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Research Article

Identification of Critical Factors for Performance Evaluation of Urban Public Road Transportation Organizations

V.S.S.S. Prasad Jakkuva[1], V.V.S. Kesava Rao[2]
[1] *Executive category Ph.D. Scholar in Department of Mechanical Engineering, College of Engineering(A), Andhra University, Visakhapatnam-3. Email: prasad.jakkuva@gmail.com*
[2]Professor, Department of Mechanical Engineering, College of Engineering(A), Andhra University, Visakhapatnam. Email: kesava9999@gmail.com

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ABSTRACT

Public road transportation plays a pivotal role in urban mobility, necessitating an efficient performance evaluation framework for transport organizations. This study aims to identify critical performance factors for State Road Transport Organizations (SRTUs) in India by leveraging secondary data spanning three years on 17 independent variables. To establish the relative priority of these factors, the study employs a comprehensive multi-method approaches.

The analysis provides insights into the most influential determinants of transport efficiency. The findings aid in formulating data-driven policies for improving public transportation systems by prioritizing key performance metrics. This Study offers a structured evaluation framework for policymakers, transport authorities, and urban planners to optimize the performance of public road transportation systems, ensuring sustainability and efficiency in urban mobility.

Keywords: Johnson's Method, Ridge Regression, Logistic Regression

Introduction

Urban public road transportation plays a crucial role in ensuring mobility, accessibility, and economic development in rapidly growing cities. Efficient and sustainable public transport systems contribute to reducing traffic congestion, minimizing environmental impacts, and enhancing overall urban quality of life. However, evaluating the performance of urban public road transportation organizations remains a complex challenge due to the multitude of factors influencing operational efficiency, service quality, and financial sustainability.

State Road Transport Organizations (SRTUs) in India are pivotal in providing affordable and accessible public transportation. Given their significant role in urban mobility, assessing their performance using robust analytical methods is essential for improving service delivery and policy formulation. This study aims to identify the critical factors that determine the efficiency and effectiveness of SRTUs by analyzing secondary data collected over three years on 17 independent variables.

To achieve this objective, we implement Johnson's Method, Ridge Regression, and Logistic Regression to determine the relative priority of various performance factors. Johnson's Method helps in decomposing variance and identifying key explanatory variables, Ridge Regression mitigates multicollinearity issues to ensure stable parameter estimation, and Logistic Regression facilitates classification-based performance evaluation.

The study's findings will provide valuable insights into the most significant determinants of performance in urban road transportation systems. By identifying these key factors, policymakers, transport planners, and administrators can prioritize resource allocation, optimize operational strategies, and enhance public transport services for better urban mobility and sustainability.

The analysis focuses on key performance indicators such as Passengers Carried, Fleet Utilisation, Average Fleet Operated, Average Age of Fleet, Over-aged Vehicles, Staff/Bus Ratio, Staff Productivity, Fuel Efficiency, Occupancy Ratio, Number of Accidents, Staff Cost, Fuel & Lubricant Cost, Tyres & Tubes Cost, Spares Cost, Interest Cost, and

Depreciation Cost. These variables provide a comprehensive understanding of the operational efficiency and financial sustainability of public transport organizations.

Literature Review

Identifying critical factors for performance evaluation of public road transportation systems requires a systematic approach using various methodologies to assess the relative importance of independent variables. Several studies have employed statistical and machine learning approaches to determine the most influential factors affecting transport efficiency.

Johnson (2000) introduced Johnson's Method, which quantifies the relative contribution of independent variables to the dependent variable, making it a valuable tool for transport performance evaluation.

Williams (2006) highlighted the advantages of OLR over standard logistic regression in cases where the response variable follows a meaningful ranking.

Bhat and Sardesai (2006) used ordinal regression to model commuter preferences for different modes of transport. Grömping (2007) compared various relative importance metrics for regression analysis, emphasizing the advantages of decomposition techniques such as Johnson's Method.

Agresti (2010) elaborated on various logistic regression models, emphasizing the proportional odds assumption in ordinal logistic regression. Greene and Hensher (2010) applied OLR in transportation research, identifying critical factors influencing travel behaviour and service satisfaction.

Kuhn and Johnson (2013) discussed the effectiveness of regularization techniques like Ridge and Lasso regression in improving predictive accuracy and feature selection.

Hosmer et al. (2013) demonstrated the application of Logistic Regression in transport sector analysis, particularly for classifying efficiency levels based on operational parameters.

Harrell (2015) provided insights into the practical applications of ordinal regression in healthcare and transportation research.

Zhang and Wang (2018) integrated machine learning techniques with logistic models to improve predictive accuracy in transport evaluation. Das et al. (2019) implemented OLR to evaluate urban transportation performance and identify key service improvement areas.

Li et al. (2020) compared classification-based performance evaluation methods, showing that logistic models effectively differentiate between high- and low-performing transport systems. Raithel and Henseler (2021) explored variance decomposition techniques in transport efficiency analysis, showing their ability to rank influential factors. Chen and Zhang (2021) applied ordinal regression to predict passenger satisfaction based on service quality indicators.

The collective findings from these studies underscore the significance of quantitative methods in determining the relative importance of performance factors in urban public transportation. By employing Johnson's Method, Ridge Regression, and Logistic Regression, this study aims to refine and validate previous research findings, providing an empirical foundation for transport policy improvements.

The critical gap is the lack of comparative studies integrating Johnson's Method, Ridge Regression, and Ordinal Logistic Regression for ranking transport performance factors. Most research efforts have used either variance decomposition (Johnson's Method) or penalized regression models (Ridge Regression) independently, with little exploration of their combined effectiveness.

The motivation for this study stems from the need to develop a comprehensive, data-driven framework that overcomes these limitations and provides transport policymakers and administrators with actionable insights. By integrating multiple analytical techniques, this study offers a holistic and reliable approach to prioritizing key factors that drive public transportation efficiency, thus contributing to improved policy formulation, strategic planning, and resource allocation in urban transport systems.

This study is structured into the following chapters to provide a systematic and comprehensive analysis of the identification of critical factors for performance evaluation in urban public transportation organizations.

Chapter 1 introduces the significance of urban public road transportation, its impact on mobility and sustainability, and the need for an effective performance evaluation framework. It outlines the research objectives, methodology, and key performance indicators considered in the study.

In chapter 2, a comprehensive review of existing studies related to public transportation performance evaluation. It discusses various approaches used to identify critical performance factors, such as Data Envelopment Analysis (DEA), Ridge Regression, Johnson's Method, and Logistic Regression. The literature gap is also addressed, highlighting the need for a multi-method approach.

Chapter 3 details the data sources, variables, and analytical techniques employed in the study. It explains the rationale for using Johnson's Method, Ridge Regression, and Logistic Regression to determine the relative priority of factors affecting public transport performance. The methodology for data collection and preprocessing is also discussed.

The findings from the analysis are presented in this chapter. It includes the results obtained from Johnson's Method, Ridge Regression, and Logistic Regression, providing insights into the most critical factors affecting urban transportation efficiency. Comparative evaluation of methods and their effectiveness is discussed in chapter 4.

A detailed interpretation of the results, their implications for policymakers, and recommendations for optimizing public transport operations. The practical significance of identified key factors in resource allocation and service improvement strategies is examined in chapter 5

Chapter 6 summarizes the key findings of the study and their relevance to urban transportation organizations. It discusses the limitations of the study and suggests potential future research directions, such as integrating advanced machine learning techniques for performance evaluation.

Research Methodology

This chapter details the data sources, variables, and analytical techniques employed in the study. The research methodology is designed to systematically analyse the relative importance of factors affecting public transport performance using a multi-method approach. The study utilizes Johnson's Method, Ridge Regression, and Logistic Regression to evaluate the critical determinants influencing urban transportation efficiency. Data preprocessing steps, variable selection criteria, and statistical validation techniques are also discussed to ensure the robustness of the results.

3.1 Johnson's Method

Stepwise Methodology for Johnson's Method is presented below.

Step 1: Data Collection and Preparation: Gather secondary data on State Road Transport Organizations (SRTUs) covering 17 independent variables over three years.

Step 2: Variable Standardization and Cleaning: Convert all independent variables to a standard scale using mean normalization.

Step 3: Principal Component Analysis (PCA): Apply Principal Component Analysis (PCA) to transform the independent variables into uncorrelated components. Extract the principal components that explain the majority of the variance.

Step 4: Regression Analysis on Principal Components: Fit a Linear Regression Model using the transformed principal components as predictors and the dependent variable as the target. Extract the regression coefficients associated with each principal component.

Step 5: Computation of Johnson's Relative Weights: Convert the regression coefficients back to the original variables. Compute relative importance scores for each independent variable using squared component loadings. Normalize the relative weights to ensure they sum to 1, indicating the proportionate importance of each factor.

3.2 Ridge Regression Method

Stepwise Methodology for Ridge Regression is presented below.

Step 1: Data Collection and Preprocessing; Gather secondary data from State Road Transport Organizations (SRTUs) covering 17 independent variables over three years.

Step 2: Defining Dependent and Independent Variables: Define the dependent variable as the cluster number obtained through K-Means clustering.

Step 3: Data Standardization: Standardize the independent variables using Standard Scaler to ensure all variables have equal importance in model training.

Step 4: Splitting the Dataset: Split the data into training (80%) and testing (20%) sets to evaluate model performance.

Step 5: Model Training using Ridge Regression: Train a Ridge Regression model with an appropriate alpha value (regularization strength). Fit the model using the training dataset to determine the regression coefficients.

Step 6: Feature Importance Computation: Extract the coefficients from the trained Ridge Regression model. Compute absolute values of coefficients to evaluate variable importance. Normalize the values to obtain Relative Priority Scores.

3.3 Ordinal Logistic Regression Method

Stepwise Procedure for Ordinal Logistic Regression.

Step 1: Data Collection and Preprocessing: Gather secondary data from State Road Transport Organizations (SRTUs) covering 17 independent variables over three years.

Step 2: Defining Dependent and Independent Variables: Identify the dependent variable (Cluster) and ensure it is in ordinal format. Select 17 factors as independent variables.

Step 3: Standardization of Features: Normalize independent variables.

Step 4: Splitting Data into Training and Testing Sets: Split data into training (80%) and testing (20%) sets

Step 5: Training the Ordinal Logistic Regression Model: Use Ordinal Ridge(alpha=1.0) from the mord package to train the model. Fit the model on the training dataset.

Step 6: Computing Feature Importance: Extract coefficients from the trained model. Convert coefficients into absolute values. Normalize values to obtain relative priority scores.

Results and Discussion

This section details the data sources, variables, and analytical techniques employed in the study. The research methodology is designed to systematically analyze the relative importance of factors affecting public transport performance using a multi-method approach. The study proposes the following methods for performance evaluation:

Johnson's Method – A variance decomposition approach to quantify the relative importance of independent variables.

Ridge Regression – A regularized regression technique to handle multicollinearity and determine factor significance.

Ordinal Logistic Regression – A classification-based approach to rank key performance indicators in an ordered framework.

These methods ensure a robust evaluation of critical performance factors in urban public transportation are implemented through Python Code. Data preprocessing steps, variable selection criteria, and statistical validation techniques are also discussed to ensure the reliability of the findings.

4.1 Johnson's Method

4.1.1 Data Collection and Preparation: Secondary data is collected through reports on State Road Transport Organizations (SRTUs) covering 17 independent variables over three years. The data is presented in table 1.

Table 1: Data on Independent Variables

S. No.	Name of State Road Transport Undertaking (SRTU)	Year	Physical Parameters				
			Passe Irei's Canned (Lakh)	Fleet Utilisation (%)	Average Fleet Operated (Number)	Avg Age of Fleet (Years)	Over aged vehicles (%)
1	Andhra Pradesh SRTC	2018-19	2 6020.85	99.71	11803.00	5.92	1.06
2	Assam STC	2018-19	185.31	49.77	639.00	5.37	24.17
3	Bangalore Metropolitan TC	2018-19	12775.00	84.12	5615.00	6.60	10.60
4	Bihar SRTC	2018-19	266.00	59.59	345.00	15.00	100.00
5	Delhi TC	2018-19	11004.48	84.62	3295.00	9.20	51.39
6	Gigarat SRTC	2018-19	7436.94	85.58	6882.00	5.41	32.68
7	J&K SRTC	2018-19	43.24	57.42	294.00	10.00	27.69
8	Karnataka SRTC	2018-19	10986.09	91.65	8045.00	5.26	37.60
9	Kerala SRTC	2018-19	9524.00	80.08	4548.00	7.09	0.00
10	Maharashtra SRTC	2018-19	24078.48	87.33	16414.00	7.10	6.18
11	Meghalaya STC	2018-19	2.52	41.93	26.00	8.00	49.00
12	North Eastern Karnataka RTC	2018-19	4945.75	86.33	4134.00	4.63	26.00
13	North Western Karnataka RTC	2018-19	8205.20	94.40	4711.00	7.31	42.60
14	Odisha SRTC	2018-19	71.70	93.65	413.00	5.12	5.00
15	Pepsu RTC	2018-19	0.28	100.00	1138.00	8.00	29.00
16	Rajasthan SRTC	2018-19	3106.89	71.73	3798.00	6.31	35.81
17	Sorth Bengal STC	2018-19	214.00	80.85	726.00	6.24	24.52
18	Telangana SRTC	2018-19	3 5605.75	99.76	10456.00	7.66	26.05
19	Uttar Pradesh SRTC (P)	2018-19	6015.69	97.77	11615.00	5.70	12.13
20	Uttarakhand TC	2018-19	377.83	94.47	1264.00	7.50	29.30
21	West Bengal Transport Corp.	2018-19	1023.00	65.96	783.00	4.57	10.80
1	Andhra Pradesh SRTC	2017-18	2423 6.00	99.63	11644.00	5.56	1.20
2	Assam STC	2017-18	178.41	47.78	634.00	4.37	29.00
3	Bangalore Metropolitan TC	2017-18	16425.00	87.55	5598.00	6.28	16.40
4	Biliar SRTC	2017-18	162.00	58.89	341.00	14.85	100.00
5	Delhi TC	2017-18	10897.91	85.69	3402.00	8.10	20.91
6	Gujarat SRTC	2017-18	7187.99	88.48	6499.00	5.55	24.65
7	J&K SRTC	2017-18	43.94	54.29	285.00	10.00	22.47
8	Karnataka SRTC	2017-18	10833.98	92.43	7915.00	4.71	29.10
9	Kerala SRTC	2017-18	10593.00	82.49	4733.00	6.32	0.00
10	Maharashtra SRTC	2017-18	24446.2 5	88.05	16424.00	6.30	0.19
11	Meghalaya STC	2017-18	2.17	45.90	28.00	7.00	38.00
12	North Eastern Karnataka RTC	2017-18	4934.80	90.45	4071.00	4.91	25.08
13	N orth Western Karnataka RTC	2017-18	8212.50	95.17	4758.00	6.59	33.60
14	Odisha SRTC	2017-18	70.89	90.74	402.00	4.82	5.00
15	Pepsu RTC	2017-18	0.28	100.00	1142.00	8.00	20.00
16	Raj asthan SRTC	2017-18	3420.77	80.24	4368.00	5.43	28.02
17	South Bengal STC	2017-18	172.00	76.13	606.00	5.65	16.58
18	Telangana SRTC	2017-18	34291.75	99.74	10531.00	6.90	20.58

S. No.	Name of State Road Transport Undertaking (SRTU)	Year	Physical Parameters				
			Passe Irei's Canned (Lakh)	Fleet Utilisation (%)	Average Fleet Operated (Number)	Avg Age of Fleet (Years)	Over aged vehicles (%)
19	Uttar Pradesh SRTC (P)	2017-18	6257.93	97.69	11862.00	5.43	7.65
20	Uttarakhand TC	2017-18	405.54	95.45	1238.00	6.50	23.00
21	West Bengal Transport Corp.	2017-18	947.00	66.96	772.00	3.73	10.49
1	Andina Pradesh SRTC	2016-17	24017.00	99.66	12031.00	5.59	2.33
2	Assam STC	2016-17	173.94	57.54	614.00	7.00	12.84
3	Bangalore Metropolitan TC	2016-17	17611.25	88.98	5579.00	7.64	22.70
4	Biliar SRTC	2016-17	111.00	46.58	225.00	13.85	100.00
5	Delhi TC	2016-17	11516.52	85.12	3547.00	7.50	6.08
6	Gigarat SRTC	2016-17	7887.10	84.48	6643.00	4.74	3.54
7	J&K SRTC	2016-17	41.91	50.09	265.00	10.00	19.13
8	Karnataka SRTC	2016-17	9959.00	90.57	7438.00	5.23	25.50
9	Kerala SRTC	2016-17	10414.00	79.47	4664.00	6.20	0.00
10	Maharashtra SRTC	2016-17	24438.41	89.97	16834.00	5.50	8.38
11	Meghalaya STC	2016-17	3.88	69.23	27.00	7.21	45.00
12	North Eastem Karnataka RTC	2016-17	4927.50	90.52	3969.00	5.64	24.02
13	North Western Karnataka RTC	2016-17	8256.30	95.16	4570.00	6.60	26.10
14	Odisha SRTC	2016-17	71.21	83.30	379.00	9.00	11.00
15	Pepsu RTC	2016-17	0.27	100.00	1067.00	8.00	25.00
16	Rajastan SRT C	2016-17	3184.50	87.40	4051.00	5.26	19.63
17	South Bengal STC	2016-17	148.00	65.19	470.00	5.43	5.55
18	Telangana SRTC	2016-17	31893.70	99.85	10399.00	7.44	21.05
19	Uttar Pradesh SRTC (P)	2016-17	5645.91	97.64	10526.00	4.53	8.26
20	Uttarakhand TC	2016-17	368.22	95.41	1185.00	6.50	10.00
21	West Bengal TransOort Com.	2016-17	986.00	86.64	720.00	5.77	5.53

S. No.	Name of State Road Transport Undertaking (SRTU)	Year	Operational parameters					
			Staff/Bus Ratio	Staff Productivity (Kms/ StaffDay)	Revenue Earning Kilometers (Lakh)]	Fuel Efficiency (Km per litre of HSD)	Occupancy Ratio (%)	Number of Accidents
1	Andhra Pradesh SRTC	2018-19	4.50	81.08	15762.74	5.20	77.75	1163.00
2	Assam STC	2018-19	2.71	19.33	245.83	3.79	87.08	71.00
3	Bangalore Metropolitan TC	2018-19	5.08	33.58	4152.85	3.74	71.39	286.00
4	Bihar SRTC	2018-19	1.88	59.74	237.68	4.66	164.00	13.00
5	Delhi TC	2018-19	6.35	25.93	2340.11	1.94	81.19	125.00
6	Gujarat SRTC	2018-19	4.99	76.92	11271.75	5.38	68.77	674.00
7	J&K SRTC	2018-19	4.19	19.09	149.58	4.23	66.29	10.00
8	Karnataka SRTC	2018-19	4.40	75.22	10598.57	4.87	71.40	1018.00
9	Kerala SRTC	2018-19	5.84	45.84	5546.00	4.12	84.44	1083.00

S. No.	Name of State Road Transport Undertaking (SRTU)	Year	Operational parameters					
			Staff/Bus Ratio	Staff Productivity (Kms/ StaffDay)	Revenue Earning Kilometers (Lakh)]	Fuel Efficiency (Km per litre of HSD)	Occupancy Ratio (%)	Number of Accidents
10	Maharashtra SRTC	2018-19	5.42	54.80	20377.97	4.57	69.14	3310.00
11	Meghalaya STC	2018-19	3.56	30.66	24.73	5.01	63.66	3.00
12	North Eastern Kama taka RTC	2018-19	4.30	68.72	5160.90	5.25	58.53	323.00
13	North Western Karnataka RTC	2018-19	4.74	68.19	5890.17	5.12	64.27	449.00
14	Odisha SRTC	2018-19	3.49	61.23	343.72	4.81	93.24	30.00
15	Pepsu RTC	2018-19	3.73	98.68	1529.65	4.69	100.05	112.00
16	Raj asthan SRTC	2018-19	2.89	97.51	5437.74	5.03	87.49	187.00
17	South Bengal STC	2018-19	3.11	63.71	649.50	4.59	81.00	23.00
18	Telangana SRTC	2018-19	4.83	70.79	13088.44	1.94	73.12	772.00
19	Uttar Pradesh SRTC (P)	2018-19	1.78	187.74	14497.28	5.23	68.00	751.00
20	Uttarakhand TC	2018-19	2.58	114.22	1438.26	4.81	90.48	74.00
21	West Bengal Transport Corp.	2018-19	3.39	19.23	282.00	1.94	75.61	80.00
1	Andina Pradesh SRTC	2017-18	4.65	78.81	15633.97	5.23	72.97	1244.00
2	Assam STC	2017-18	2.45	24.54	291.41	3.70	78.71	65.00
3	Bangalore Metropolitan TC	2017-18	5.34	33.45	4164.53	3.74	64.83	293.00
4	Bihar SRTC	2017-18	2.02	53.86	229.99	4.66	113.00	12.00
5	Delhi TC	2017-18	6.42	25.50	2372.56	1.97	83.67	121.00
6	Gujarat SRTC	2017-18	5.42	73.17	10638.29	5.27	68.66	615.00
7	J&K SRTC	2017-18	4.27	19.11	156.55	4.28	64.37	18.00
8	Karnataka SRTC	2017-18	4.49	74.73	10487.54	4.84	69.90	1049.00
9	Kerala SRTC	2017-18	6.98	40.49	5921.00	4.08	90.36	1763.00
10	Maharashtra SRTC	2017-18	5.43	55.06	2033 7.5 8	4.72	70.84	2933.00
11	Meghalaya STC	2017-18	4.11	26.12	23.93	5.12	61.05	2.00
12	North Eastern Karnataka RTC	2017-18	4.49	68.38	5046.31	5.20	51.50	336.00
13	North Western Karnataka RTC	2017-18	4.74	69.85	6044.55	5.16	59.79	452.00
14	Odisha SRTC	2017-18	3.57	59.29	342.38	4.74	93.15	28.00
15	Pepsu RTC	2017-18	3.63	89.75	1359.21	4.68	100.05	170.00
16	Raj asthan SRTC	2017-18	3.04	102.29	6184.81	5.10	93.44	213.00
17	South Bengal STC	2017-18	2.91	62.30	526.67	4.02	81.10	35.00
18	Telangana SRTC	2017-18	4.97	68.83	13191.92	1.97	70.36	729.00
19	Uttar Pradesh SRTC (P)	2017-18	1.86	180.78	14934.11	5.25	67.00	741.00
20	Uttarakhand TC	2017-18	3.35	98.02	1552.42	4.85	89.76	64.00

S. No.	Name of State Road Transport Undertaking (SRTU)	Year	Operational parameters					
			Staff/Bus Ratio	Staff Productivity (Kms/ StaffDay)	Revenue Earning Kilometers (Lakh)]	Fuel Efficiency (Km per litre of HSD)	Occupancy Ratio (%)	Number of Accidents
21	West Bengal Transport Corp.	2017-18	3.78	17.65	281.00	1.97	86.44	208.00
1	Andina Pradesh SRTC	2016-17	4.69	80.29	16584.57	5.20	67.06	1206.00
2	Assam STC	2016-17	3.35	20.43	266.89	3.71	74.53	76.00
3	Bangalore Metropolitan TC	2016-17	5.47	33.58	4205.20	3.74	68.79	299.00
4	Bihar SRTC	2016-17	2.58	35.34	160.46	4.66	106.00	2.00
5	Delhi TC	2016-17	6.69	25.34	2578.71	2.04	81.02	128.00
6	Gujarat SRTC	2016-17	4.79	78.08	10740.52	5.42	66.22	560.00
7	J&K SRTC	2016-17	4.41	18.41	156.90	4.33	74.09	16.00
8	Karnataka SRTC	2016-17	4.59	71.62	9848.78	4.84	60.63	1050.00
9	Kerala SRTC	2016-17	7.34	36.70	5771.00	4.05	83.94	1445.00
10	Maharashtra SRTC	2016-17	5.51	54.93	20661.17	4.77	68.74	2772.00
11	Meghalaya STC	2016-17	5.00	30.21	28.67	5.40	59.07	0.00
12	North Eastern Karnataka RTC	2016-17	4.69	64.62	4853.05	5.17	53.55	408.00
13	North Western Karnataka RTC	2016-17	5.06	65.95	5854.09	5.18	58.53	448.00
14	Odisha SRTC	2016-17	3.63	56.37	339.69	4.72	92.14	27.00
15	Pepsu RTC	2016-17	3.43	94.36	1259.85	4.65	99.77	43.00
16	Raj asthan SRTC	2016-17	3.85	89.21	5810.25	5.06	93.19	274.00
17	South Bengal STC	2016-17	2.83	63.25	471.45	4.29	77.36	61.00
18	Telangana SRTC	2016-17	5.20	64.43	12727.13	2.04	65.99	796.00
19	Uttar Pradesh SRTC (P)	2016-17	2.18	157.68	13517.38	5.24	68.00	648.00
20	Uttarakliand TC	2016-17	3.63	84.92	1396.65	4.76	86.12	84.00
21	West Bengal Transport Corp.	2016-17	5.59	17.16	291.00	2.04	58.56	243.00

S. No.	Name of State Road Transport Undertaking (SRTU)	Year	Financial Parameters					
			Staff Cost as % of Total Cost	Fuel & Lubricant Cost as % of Total Cost	Tyres & Tubes Cost as % of Total Cost	Spares Cost as % of Total Cost	Interest Cost as % of Total Cost	Depreciation Cost as % of Total Cost
1	Andin a Pradesh SRTC	2018-19	47.31	23.07	1.19	1.16	3.98	2.03
2	Assam STC	2018-19	45.66	26.78	1.84	0.82	9.78	8.94
3	Bangalore Metropolitan TC	2018-19	52.95	28.40	0.60	3.50	1.00	5.41
4	Bihar SRTC	2018-19	22.91	44.27	2.13	1.33	0.00	0.00
5	Delhi TC	2018-19	21.22	5.27	0.00	0.06	65.90	2.10
6	Gigarat SRTC	2018-19	35.54	40.66	1.55	1.40	2.02	6.36
7	J&K SRTC	2018-19	39.93	16.18	0.36	1.46	0.00	3.33

S. No.	Name of State Road Transport Undertaking (SRTU)	Year	Financial Parameters					
			Staff Cost as % of Total Cost	Fuel & Lubricant Cost as % of Total Cost	Tyres & Tubes Cost as % of Total Cost	Spares Cost as % of Total Cost	Interest Cost as % of Total Cost	Depreciation Cost as % of Total Cost
8	Karnataka SRTC	2018-19	40.92	38.06	1.42	2.50	0.57	5.68
9	Kerala SRTC	2018-19	29.99	29.55	0.12	0.19	8.43	2.45
10	Maharashtra SRTC	2018-19	41.77	33.50	1.76	1.57	0.02	3.03
11	Meghalaya STC	2018-19	63.88	21.80	1.85	3.43	0.00	6.18
12	North Eastern Karnataka RTC	2018-19	46.90	35.74	1.67	1.31	0.48	5.94
13	North Western Karnataka RTC	2018-19	46.14	36.70	1.55	1.50	0.49	4.32
14	Odislia SRTC	2018-19	26.32	50.41	2.45	2.38	0.00	7.72
15	Pepsu RTC	2018-19	32.89	33.10	0.67	0.83	0.00	2.15
16	Rajasthan SRTC	2018-19	41.34	22.45	1.10	1.33	3.43	2.46
17	South Bengal STC	2018-19	30.02	31.65	1.16	2.89	12.36	4.51
18	Telangana SRTC	2018-19	39.91	23.66	1.02	2.34	3.18	2.92
19	Uttar Pradesh SRTC (P)	2018-19	35.59	28.55	1.48	2.69	0.00	3.87
20	Uttarakliand TC	2018-19	41.97	34.27	1.56	1.50	0.00	4.02
21	West Bengal Transport Corp.	2018-19	40.41	44.88	0.66	1.86	0.00	12.19
1	Andhra Pradesh SRTC	2017-18	50.14	20.24	1.06	1.20	3.74	2.50
2	Assam STC	2017-18	44.19	26.81	1.83	0.82	9.44	9.38
3	Bangalore Metropolitan TC	2017-18	53.39	26.84	0.97	3.36	2.01	5.09
4	Bihar SRTC	2017-18	29.94	41.21	1.54	1.22	0.00	0.00
5	Delhi TC	2017-18	25.17	5.50	0.01	0.07	61.66	2.32
6	Gigarat SRTC	2017-18	40.07	38.01	1.58	1.22	2.57	5.02
7	J&K SRTC	2017-18	86.59	3.35	0.14	0.42	0.00	0.07
8	Karnataka SRTC	2017-18	42.36	36.47	1.61	2.83	0.48	5.27
9	Kerala SRTC	2017-18	26.92	23.75	0.06	0.19	17.87	1.96
10	Maharashtra SRTC	2017-18	46.23	31.19	1.66	1.41	0.06	2.97
11	Meghalaya STC	2017-18	61.23	17.73	1.36	2.23	0.00	5.06
12	North Eastern Karnataka RTC	2017-18	48.48	34.30	2.02	1.61	0.29	4.61
13	North Western Karnataka RTC	2017-18	47.48	35.03	1.62	1.69	0.58	4.34
14	Odislia SRTC	2017-18	26.49	48.25	2.92	2.72	1.08	6.99
15	Pepsu RTC	2017-18	36.60	29.74	0.77	1.73	0.00	2.54
16	Rajasthan SRTC	2017-18	43.24	22.54	0.96	1.09	3.50	2.73
17	South Bengal STC	2017-18	33.83	27.52	1.78	3.27	13.62	4.54
18	Telangana SRTC	2017-18	40.91	22.12	0.91	2.59	3.13	2.81
19	Uttar Pradesh SRTC (P)	2017-18	33.08	28.93	1.34	2.41	0.23	4.91
20	Uttarakhand TC	2017-18	41.58	33.29	1.51	1.41	0.00	5.96
21	West Bengal Transport Corp.	2017-18	46.58	39.66	0.84	1.69	0.00	11.23
1	Andhra Pradesh SRTC	2016-17	44.54	22.77	1.15	1.51	4.10	2.47
2	Assam STC	2016-17	45.98	24.36	0.78	0.66	9.50	13.18
3	Bangalore Metropolitan TC	2016-17	52.57	27.76	1.07	3.35	2.16	5.28

S. No.	Name of State Road Transport Undertaking (SRTU)	Year	Financial Parameters					
			Staff Cost as % of Total Cost	Fuel & Lubricant Cost as % of Total Cost	Tyres & Tubes Cost as % of Total Cost	Spares Cost as % of Total Cost	Interest Cost as % of Total Cost	Depreciation Cost as % of Total Cost
4	Bihar SRTC	2016-17	37.21	19.24	2.30	1.11	0.00	0.00
5	Dellii TC	2016-17	24.50	6.06	0.01	0.08	60.77	2.68
6	Gigarat SRTC	2016-17	39.30	37.66	1.62	1.19	3.02	5.42
7	J&K SRTC	2016-17	51.32	18.44	0.80	2.19	0.00	3.99
8	Karnataka SRTC	2016-17	43.17	35.22	1.91	2.91	0.48	5.26
9	Kerala SRTC	2016-17	28.48	24.58	0.07	0.26	16.63	2.04
10	Maharashtra SRTC	2016-17	42.39	32.79	1.94	1.34	0.03	4.28
11	Meghalaya STC	2016-17	65.86	20.29	1.05	1.66	0.00	5.13
12	North Eastern Karnataka RTC	2016-17	47.77	34.86	2.45	2.13	0.44	3.75
13	North Western Karnataka RTC	2016-17	45.34	35.22	1.79	1.84	0.94	4.80
14	Odislia SRTC	2016-17	27.83	46.74	4.03	2.95	1.15	6.81
15	Pepsu RTC	2016-17	40.80	26.87	1.12	0.92	0.00	2.14
16	Rajasthan SRTC	2016-17	68.46	14.27	0.53	0.85	2.24	1.62
17	South Bengal STC	2016-17	35.50	27.52	2.13	2.69	13.40	4.46
18	Telangana SRTC	2016-17	43.10	21.21	1.13	2.73	2.71	2.21
19	Uttar Pradesh SRTC (P)	2016-17	35.84	27.01	1.35	2.40	0.30	4.45
20	Uttarakhand TC	2016-17	42.87	30.64	1.60	1.98	0.00	4.40
21	West Bengal Transport Corp.	2016-17	48.94	36.96	0.89	1.78	0.00	11.43

Table 2: Descriptive Statistics

S.NO	Description of the Independent variable	Designation	Average	Standard Dev
1	Passengers Carried (Lakh)	Fl	7709.00	9916.17
2	Fleet Utilisation (%)	F2	81.27	17.20
3	Average Fleet Operated (Number)	F3	4616.38	4685.70
4	AvgAge of Fleet (Years)	F4	7.05	2.32
5	Over aged vehicles (%)	F5	27.69	22.32
6	Staff/Bus Ratio	F6	3.99	1.24
7	Staff Productivity (Kms/Staff/Day)	F7	65.34	39.20
8	Revenue Earning Kilometers (Lakh)	F8	5667.88	6162.43
9	Fuel Efficiency (Kmper litre of HSD)	F9	4.33	1.10
10	Occupancy Ratio (%)	F10	80.80	21.94
11	Number of Accidents	Fil	502.71	751.48
12	Staff Cost as % of Total Cost	F12	39.22	10.07
13	Fuel & Lubricant Cost as % of Total Cost	F13	30.90	10.38
14	Tyres & Tubes Cost as % of Total Cost	F14	1.24	0.65
15	Spares Cost as % of Total Cost	F15	1.72	0.94
16	Interest Cost as % of Total Cost	F16	5.32	14.34
17	Depreciation Cost as % of TotalCost	F17	4.55	2.76

4.1.2 Correlation: Correlation map of the Parameters are presented in figure 1.

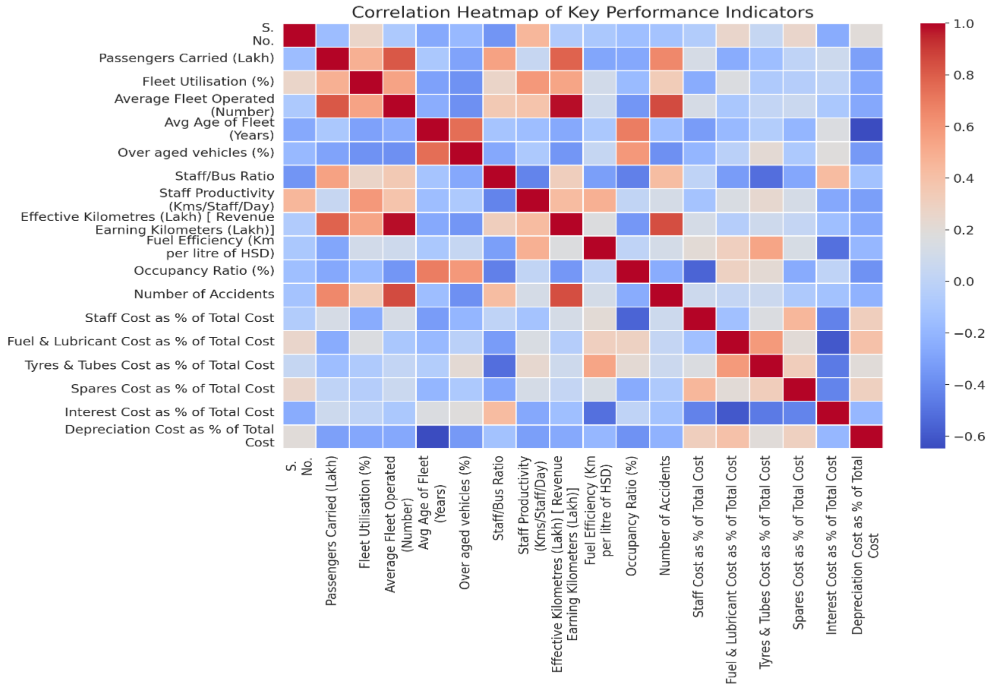

Figure 1: Correlation map of performance indicators

4.1.3 Variable Standardization: Convert all independent variables to a standard scale using mean normalization. Standardized values are presented in table 3.

Table 3: Standardized data

SRTUs	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17
SRTU1	1.914	1.059	1.565	-0.400	-1.025	0.213	0.514	1.669	0.811	0.006	0.924	0.467	-0.561	-0.157	-0.601	-0.115	-0.874
SRTU2	-0.790	-1.948	-0.858	-0.644	0.050	-1.174	-1.193	-0.893	-0.503	0.540	-0.625	0.324	-0.195	0.713	-0.972	0.311	1.600
SRTU3	0.528	0.121	0.222	-0.097	-0.581	0.662	-0.799	-0.248	-0.550	-0.357	-0.320	0.953	-0.035	-0.947	1.953	-0.334	0.336
SRTU4	-0.782	-1.356	-0.922	3.636	3.575	-1.817	-0.076	-0.895	0.308	4.937	-0.708	-1.639	1.528	1.102	-0.415	-0.408	-1.601
SRTU5	0.342	0.151	-0.282	1.058	1.315	1.646	-1.011	-0.547	-2.228	0.203	-0.549	-1.785	-2.314	-1.750	-1.801	4.432	-0.849
SRTU6	-0.031	0.209	0.497	-0.626	0.446	0.592	0.399	0.928	0.979	-0.507	0.230	-0.549	1.172	0.325	-0.339	-0.259	0.676
SRTU7	-0.805	-1.487	-0.933	1.414	0.214	-0.027	-1.200	-0.909	-0.093	-0.649	-0.712	-0.170	-1.239	-1.268	-0.273	-0.408	-0.409
SRTU8	0.340	0.574	0.749	-0.693	0.674	0.135	0.352	0.816	0.503	-0.357	0.718	-0.085	0.916	0.151	0.862	-0.366	0.433
SRTU9	0.187	-0.123	-0.010	0.120	-1.074	1.251	-0.460	-0.018	-0.196	0.389	0.811	-1.028	0.078	-1.590	-1.660	0.211	-0.724
SRTU10	1.711	0.314	2.565	0.125	-0.787	0.926	-0.213	2.432	0.224	-0.486	3.971	-0.011	0.467	0.606	-0.153	-0.406	-0.516
SRTU11	-0.809	-2.419	-0.991	0.525	1.204	-0.515	-0.880	-0.930	0.634	-0.799	-0.722	1.897	-0.686	0.727	1.877	-0.408	0.612
SRTU12	-0.292	0.254	-0.100	-0.973	0.135	0.058	0.172	-0.082	0.858	-1.092	-0.268	0.431	0.688	0.486	-0.437	-0.373	0.526
SRTU13	0.049	0.740	0.025	0.218	0.907	0.399	0.157	0.039	0.736	-0.764	-0.089	0.366	0.782	0.325	-0.230	-0.372	-0.054
SRTU14	-0.802	0.695	-0.907	-0.755	-0.841	-0.570	-0.035	-0.877	0.448	0.892	-0.683	-1.345	2.133	1.530	0.731	-0.408	1.163
SRTU15	-0.809	1.077	-0.750	0.525	0.274	-0.384	1.000	-0.681	0.336	1.281	-0.567	-0.778	0.428	-0.853	-0.961	-0.408	-0.831
SRTU16	-0.484	-0.625	-0.173	-0.226	0.591	-1.034	0.968	-0.036	0.653	0.563	-0.461	-0.049	-0.622	-0.277	-0.415	-0.156	-0.720
SRTU17	-0.787	-0.076	-0.839	-0.258	0.066	-0.864	0.034	-0.827	0.242	0.192	-0.693	-1.025	0.285	-0.197	1.287	0.500	0.014
SRTU18	2.917	1.062	1.272	0.374	0.137	0.469	0.229	1.228	-2.228	-0.258	0.369	-0.172	-0.502	-0.384	0.687	-0.174	-0.555
SRTU19	-0.180	0.943	1.524	-0.498	-0.510	-1.894	3.463	1.460	0.839	-0.551	0.340	-0.545	-0.021	0.231	1.069	-0.408	-0.215
SRTU20	-0.770	0.744	-0.723	0.303	0.288	-1.275	1.430	-0.696	0.448	0.734	-0.621	0.006	0.543	0.339	-0.230	-0.408	-0.162
SRTU21	-0.702	-0.973	-0.827	-1.000	-0.572	-0.647	-1.196	-0.887	-2.228	-0.116	-0.612	-0.129	1.588	-0.866	0.163	-0.408	2.763
SRTU22	1.727	1.055	1.530	-0.560	-1.018	0.329	0.451	1.648	0.839	-0.267	1.039	0.711	-0.839	-0.331	-0.557	-0.133	-0.706
SRTU23	-0.791	-2.067	-0.859	-1.089	0.274	-1.375	-1.049	-0.886	-0.587	0.061	-0.634	0.197	-0.192	0.700	-0.972	0.286	1.757
SRTU24	0.910	0.327	0.218	-0.240	-0.311	0.864	-0.803	-0.246	-0.550	-0.732	-0.310	0.991	-0.189	-0.451	1.800	-0.260	0.221
SRTU25	-0.793	-1.398	-0.923	3.569	3.575	-1.708	-0.239	-0.896	0.308	2.021	-0.709	-1.032	1.227	0.312	-0.535	-0.408	-1.601
SRTU26	0.331	0.215	-0.259	0.569	-0.102	1.700	-1.023	-0.542	-2.200	0.345	-0.554	-1.444	-2.292	-1.737	-1.791	4.121	-0.770
SRTU27	-0.057	0.383	0.414	-0.564	0.072	0.926	0.295	0.823	0.876	-0.513	0.147	-0.158	0.911	0.365	-0.535	-0.219	0.196
SRTU28	-0.805	-1.675	-0.935	1.414	-0.029	0.035	-1.199	-0.908	-0.046	-0.758	-0.700	3.856	-2.503	-1.563	-1.409	-0.408	-1.576
SRTU29	0.324	0.621	0.721	-0.938	0.279	0.205	0.338	0.798	0.476	-0.442	0.762	0.040	0.760	0.406	1.222	-0.373	0.286
SRTU30	0.299	0.023	0.030	-0.222	-1.074	2.134	-0.608	0.044	-0.233	0.727	1.776	-1.293	-0.494	-1.670	-1.660	0.905	-0.899
SRTU31	1.749	0.357	2.568	-0.231	-1.065	0.933	-0.205	2.425	0.364	-0.389	3.436	0.373	0.239	0.472	-0.328	-0.403	-0.538
SRTU32	-0.809	-2.181	-0.991	0.080	0.693	-0.089	-1.006	-0.930	0.736	-0.948	-0.723	1.668	-1.087	0.071	0.567	-0.408	0.211

SRTUs	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17
SRTU33	-0.293	0.502	-0.113	-0.849	0.092	0.205	0.163	-0.101	0.811	-1.494	-0.249	0.568	0.546	0.954	-0.110	-0.386	0.050
SRTU34	0.050	0.786	0.036	-0.102	0.488	0.399	0.203	0.064	0.774	-1.020	-0.085	0.481	0.618	0.419	-0.022	-0.365	-0.047
SRTU35	-0.802	0.519	-0.910	-0.889	-0.841	-0.508	-0.089	-0.877	0.382	0.887	-0.686	-1.330	1.920	2.160	1.102	-0.328	0.902
SRTU36	-0.809	1.077	-0.749	0.525	-0.144	-0.461	0.754	-0.709	0.326	1.281	-0.485	-0.458	0.097	-0.719	0.021	-0.408	-0.691
SRTU37	-0.451	-0.113	-0.049	-0.618	0.229	-0.918	1.100	0.087	0.718	0.903	-0.424	0.115	-0.613	-0.465	-0.677	-0.151	-0.623
SRTU38	-0.791	-0.360	-0.865	-0.520	-0.303	-1.019	-0.005	-0.847	-0.289	0.198	-0.676	-0.697	-0.122	0.633	1.702	0.593	0.024
SRTU39	2.780	1.061	1.289	0.036	-0.117	0.577	0.175	1.245	-2.200	-0.416	0.308	-0.086	-0.654	-0.532	0.960	-0.178	-0.595
SRTU40	-0.155	0.938	1.578	-0.618	-0.718	-1.832	3.270	1.532	0.858	-0.608	0.325	-0.761	0.017	0.044	0.764	-0.391	0.157
SRTU41	-0.767	0.803	-0.728	-0.142	-0.005	-0.678	0.982	-0.678	0.485	0.693	-0.635	-0.028	0.446	0.272	-0.328	-0.408	0.533
SRTU42	-0.710	-0.913	-0.829	-1.373	-0.586	-0.345	-1.240	-0.888	-2.200	0.503	-0.431	0.404	1.074	-0.625	-0.022	-0.408	2.419
SRTU43	1.704	1.056	1.614	-0.546	-0.966	0.360	0.492	1.805	0.811	-0.605	0.985	0.228	-0.590	-0.210	-0.219	-0.107	-0.717
SRTU44	-0.791	-1.480	-0.864	0.080	-0.477	-0.678	-1.163	-0.890	-0.578	-0.178	-0.618	0.352	-0.434	-0.706	-1.147	0.290	3.117
SRTU45	1.034	0.413	0.214	0.365	-0.018	0.964	-0.799	-0.239	-0.550	-0.506	-0.302	0.921	-0.099	-0.318	1.789	-0.249	0.289
SRTU46	-0.798	-2.140	-0.948	3.125	3.575	-1.275	-0.751	-0.907	0.308	1.621	-0.723	-0.405	-0.938	1.329	-0.655	-0.408	-1.601
SRTU47	0.396	0.181	-0.227	0.303	-0.791	1.909	-1.027	-0.508	-2.134	0.193	-0.544	-1.502	-2.236	-1.737	-1.780	4.056	-0.641
SRTU48	0.016	0.142	0.445	-0.924	-0.909	0.438	0.431	0.840	1.016	-0.653	0.069	-0.225	0.877	0.419	-0.568	-0.186	0.340
SRTU49	-0.805	-1.928	-0.939	1.414	-0.185	0.143	-1.219	-0.908	0.000	-0.203	-0.703	0.813	-1.017	-0.679	0.523	-0.408	-0.172
SRTU50	0.233	0.509	0.617	-0.706	0.112	0.283	0.252	0.693	0.476	-0.972	0.764	0.109	0.636	0.807	1.309	-0.373	0.282
SRTU51	0.280	-0.159	0.015	-0.275	-1.074	2.413	-0.713	0.019	-0.261	0.360	1.324	-1.158	-0.412	-1.656	-1.583	0.814	-0.870
SRTU52	1.748	0.473	2.657	-0.586	-0.684	0.995	-0.209	2.478	0.410	-0.509	3.207	0.042	0.397	0.847	-0.404	-0.406	-0.069
SRTU53	-0.809	-0.776	-0.991	0.174	1.018	0.600	-0.893	-0.929	0.997	-1.061	-0.726	2.067	-0.835	-0.344	-0.055	-0.408	0.236
SRTU54	-0.294	0.506	-0.136	-0.524	0.043	0.360	0.059	-0.132	0.783	-1.377	-0.147	0.506	0.601	1.530	0.458	-0.375	-0.258
SRTU55	0.055	0.785	-0.005	-0.097	0.140	0.647	0.096	0.033	0.792	-1.092	-0.090	0.297	0.636	0.647	0.141	-0.339	0.118
SRTU56	-0.802	0.071	-0.915	0.969	-0.562	-0.461	-0.169	-0.878	0.364	0.829	-0.688	-1.214	1.771	3.646	1.353	-0.323	0.837
SRTU57	-0.809	1.077	-0.765	0.525	0.088	-0.616	0.881	-0.726	0.298	1.265	-0.665	-0.095	-0.186	-0.251	-0.863	-0.408	-0.835
SRTU58	-0.476	0.318	-0.118	-0.693	-0.161	-0.291	0.739	0.026	0.681	0.889	-0.337	2.292	-1.428	-1.041	-0.939	-0.243	-1.021
SRTU59	-0.794	-1.019	-0.895	-0.618	-0.816	-1.081	0.021	-0.856	-0.037	-0.016	-0.639	-0.552	-0.122	1.102	1.069	0.576	-0.004
SRTU60	2.529	1.068	1.260	0.276	-0.095	0.755	0.054	1.168	-2.134	-0.666	0.403	0.103	-0.744	-0.237	1.113	-0.209	-0.810
SRTU61	-0.219	0.935	1.288	-1.018	-0.690	-1.584	2.632	1.298	0.848	-0.551	0.193	-0.523	-0.172	0.057	0.753	-0.386	-0.008
SRTU62	-0.771	0.801	-0.740	-0.142	-0.609	-0.461	0.620	-0.703	0.401	0.485	-0.607	0.084	0.185	0.392	0.294	-0.408	-0.026
SRTU63	-0.706	0.272	-0.841	-0.466	-0.817	1.057	-1.253	-0.886	-2.134	-1.091	-0.381	0.607	0.808	-0.559	0.076	-0.408	2.491

4.1.4 Principal Component Analysis (PCA): PCA is implemented through Minitab 16 and the results are presented below.

Table 4: Eigen values

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15	PC16	PC17
Eigenvalue	4.786	3.4529	2.419	1.6827	1.2578	0.9514	0.6624	0.5874	0.3885	0.2851	0.1804	0.1201	0.1049	0.0494	0.0471	0.0198	0.0053
Proportion	0.282	0.203	0.142	0.099	0.074	0.056	0.039	0.035	0.023	0.017	0.011	0.007	0.006	0.003	0.003	0.001	0
Cumulative	0.282	0.485	0.627	0.726	0.8	0.856	0.895	0.929	0.952	0.969	0.98	0.987	0.993	0.996	0.999	1	1

Table 5: PCA Scores

SRTUs	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	PCA scores
SRTU1	26021	99.71	11803	5.92	1.06	4.5	81.08	15763	5.2	77.75	1163	47.31	23.07	1.19	1.16	3.98	2.03	3.324
SRTU2	185.31	49.77	639	5.37	24.17	2.71	19.33	245.83	3.79	87.08	71	45.66	26.78	1.84	0.82	9.78	8.94	-2.497
SRTU3	12775	84.12	5615	6.6	10.6	5.08	33.58	4152.9	3.74	71.39	286	52.95	28.4	0.6	3.5	1	5.41	0.476
SRTU4	266	59.59	345	15	100	1.88	59.74	237.68	4.66	164	13	22.91	44.27	2.13	1.33	0	0	-5.102
SRTUS	11004	84.62	3295	9.2	51.39	6.35	25.93	2340.1	1.94	81.19	125	21.22	5.27	0	0.06	65.9	2.1	-1.023
SRTU6	7436.9	85.58	6882	5.41	32.68	4.99	76.92	11272	5.38	68.77	674	35.54	40.66	1.55	1.4	2.02	6.36	1.044
SRTU7	43.24	57.42	294	10	27.695	4.19	19.09	149.58	4.23	66.29	10	39.93	16.18	0.36	1.46	0	3.33	-2.200
SRTU8	10986	91.65	8045	5.26	37.6	4.4	75.22	10599	4.87	71.4	1018	40.92	38.06	1.42	2.5	0.57	5.68	1.420
SRTU9	9524	80.08	4548	7.09	0	5.84	45.84	5546	4.12	84.44	1083	29.99	29.55	0.12	0.19	8.43	2.45	0.685
SRTU10	24078	87.33	16414	7.1	6.18	5.42	54.8	20378	4.57	69.14	3310	41.77	33.5	1.76	1.57	0.02	3.03	4.794
SRTU11	2.52	41.935	26	8	49	3.56	30.66	24.73	5.01	63.66	3	63.88	21.8	1.85	3.43	0	6.18	-2.603
SRTU12	4945.8	86.33	4134	4.63	26	4.3	68.72	5160.9	5.25	58.53	323	46.9	35.74	1.67	1.31	0.48	5.94	0.259
SRTU13	8205.2	94.4	4711	7.31	42.6	4.74	68.19	5890.2	5.12	64.27	449	46.14	36.7	1.55	1.5	0.49	4.32	0.251
SRTU14	71.7	93.65	413	5.12	5	3.49	61.23	343.72	4.81	93.24	30	26.32	50.41	2.45	2.38	0	7.72	-1.095
SRTU15	0.28	100	1138	8	29	3.73	98.68	1529.7	4.69	100.05	112	32.89	33.1	0.67	0.83	0	2.15	-1.135
SRTU16	3106.9	71.73	3798	6.31	35.81	2.89	97.51	5437.7	5.03	87.49	187	41.34	22.45	1.1	1.33	3.43	2.46	-0.870

SRTUs	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	PCA scores
SRTU17	214	80.85	726	6.24	24.52	3.11	63.71	649.5	4.59	81	23	30.02	31.65	1.16	2.89	12.36	4.51	-1.409
SRTU18	35606	99.76	10456	7.66	26.05	4.83	70.79	13088	1.94	73.12	772	39.91	23.66	1.02	2.34	3.18	2.92	2.696
SRTU19	6015.7	97.77	11615	5.7	12.13	1.78	187.74	14497	5.23	68	751	35.59	28.55	1.48	2.69	0	3.87	2.275
SRTU2O	377.83	94.47	1264	7.5	29.3	2.58	114.22	1438.3	4.81	90.48	74	41.97	34.27	1.56	1.5	0	4.02	-1.219
SRTU21	1023	65.96	783	4.57	10.8	3.39	19.23	282	1.94	75.61	80	40.41	44.88	0.66	1.86	0	12.19	-1.618
SRTU22	24236	99.63	11644	5.56	1.2	4.65	78.81	15634	5.23	72.97	1244	50.14	20.24	1.06	1.2	3.74	2.5	3.389
SRTU23	178.41	47.78	634	4.37	29	2.45	24.54	291.41	3.7	78.71	65	44.19	26.81	1.83	0.82	9.44	9.38	-2.409
SRTU24	16425	87.55	5598	6.28	16.4	5.34	33.45	4164.5	3.74	64.83	293	53.39	26.84	0.97	3.36	2.01	5.09	0.755
SRTU25	162	58.89	341	14.85	100	2.02	53.86	229.99	4.66	113	12	29.94	41.21	1.54	1.22	0	0	-4.401
SRTU26	10898	85.69	3402	8.1	20.91	6.42	25.5	2372.6	1.97	83.67	121	25.17	5.5	0.01	0.07	61.66	2.32	-0.510
SRTU27	7188	88.48	6499	5.55	24.65	5.42	73.17	10638	5.27	68.66	615	40.07	38.01	1.58	1.22	2.57	5.02	1.138
SRTU28	43.94	54.29	285	10	22.473	4.27	19.11	156.55	4.28	64.37	18	86.59	3.35	0.14	0.42	0	0.07	-2.078
SRTU29	10834	92.43	7915	4.71	29.1	4.49	74.73	10488	4.84	69.9	1049	42.36	36.47	1.61	2.83	0.48	5.27	1.639
SRTU3O	10593	82.49	4733	6.32	0	6.98	40.49	5921	4.08	90.36	1763	26.92	23.75	0.06	0.19	17.87	1.96	1.329
SRTU31	24446	88.05	16424	6.3	0.19	5.43	55.06	20338	4.72	70.84	2933	46.23	31.19	1.66	1.41	0.06	2.97	4.770
SRTU32	2.17	45.9	28	7	38	4.11	26.12	23.93	5.12	61.05	2	61.23	17.73	1.36	2.23	0	5.06	-2.187
SRTU33	4934.8	90.45	4071	4.91	25.08	4.49	68.38	5046.3	5.2	51.5	336	48.48	34.3	2.02	1.61	0.29	4.61	0.459
SRTU34	8212.5	95.17	4758	6.59	33.6	4.74	69.85	6044.6	5.16	59.79	452	47.48	35.03	1.62	1.69	0.58	4.34	0.548
SRTU35	70.89	90.74	402	4.82	5	3.57	59.29	342.38	4.74	93.15	28	26.49	48.25	2.92	2.72	1.08	6.99	-1.112
SRTU36	0.28	100	1142	8	20	3.63	89.75	1359.2	4.68	100.05	170	36.6	29.74	0.77	1.73	0	2.54	-1.027
SRTU37	3420.8	80.24	4368	5.43	28.02	3.04	102.29	6184.8	5.1	93.44	213	43.24	22.54	0.96	1.09	3.5	2.73	-0.423
SRTU38	172	76.13	606	5.65	16.58	2.91	62.3	526.67	4.02	81.1	35	33.83	27.52	1.78	3.27	13.62	4.54	-1.420
SRTU39	34292	99.74	10531	6.9	20.58	4.97	68.83	13192	1.97	70.36	729	40.91	22.12	0.91	2.59	3.13	2.81	2.858
SRTU40	6257.9	97.69	11862	5.43	7.65	1.86	180.78	14934	5.25	67	741	33.08	28.93	1.34	2.41	0.23	4.91	2.380
SRTU41	405.54	95.45	1238	6.5	23	3.35	98.02	1552.4	4.85	89.76	64	41.58	33.29	1.51	1.41	0	5.96	-0.995
SRTU42	947	66.96	772	3.73	10.49	3.78	17.65	281	1.97	86.44	208	46.58	39.66	0.84	1.69	0	11.23	-1.520
SRTU43	24017	99.66	12031	5.59	2.33	4.69	80.29	16585	5.2	67.06	1206	44.54	22.77	1.15	1.51	4.1	2.47	3.542
SRTU44	173.94	57.54	614	7	12.84	3.35	20.43	266.89	3.71	74.53	76	45.98	24.36	0.78	0.66	9.5	13.18	-2.146
SRTU45	17611	88.98	5579	7.64	22.7	5.47	33.58	4205.2	3.74	68.79	299	52.57	27.76	1.07	3.35	2.16	5.28	0.567
SRTU46	111	46.58	225	13.85	100	2.58	35.34	160.46	4.66	106	2	37.21	19.24	2.3	1.11	0	0	-4.487
SRTU47	11517	85.12	3547	7.5	6.08	6.69	25.34	2578.7	2.04	81.02	128	24.5	6.06	0.01	0.08	60.77	2.68	-0.140
SRTU48	7887.1	84.48	6643	4.74	3.54	4.79	78.08	10741	5.42	66.22	560	39.3	37.66	1.62	1.19	3.02	5.42	1.377
SRTU49	41.91	50.09	265	10	19.126	4.41	18.41	156.9	4.33	74.09	16	51.32	18.44	0.8	2.19	0	3.99	-2.290
SRTU50	9959	90.57	7438	5.23	25.5	4.59	71.62	9848.8	4.84	60.63	1050	43.17	35.22	1.91	2.91	0.48	5.26	1.587
SRTU51	10414	79.47	4664	6.2	0	7.34	36.7	5771	4.05	83.94	1445	28.48	24.58	0.07	0.26	16.63	2.04	1.223
SRTU52	24438	89.97	16834	5.5	8.38	5.51	54.93	20661	4.77	68.74	2772	42.39	32.79	1.94	1.34	0.03	4.28	4.757
SRTU53	3.88	69.23	27	7.21	45	5	30.21	28.67	5.4	59.07	0	65.86	20.29	1.05	1.66	0	5.13	-1.665
SRTU54	4927.5	90.52	3969	5.64	24.02	4.69	64.62	4853.1	5.17	53.55	408	47.77	34.86	2.45	2.13	0.44	3.75	0.418
SRTU55	8256.3	95.16	4570	6.6	26.1	5.06	65.95	5854.1	5.18	58.53	448	45.34	35.22	1.79	1.84	0.94	4.8	0.648
SRTU56	71.21	83.3	379	9	11	3.63	56.37	339.69	4.72	92.14	27	27.83	46.74	4.03	2.95	1.15	6.81	-1.808
SRTU57	0.27	100	1067	8	25	3.43	94.36	1259.9	4.65	99.77	43	40.8	26.87	1.12	0.92	0	2.14	-1.222
SRTU58	3184.5	87.4	4051	5.26	19.63	3.85	89.21	5810.3	5.06	93.19	274	68.46	14.27	0.53	0.85	2.24	1.62	-0.063
SRTU59	148	65.19	470	5.43	5.55	2.83	63.25	471.45	4.29	77.36	61	35.5	27.52	2.13	2.69	13.4	4.46	-1.462
SRTU60	31894	99.85	10399	7.44	21.05	5.2	64.43	12727	2.04	65.99	796	43.1	21.21	1.13	2.73	2.71	2.21	2.783
SRTU61	5645.9	97.64	10526	4.53	8.26	2.18	157.68	13517	5.24	68	648	35.84	27.01	1.35	2.4	0.3	4.45	2.115
SRTU62	368.22	95.41	1185	6.5	10	3.63	84.92	1396.7	4.76	86.12	84	42.87	30.64	1.6	1.98	0	4.4	-0.751
SRTU63	986	86.64	720	5.77	5.53	5.59	17.16	291	2.04	58.56	243	48.94	36.96	0.89	1.78	0	11.43	-0.619

4.1.5 Regression Analysis on Principal Components: Linear Regression Model is fitted with factors as predictors and PCA score as dependent variable using Minitab 16. The results are presented below.

Regression Equation:

$$\text{PCA SCORE} = 0.000000 + 0.3696\,F1 + 0.3165\,F2 + 0.4263\,F3 - 0.2397\,F4 - 0.2720\,F5 + 0.2104\,F6 + 0.1687\,F7 + 0.4220\,F8 + 0.02972\,F9 - 0.2323\,F10 + 0.3701\,F11 + 0.01010\,F12 - 0.001519\,F13 - 0.03733\,F14 + 0.04349\,F15 - 0.02619\,F16 - 0.05828\,F17$$

4.1.6 Johnson's Relative Weights: Convert the regression coefficients back to the original variables. Compute relative importance scores for each independent variable using squared component loadings. Normalize the relative weights to ensure they sum to 1, indicating the proportionate importance of each factor. The resulted relative weights are presented in table

Table 6: Johnson's Relative Weights

Factors	BETA COEF.	PC1	RW	Norm.RW
F1	0.370	0.370	0.273	0.137
F2	0.317	0.317	0.201	0.100
F3	0.426	0.426	0.363	0.182
F4	-0.240	-0.240	0.115	0.058
F5	-0.272	-0.272	0.148	0.074
F6	0.210	0.210	0.088	0.044
F7	0.169	0.169	0.057	0.029
F8	0.422	0.422	0.356	0.178
F9	0.030	0.030	0.002	0.001
F10	-0.232	-0.232	0.108	0.054
F11	0.370	0.370	0.274	0.137
F12	0.010	0.010	0.000	0.000
F13	-0.002	-0.002	0.000	0.000
F14	-0.037	-0.037	0.003	0.001
F15	0.043	0.043	0.004	0.002
F16	-0.026	-0.026	0.001	0.001
F17	-0.058	-0.058	0.007	0.003

PCA Loadings represent the correlation between original variables and the principal components. Beta Weights in regression indicate the strength of each independent variable in predicting the first principal component (PC1 scores). Since PC1 is derived from a linear combination of the original variables, regressing PC1 scores on the original variables often results in similar coefficients to PCA loadings.

4.2 Ridge Regression Method

4.2.1. Defining Dependent and Independent Variables: Factors are considered as independent variables and the cluster number obtained through K-Means clustering is considered as dependent variable and is presented in table 7.

Table 7: Cluster Analysis

SRTUs	Year	Cluster	Membership
SRTU1	2018-19	3	0.990
SRTU2	2018-19	1	0.997
SRTU3	2018-19	2	0.843
SRTU4	2018-19	1	0.996
SRTU5	2018-19	2	0.733
SRTU6	2018-19	2	0.877
SRTU7	2018-19	1	0.994
SRTU8	2018-19	2	0.884
SRTU9	2018-19	2	0.947
SRTU10	2018-19	3	0.898
SRTU11	2018-19	1	0.991
SRTU12	2018-19	2	0.648
SRTU13	2018-19	2	0.951
SRTU14	2018-19	1	0.996
SRTU15	2018-19	1	0.993
SRTU16	2018-19	1	0.529
SRTU17	2018-19	1	0.999
SRTU18	2018-19	3	0.848
SRTU19	2018-19	2	0.673
SRTU20	2018-19	1	0.994
SRTU21	2018-19	1	0.996
SRTU1	2017-18	3	0.958
SRTU2	2017-18	1	0.997

SRTUs	Year	Cluster	Membership
SRTU3	2017-18	2	0.704
SRTU4	2017-18	1	0.996
SRTU5	2017-18	2	0.738
SRTU6	2017-18	2	0.896
SRTU7	2017-18	1	0.994
SRTU8	2017-18	2	0.893
SRTU9	2017-18	2	0.943
SRTU10	2017-18	3	0.907
SRTU11	2017-18	1	0.991
SRTU12	2017-18	2	0.634
SRTU13	2017-18	2	0.957
SRTU14	2017-18	1	0.996
SRTU15	2017-18	1	0.994
SRTU16	2017-18	2	0.565
SRTU17	2017-18	1	0.999
SRTU18	2017-18	3	0.871
SRTU19	2017-18	2	0.660
SRTU20	2017-18	1	0.993
SRTU21	2017-18	1	0.996
SRTU1	2016-17	3	0.960
SRTU2	2016-17	1	0.997
SRTU3	2016-17	2	0.654
SRTU4	2016-17	1	0.994
SRTU5	2016-17	2	0.755
SRTU6	2016-17	2	0.907
SRTU7	2016-17	1	0.994
SRTU8	2016-17	2	0.935
SRTU9	2016-17	2	0.945
SRTU10	2016-17	3	0.898
SRTU11	2016-17	1	0.991
SRTU12	2016-17	2	0.612
SRTU13	2016-17	2	0.946
SRTU14	2016-17	1	0.996
SRTU15	2016-17	1	0.996
SRTU16	2016-17	2	0.498
SRTU17	2016-17	1	0.998
SRTU18	2016-17	3	0.900
SRTU19	2016-17	2	0.713
SRTU20	2016-17	1	0.996
SRTU21	2016-17	1	0.996

Cluster 1: “Low-Capacity, High-Cost Operators”

- Characteristics:
  - Low Fleet Utilization and Average Fleet Operated.
  - High Staff Cost, Interest Cost, and Fuel & Lubricant Cost.
  - Higher Occupancy Ratio (indicating over-reliance on fewer vehicles).

These are operators that struggle with efficiency, have a high-cost burden, and operate with a small fleet size. The Staff Productivity and Fuel Efficiency are lower than the other clusters.

Cluster 2: “Mid-Scale Operators with Balanced Operations”

- Characteristics:
  - Moderate fleet size and utilization rates.

- Balanced costs across staff, fuel, and depreciation.
- Intermediate occupancy ratio (suggesting better route optimization).

These SRTUs are operationally stable, neither struggling with inefficiencies nor leading in fleet optimization. Cost and resource management are balanced, leading to moderate financial sustainability.

Cluster 3: "High-Capacity, Efficient Operators"

- Characteristics:
  - Large fleet size with high utilization.
  - Lowest Over-Aged Vehicles percentage (modern fleets).
  - Best Fuel Efficiency and Staff Productivity.
  - Lower cost per unit operation compared to other clusters.

These are the most efficient operators, running with a large fleet and optimized workforce. Cost-effective operations, indicating financial sustainability and efficient use of assets.

4.2.2. Ridge Regression: Dataset is divided into training (80%) and testing (20%) sets to evaluate model performance. Train a Ridge Regression model by developing Python code to fit the model using the training dataset to determine the regression coefficients. Extract the coefficients from the trained Ridge Regression model and absolute values of coefficients to evaluate variable importance. Normalize the values to obtain Relative Priority Scores. The results are presented in table 8.

Table 8. Relative Weights through Ridge Regression.

Factors	Feature Coeff	Relative Weight
F1	0.360	0.260
F2	0.006	0.005
F3	0.229	0.165
F4	-0.012	0.009
F5	0.011	0.008
F6	0.069	0.050
F7	-0.026	0.019
F8	0.107	0.077
F9	0.034	0.024
F10	-0.108	0.078
F11	-0.070	0.050
F12	-0.008	0.006
F13	0.104	0.075
F14	0.023	0.016
F15	-0.053	0.038
F16	0.078	0.056
F17	-0.087	0.063

4.3 Ordinal Logistic Regression

Data is Split into Training and Testing Sets and the model is fitted through Ordinal Logistic Regression by developing the Python code. Feature coefficients are extracted from the trained model. These coefficients are converted into absolute values. The values are normalized values to obtain relative priority scores and are presented in table 9.

Table 9. Relative Weights through Ordinal regression.

Factors	Feature Coeff	Relative Weight
F1	0.348	0.235
F2	-0.005	0.003
F3	0.254	0.172

Factors	Feature Coeff	Relative Weight
F4	-0.069	0.046
F5	0.028	0.019
F6	0.053	0.036
F7	-0.041	0.028
F8	0.107	0.072
F9	0.031	0.021
F10	-0.096	0.065
F11	-0.074	0.050
F12	-0.008	0.005
F13	0.108	0.073
F14	0.009	0.006
F15	-0.047	0.032
F16	0.074	0.050
F17	-0.129	0.087

4.4 Comparison of Proposed Methods

In this context, there's a need for metrics to assess the similarity and dissimilarity of ranked lists. Three popular methodologies in this regard are the Kendall's Tau, Pearson's correlation coefficient, and Rank-Biased Overlap (RBO). Each offers a unique lens to view and evaluate rank similarity.

Table 10: Relative weights through Proposed methods

Factors	Johnson's Method	Ordinal Logistic Regression	Ridge regression
F1	0.137	0.235	0.260
F2	0.100	0.003	0.005
F3	0.182	0.172	0.165
F4	0.058	0.046	0.009
F5	0.074	0.019	0.008
F6	0.044	0.036	0.050
F7	0.029	0.028	0.019
F8	0.178	0.072	0.077
F9	0.001	0.021	0.024
F10	0.054	0.065	0.078
F11	0.137	0.050	0.050
F12	0.000	0.005	0.006
F13	0.000	0.073	0.075
F14	0.001	0.006	0.016
F15	0.002	0.032	0.038
F16	0.001	0.050	0.056
F17	0.003	0.087	0.063

4.4.1 Consistence of the proposed Methods: The following methods are proposed for consistency of the relative weights obtained through the proposed methods

Correlation analysis: Correlation coefficients of the proposed methods are determined through Pearson's Coefficient method and presented in table 11.

Table 11: Correlation of proposed Methods for dtermination factors of Performance evaluation SRUTs

Method	Johnson's Method	Ordinal Logistic Regression	Ridge Regression
Johnson's Method	1.000	0.549	0.530
Ordinal Logistic Regression	0.549	1.000	0.976
Ridge regression	0.530	0.976	1.000

For consistency in factor ranking, Ridge Regression and Ordinal Logistic Regression are closely aligned. Johnson's Method offers a different but complementary perspective, making it useful when focusing on individual variable contributions. Using a combination of these methods can provide a more robust and comprehensive performance evaluation framework for SRTUs.

4.4.2 Kendall's index: Kendall's index of the proposed methods are determined through Mat-lab code and presented in the table 6.

Table 6: Kendal index values

Method	Johnson's Method	Ordinal Logistic Regression	Ridge regression
Johnson's Method	1.000	0.286	0.195
Ordinal Logistic Regression	0.286	1.000	0.800
Ridge regression	0.195	0.659	1.000

The table shows the Kendall coefficient. Ordinal Logistic Regression & Ridge Regression produce highly aligned rankings, making them reliable for predictive modelling. Johnson's Method provides a distinct perspective, making it useful for an independent assessment of factor importance. Combining insights from all three methods can lead to a more comprehensive understanding of factor significance in performance evaluation.

4.4.3 RBO index: In this method the overlap of ranking depth is determined through Python code to arrive the RBO Index and the results are presented in table 7.

Table 7: RBO Index Values

Method	Johnson's Method	Ordinal Logistic Regression	Ridge regression
Johnson's Method	1.000	0.400	0.398
Ordinal Logistic Regression	0.400	1.000	0.659
Ridge regression	0.398	0.659	1.000

The table provided shows the results for the Rank-Biased Overlap (RBO) method. Ordinal Logistic Regression and Ridge Regression are highly aligned and can be used interchangeably for factor ranking in performance evaluation. Johnson's Method provides an alternative perspective, which may be valuable when assessing factor importance in a more decomposed and interpretable manner. Using a combination of these methods can provide a more balanced and robust performance evaluation for decision-making.

4.4.4 Average Ranking Consistency Index: Average consistency index ofeach MCDM method, is determined by averaging the values in the i^{th} row and the i^{th} column (excluding the diagonal element which will always be 1 as it's the comparison of the method with itself). Average Consistency index values are presented in the table 8.

Table 8: Average Consistency index values.

Index Values	Consistency Method			Average
Relative Weight Method	Correlation	Kendall's	RBO	
Johnson's Method	0.539	0.399	0.241	0.393
Ordinal Logistic Regression	0.762	0.530	0.543	0.612
Ridge regression	0.753	0.529	0.427	0.569

OLR is the preferred choice for performance evaluation, offering stability and alignment with regression-based approaches. Ridge Regression serves as a viable alternative, while Johnson's Method provides a distinct perspective that may be useful when analyzing factor importance independently. A combination of these methods can provide a more comprehensive evaluation framework, balancing interpretability with statistical rigor.

4.4.5 Expected Relative Weights: The Three-Point Estimate (TPE) is commonly used in risk analysis and project management but can also be applied for aggregating weights from multiple methods. It helps in estimating a central tendency while accounting for variability. The expected relative weights of the factors are presented below

Factors	Johnson's Method	Ordinal Logistic Regression	Ridge regression	Min	Avg	Max	Expected
F1	0.137	0.235	0.260	0.137	0.211	0.260	0.207
F2	0.100	0.003	0.005	0.003	0.036	0.100	0.041
F3	0.182	0.172	0.165	0.165	0.173	0.182	0.173
F4	0.058	0.046	0.009	0.009	0.038	0.058	0.036
F5	0.074	0.019	0.008	0.008	0.034	0.074	0.036
F6	0.044	0.036	0.050	0.036	0.043	0.050	0.043
F7	0.029	0.028	0.019	0.019	0.025	0.029	0.025
F8	0.178	0.072	0.077	0.072	0.109	0.178	0.114
F9	0.001	0.021	0.024	0.001	0.015	0.024	0.014
F10	0.054	0.065	0.078	0.054	0.065	0.078	0.066
F11	0.137	0.050	0.050	0.050	0.079	0.137	0.084
F12	0.000	0.005	0.006	0.000	0.004	0.006	0.004
F13	0.000	0.073	0.075	0.000	0.050	0.075	0.046
F14	0.001	0.006	0.016	0.001	0.008	0.016	0.008
F15	0.002	0.032	0.038	0.002	0.024	0.038	0.023
F16	0.001	0.050	0.056	0.001	0.036	0.056	0.033
F17	0.003	0.087	0.063	0.003	0.051	0.087	0.049

4.4.6 Discussion of Results: The study's findings provide valuable insights into the performance evaluation of State Road Transport Undertakings (SRTUs) using a combination of Johnson's Method, Ridge Regression, and Ordinal Logistic Regression. One of the key results is that Fleet Utilization, Fuel Efficiency, and Staff Productivity emerge as the most significant determinants of transport efficiency across all methods. However, Ordinal Logistic Regression and Ridge Regression show the highest alignment, with a Kendall's Tau of 0.800 and an RBO score of 0.659, indicating strong consistency in ranking factor importance. In contrast, Johnson's Method deviates from regression-based approaches, showing a lower correlation (0.286 with OLR and 0.195 with Ridge Regression), suggesting it captures independent factor contributions differently.

Another significant finding is that cluster analysis classified SRTUs into three distinct groups based on performance. Cluster 1 represents low-capacity, high-cost operators, characterized by low fleet utilization and high operational costs. Cluster 2 consists of mid-scale operators, exhibiting balanced costs and moderate fleet efficiency. Cluster 3 includes high-capacity, efficient operators, demonstrating the best fuel efficiency, lower cost per unit operation, and optimized workforce productivity. This classification helps in understanding which SRTUs require targeted policy interventions to improve performance.

To further enhance the robustness of factor ranking, the study employed multiple aggregation techniques, including the Three-Point Estimate (TPE), Rank-Biased Overlap (RBO), and Kendall's Tau, ensuring that the rankings were less sensitive to variations across methods. The final aggregated ranking confirmed that Fleet Utilization, Fuel Efficiency, and Staff Productivity remain dominant factors, reinforcing their critical role in transport performance.

Concluding Remarks

The study presents a comprehensive evaluation of State Road Transport Undertakings (SRTUs) in India by identifying and ranking key performance factors using Johnson's Method, Ridge Regression, and Ordinal Logistic Regression. The results highlight that Fleet Utilization, Fuel Efficiency, and Staff Productivity are the most critical determinants of transport efficiency, with Ordinal Logistic Regression and Ridge Regression showing the highest consistency and alignment. Cluster analysis further classified the SRTUs into three distinct groups, where high-performing operators exhibited better fuel efficiency, cost-effectiveness, and optimized workforce productivity. The study also employed weight aggregation techniques, including the Three-Point Estimate (TPE), Rank-Biased Overlap (RBO), and Kendall's Tau, ensuring robustness in ranking factor importance. The findings provide valuable insights for policymakers, emphasizing the need for fleet optimization, cost reduction, and sustainable transport strategies. While this research establishes a strong methodological foundation, future work can enhance the framework by integrating machine learning models, expanding data scope, incorporating real-time transport metrics, and exploring sustainability-focused evaluations. By leveraging advanced analytics and AI-driven approaches, future studies can further optimize public transport efficiency, policy formulation, and strategic decision-making for sustainable urban mobility.

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