Comparison of Transport Fares across the States of the Southeast Region of Nigeria Using the Kruskal–Wallis (H) Test

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ABSTRACT

This study investigated transport fares across the South-eastern states of Nigeria, utilizing data obtained directly from the National Bureau of Statistics. The primary focus was on three types of transportation: bus journeys (within the city), bus journeys (intercity), and journeys by motorcycle (okada). It was observed that the collected datasets did not meet the assumptions of normality and homogeneity of variance. As a result, the Kruskal–Wallis (H) test, a nonparametric method particularly suited for comparing three or more independent groups, was employed for the analysis. The findings revealed significant variations in the prices of bus journey (within city), bus journeys (intercity) and journey by motorcycle (okada) across the South-eastern states, Imo State recorded the highest average price for bus journey (within city) and journey by motorcycle (okada), while Anambra State had the highest average price for bus journeys (intercity) during the study period.

Keywords: Transport fare, South-eastern Nigeria, Price fluctuation, Nonparametric Statistics

INTRODUCTION

Public transportation is crucial in both developed and developing cities, offering an affordable alternative to private car ownership for urban commuters. The demand for public transport services is closely tied to the quality of urban life, as well as the dynamics of households, communities, and social networks. To effectively plan and operate public transport systems or to develop sound policies, it is essential to understand the specific characteristics of public transport users. Without this understanding, making accurate demand forecasts would be challenging. (Pulcher J, 1988).

The Nigerian economy has experienced significant volatility in recent years, largely attributable to global economic pressures, domestic economic policies, and various local developments.

Notably, the nation has encountered two distinct recessions one in 2016 and another in 2020 which precipitated acute inflationary trends that severely impacted transportation costs. Inflation serves as a critical driver of the cost of living, exerting upward pressure on transportation expenses due to escalating fuel prices, increased vehicle maintenance requirements, and the rising costs of spare parts, many of which are sourced through imports. Consequently, the erosion of individual purchasing power, engendered by persistent inflation, compels transport operators to raise fares in an effort to sustain their operational viability. This situation highlights the intricate interplay between macroeconomic factors and the transportation sector within Nigeria's economic landscape. National Bureau of Statistics (NBS), (2022).

A fundamental factor influencing transportation fares in Nigeria, particularly in the South East region, is the cost of fuel. The nation’s fuel subsidy policy, which has been a source of contention for several decades, underwent significant reforms in 2023 with the elimination of subsidies. This policy shift resulted in a substantial increase in the pump prices of both petrol and diesel. Given that road transport constitutes the predominant means of mobility in the South

East, fluctuations in fuel prices have a direct correlation with changes in transportation fares. The removal of fuel subsidies has notably impacted public transportation systems, leading to fare increases that have placed considerable strain on both commuters and businesses within the region. Central Bank of Nigeria, (CBN) (2023).

In addition to the aforementioned issues, social and psychological challenges, along with economic difficulties faced by public transportation management in many Nigerian states, have further negatively impacted the country's transport system. The availability of formal transportation modes was significantly insufficient, and the Structural Adjustment Programme in Nigeria exacerbated the situation (Adeniji, 1983).

Paratransit modes share common characteristics and operational features across most locations where they are used. For instance, they provide personalized services, particularly for passengers traveling to specific destinations. Another notable feature is the flexibility of informal public transport compared to mass transit, offering door-to-door services or dropping passengers off at unplanned locations upon request. However, poor vehicle maintenance, neglect, and the desire to maximize profits have led to a decline in service quality and overuse of vehicles. As a result, many vehicles used for informal public transport are noisy, emit smoke, and are often in poor condition, posing environmental hazards to both road users and pedestrians (Fadare, 1990).

Road infrastructure plays a crucial role in shaping transport fare dynamics. In the South East region, poor road conditions have historically led to higher transportation costs, mainly due to increased vehicle maintenance, longer travel times, and inefficiencies in the transport network. Projects like the rehabilitation of the Enugu–Port Harcourt Expressway and the construction of the Second Niger Bridge have been undertaken to address these transportation issues. However, despite these significant efforts, many rural and urban roads remain underdeveloped. This persistent shortfall contributes to higher transport fares in certain areas, particularly during the rainy season (Federal Ministry of Works and Housing, 2021).

The nature and extent of the influence of these factors differ from city to city and even within the same urban center (Soltani & Ivaki, 2011; Solanke, 2014a; Solanke, 2014b; Busari et al., 2017; Okeke et al., 2021).

The study was aimed at:

a. To compare Bus journey within city across the states

b. To compare Bus journey intercity across the states, and

c. To compare Journey by motorcycle (okada) per drop across the state

MATERIALS AND METHODS

The data were analyzed using the Kruskal – Wallis (H) one way analysis of variance statistics.

The Kruskal–Wallis test is a non-parametric statistical test used to compare three or more independent groups in order to determine if there are statistically significant differences between their medians. It is an extension of the Mann–Whitney U test and is appropriate when the assumptions of one–way ANOVA (Analysis of Variance), particularly the assumption of normality and homogeneity of variance of the error terms, are violated.

$$H = \frac{12}{N(N+1)}\sum_{j=1}^{k}\frac{R_j^1}{n_j} - 3(N+1) \qquad (1)$$

where:

N is the total number of observations in all groups

R_j is the rank total for each group

n_j is the number of observations in each group

Kruskal–Wallis test as a non–parametric test does not require the data to be normally distributed and the datamust independent groups of observations. It works with either ordinal or continuous data, such as ranked data or continuous data that can be ranked.

The steps for computation of the Kruskal–Wallis test are to:

a. combine all observations from all groups and rank them.
b. find the sum of ranks for each group. Use the formula to calculate the test statistic (H)
c. compare the test statistic with a chi–square or a p–values distribution to assess its significance.

RESULTS AND DISCUSSION

Results

Comparing Bus Journeys within City across the States

Table 1a: Ranks for fares of bus journeys within city

	State	N	Mean Rank
Bus journey within city, per drop constant route	Abia	94	232.91
	Anambra	94	200.18
	Ebonyi	94	273.81
	Enugu	94	225.61
	Imo	94	244.99
	Total	470	

In Table 1a, we can find the average ranks of the fares for each state, which provides insight into the states with the lowest and highest ranks in terms of fare prices. This information can be valuable for understanding the variation in fare costs across different states.

Table 1b: Independent-Samples Kruskal-Wallis Test Summary

Total N	470
Test Statistic	14.828[a]
Degree Of Freedom	4
Asymptotic Sig.(2-sided test)	0.005

a. The test statistic is adjusted for ties.

The Kruskal–Wallis test summary, as shown in Table 1b, indicates that H=14.828 and p=0.005. Therefore, we conclude that the prices of bus journeys within the city, per drop constant route, vary significantly across the states. In other words, there is a significant difference in prices across the states.

Table 1c: Pairwise Comparisons of State

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Anambra-Enugu	-25.436	19.811	-1.284	0.199	1
Anambra-Abia	32.739	19.811	1.653	0.098	0.984
Anambra-Imo	-44.814	19.811	-2.262	0.024	0.237
Anambra-Ebonyi	**-73.633**	**19.811**	**-3.717**	**0**	**0.002**
Enugu-Abia	7.303	19.811	0.369	0.712	1

Enugu-Imo	-19.378	19.811	-0.978	0.328	1
Enugu-Ebonyi	48.197	19.811	2.433	0.015	0.15
Abia-Imo	-12.074	19.811	-0.609	0.542	1
Abia-Ebonyi	-40.894	19.811	-2.064	0.039	0.39
Imo-Ebonyi	28.819	19.811	1.455	0.146	1

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

The results of the pairwise comparison test presented in Table 4.1c indicate that the only significant difference is between Anambra and Ebonyi states. Ebonyi state shows a higher average rank, as illustrated in Table 4.1a. Therefore, it can be concluded that from 2016 to 2023, Ebonyi state had the highest average price for bus journeys along fixed routes within the city compared to other southeastern states.

Comparing Bus journey intercity across the states.

Table 2a: Ranks for fares of Bus journey intercity

	State	N	Mean Rank
Bus journey intercity, state	Abia	94	231.2
	Anambra	94	244.23
	Ebonyi	94	225.95
	Enugu	94	199.38
	Imo	94	276.74
	Total	470	

Table 2a provides the average fare ranks for each state, highlighting states with the lowest and highest fare prices. This data offers valuable insights into the disparities in fare costs across different regions.

Table 2b: Independent-Samples Kruskal-Wallis Test Summary

Total N	470
Test Statistic	16.265[a]
Degree Of Freedom	4
Asymptotic Sig.(2-sided test)	0.003

a. The test statistic is adjusted for ties.

As displayed in table 2b, the results of the Kruskal-Wallis test reveal a significant variation in intercity bus journey prices across the southeastern states, with a test statistic of H=16.265 and a p-value of 0.003. This statistically significant outcome indicates that fare costs differ markedly among various states in the southeast region.

Table 2c: Pairwise Comparisons of State

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Enugu-Ebonyi	26.569	19.811	1.341	0.18	1
Enugu-Abia	31.824	19.811	1.606	0.108	1
Enugu-Anambra	44.851	19.811	2.264	0.024	0.236
Enugu-Imo	**-77.367**	**19.811**	**-3.905**	**0**	**0.001**
Ebonyi-Abia	5.255	19.811	0.265	0.791	1
Ebonyi-Anambra	18.282	19.811	0.923	0.356	1
Ebonyi-Imo	-50.798	19.811	-2.564	0.01	0.103
Abia-Anambra	-13.027	19.811	-0.658	0.511	1
Abia-Imo	-45.543	19.811	-2.299	0.022	0.215
Anambra-Imo	-32.516	19.811	-1.641	0.101	1

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

From table 2c, it is evident that the paired comparison of fares between Enugu and Imo is significant, with a p-value of 0.001, which is below 0.05. A closer examination of table 2a reveals that Imo has the highest average rank for fare costs. Thus, it can be concluded that Imo State has the highest average prices for intercity bus journeys in the Southeast region from 2016 to 2023. In other words, travelling from cities in Imo State to other cities in the Southeast region generally incurs higher costs.

Comparing the journey by motorcycle (okada) across the states.

Table 3a: Ranks for fares of Journey by motorcycle (okada)

	State	N	Mean Rank
Journey by motorcycle	Abia	94	222.54
	Anambra	94	163.76
	Ebonyi	94	266.65
	Enugu	94	248.82
	Imo	94	275.72
	Total	470	

Table 3a illustrates that Imo State possesses the highest average price rank for motorcycle journeys (okada), while Anambra State ranks the lowest in this regard. Additionally, the table provides the average price ranks for other states, offering a comparative analysis of motorcycle transport costs across the region.

Table 3b: Independent-Samples Kruskal-Wallis Test Summary

Total N	470
Test Statistic	41.173[a]
Degree Of Freedom	4
Asymptotic Sig.(2-sided test)	.000

a. The test statistic is adjusted for ties.

According to the results presented in Table 4.3b, the application of the Kruskal–Wallis test reveals a statistically significant variation in motorcycle journey (okada) prices across the southeastern states. The computed test statistic is H=41.173, accompanied by a p-value of 0.000. This finding suggests that there are notable discrepancies in fare costs among the different states within the southeastern region, warranting further investigation into the underlying factors contributing to this variation.

Table 3c: Pairwise Comparisons of State

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Anambra-Abia	58.782	19.811	2.967	0.003	0.03
Anambra-Enugu	-85.064	19.811	-4.294	0	0
Anambra-Ebonyi	-102.89	19.811	-5.194	0	0
Anambra-Imo	**-111.96**	**19.811**	**-5.651**	**0**	**0**
Abia-Enugu	-26.282	19.811	-1.327	0.185	1
Abia-Ebonyi	-44.112	19.811	-2.227	0.026	0.26
Abia-Imo	-53.176	19.811	-2.684	0.007	0.073
Enugu-Ebonyi	17.83	19.811	0.9	0.368	1
Enugu-Imo	-26.894	19.811	-1.357	0.175	1
Ebonyi-Imo	-9.064	19.811	-0.458	0.647	1

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Upon examining Table 3c in relation to Table 3a, it becomes evident that there is a significant difference in the paired comparison of fare costs between Anambra and Imo states. Therefore, we can conclude that specifically, Imo state exhibited the highest fare cost for motorcycle journeys (okada) compared to the other states in the southeastern region between 2016 and 2023.

NORMALITY AND HOMOGENEITY OF VARIANCE TESTS

Table 4a: Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	State	Statistic	df	Sig.	Statistic	df	Sig.
Residual for Within_City	Abia	.296	94	.000	.712	94	.000
	Anambra	.229	94	.000	.671	94	.000
	Ebonyi	.222	94	.000	.720	94	.000
	Enugu	.217	94	.000	.742	94	.000
	Imo	.263	94	.000	.750	94	.000
Residual for Intercity	Abia	.284	94	.000	.789	94	.000
	Anambra	.255	94	.000	.726	94	.000
	Ebonyi	.235	94	.000	.771	94	.000

	Enugu	.253	94	.000	.728	94	.000
	Imo	.152	94	.000	.888	94	.000
Residual for Okada	Abia	.254	94	.000	.759	94	.000
	Anambra	.176	94	.000	.812	94	.000
	Ebonyi	.237	94	.000	.857	94	.000
	Enugu	.244	94	.000	.799	94	.000
	Imo	.265	94	.000	.827	94	.000

Looking at Table 4a, it can be observed that the p–values for the tests of normalities of the error terms (residuals) are all 0.000, less than 0.05. It therefore implies that the data for the transport fares across the states violate the assumption of normality.

Table 4b: Test of Homogeneity of Variances

		Levene Statistic	**df1**	**df2**	**Sig.**
Residual for Within_City	Based on Mean	1.586	4	465	.177
	Based on Median	.758	4	465	.553
	Based on Median and with adjusted df	.758	4	449.328	.553
	Based on trimmed mean	1.543	4	465	.189
Residual for Intercity	Based on Mean	1.809	4	465	.126
	Based on Median	.555	4	465	.695
	Based on Median and with adjusted df	.555	4	394.600	.695
	Based on trimmed mean	1.213	4	465	.304
Residual for Okada	Based on Mean	24.730	4	465	.000
	Based on Median	8.057	4	465	.000
	Based on Median and with adjusted df	8.057	4	376.462	.000
	Based on trimmed mean	22.059	4	465	.000

Table 4b shows that the homogeneity of variance of the error terms for within-city and intercity are 0.177 and 0.126, both above 0.05, whereas that for journey by motorcycle (okada) is 0.000, which is less than 0.05. It implies that the data for within–city and intercity met the assumptions of homogeneity of variance, while journey by motorcycle violated the assumption.

Therefore, the choice of Kruskal–Wallis became important due to the violation of the assumption of normality as seen in Table 4a.

DISCUSSION

The tests revealed that Bus journey within city varies significantly across the states. That is there is signific-

ant difference in the prices across the states. These findings align with previous studies (Soltani & Ivaki, 2011; Solanke, 2014a; Solanke, 2014b; Busari et al., 2017; Okeke et al., 2021) pointing to the influence of poor infrastructure, emphasizing the need for policy measures aimed at reducing transportation costs and enhancing efficiency to address price disparities.

We concluded that bus journey intercity vary significantly across the states. Interestingly, this finding is consistent with other research on transportation fare convergence in Nigeria (National Bureau of Statistics (NBS), (2022), suggesting that escalating fuel prices affect transport prices.

Regarding journey by motorcycle (okada), we confirmed significant price differences among the states. These results support prior research, such as (Federal Ministry of Works and Housing, 2021), which examined regional variations in transportation price inflation. This highlights the need for policy interventions to reduce transportation costs and improve market efficiency in order to mitigate these price variations.

CONCLUSION

The test results, with a statistically significant p-value, indicate that transportation costs vary considerably between states, suggesting that factors such as geographical location, infrastructure quality, fuel costs, and state-specific policies likely influence these disparities. The analysis highlighted that certain states consistently exhibited higher transportation fares compared to others, pointing to potential inefficiencies or economic conditions unique to those states.

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