Validity: The correlation among constructs was lower than their AVE values, ensuring that each factor was measuring a distinct concept.
3. Goodness-of-Fit Measures in CFA:
    - The CFA results demonstrated excellent model fit with key fit indices:
        - $\chi^2/df = 1.467$ (acceptable if < 3)
        - GFI = 0.9236 (good fit, > 0.9)
        - AGFI = 0.9063 (acceptable, > 0.9)
        - CFI = 0.9823 (excellent fit, > 0.95)
        - RMSEA = 0.035 (ideal fit, < 0.08)
        - SRMR = 0.019 (ideal fit, < 0.05)

These indices confirm that the five-factor structure identified in EFA was a good representation of the latent constructs.

Interpretation of Key Findings:

Conceptual Coherence

- The five-factor structure reflects well-defined aspects of transport services, such as efficiency, accessibility, compliance, and public awareness.
- Factors such as Penalty Management and Public Awareness and Safety and Emergency Management highlight the department's role in enforcement and public welfare.

Strengths of EFA-CFA Integration

- EFA helped in exploratory hypothesis generation, while CFA validated and confirmed those hypotheses, ensuring that the model was not only statistically significant but also conceptually meaningful.
- The moderate to high factor loadings in CFA reinforced the robustness of the identified factors.

Areas for Improvement

- The AVE for Penalty Management and Public Awareness was slightly lower than the ideal threshold, suggesting that some items in this factor may need refinement or rewording for better construct validity.
- Future research may include higher-order CFA models to assess interactions between factors and their influence on transport service efficiency.

7. Concluding Remarks

The results of EFA and CFA in the transportation department study strongly correlate, demonstrating a well-structured and validated model for analysing transport services. The integration of both techniques ensures methodological rigor, helping policymakers and researchers draw meaningful conclusions about service effectiveness and user satisfaction. While the overall fit of the model is strong, minor refinements in measurement items could further improve construct validity. This study provides a robust framework for future assessments of transport service performance. The findings emphasize the need for improved user accessibility, transparent licensing and registration procedures, and efficient penalty management systems. By validating the factor structure, policymakers can rely on a well-tested model to assess and improve transport services. The significant loading of public awareness indicators in the penalty management factor suggests that increasing education campaigns could improve compliance with transport regulations.

The study can be extended to develop decision-support frameworks for government agencies to improve service delivery based on EFA and CFA findings. Collaborating with law enforcement, public health, and smart city initiatives to develop integrated transport safety policies. Also, the study can be implemented to explore alternative factor structures to test if additional or fewer factors provide a better fit for transport service evaluation.

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