



Perceived Impact of Abuja-Kaduna Rail Transit on the Commuters' Mode of Choice

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ABSTRACT

The Abuja-Kaduna rail is expected to make huge impact on mobility of commuters and on transportation infrastructure within the connecting cities. This research examines the impact of rail transit on the mode of choice of commuters along the route. The data for the study was collected through issuance of structured questionnaire with particular interest to safety, trip fare, waiting time, comfort, and in-vehicle travel time. These parameters showed strong relationship as indicated using regression analysis. The willingness of commuters to shift mode was determined using Kolmogorov-Smirnov test. The result shows about 65% of bus transit users are willing to shift to rail transit. This shift was estimated to attract an increase of about 10,054 passengers which will increase the number of rail transit trips from 8 to 16 trips/day. In order to make rail transit more successful, the study recommends that the policy makers should; improve the safety of train by engaging on track inspection, provide on-board monitoring system and passenger equipment safety, improve comfort through provision of adequate and hygienic convenience at stations and within train coaches, increase number of stoppages as well as frequency of the trips to cover most of the trips made by commuters.

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INTRODUCTION

Transport needs of major cities in Nigeria now present significant challenges for policy makers as unpredicted shifts in population dynamics in response to the need for employment, housing, and sustenance continues. The expansion of the cities in Nigeria, coupled with increasing urban population, results in greater demand for transport provision. This demand has, however, not always been met, and efforts to provide adequate transport infrastructural facilities are ad hoc, uncoordinated and poor [1].

Despite the development of road transportation system in Nigeria as a whole and in urban centers in particular, the urban centers are still experiencing many transportation problems which include traffic overloading especially during working hours, decreasing travel speeds and deteriorating travel environment for pedestrians and non-motorized modes of transportation [2]. This is because the provision of transport facilities is expanding at rates slower than the rates of growth of the urban population and expansion of urban area

thus creating a wide margin between demand and supply of urban infrastructural facilities and services [3].

Abuja-Kaduna highway is one of the major roads that links two of the most important cities in the country, but is faced with increasing uncertainties to do with safety of the travel which include bad state of the road, accidents, over-speeding, traffic overloading, poor condition of the vehicles, disobeying of traffic rules and regulations by some drivers, percentage of heavy vehicles on the road, drivers' perception and reaction to obstacles, etc. The issue of longer waiting time is another factor which commuters using public transport always battle with at various motor parks because there are no transport schedules. In addition, higher and fluctuating ticket prices, longer in-vehicle travel time and lack of comfort are not to be overlooked as many public transport commuters felt various degree of unsatisfied services from the operators ranging from overloading to condition of vehicles, excessive stoppages etc. These uncertainties and challenges faced by commuters prompted



the urgent need for government to provide other means of transportation to cushion the hardships felt by the commuters.

The 186km Abuja-Kaduna standard gauge railway provide a safe and secure, fast and affordable means transportation that will give commuters more variety of options for their day-to-day mobility between the two cities. The rail transit serves as a viable alternative means of transportation among commuters traveling between Abuja-Kaduna and is gaining more popularity and patronage because of its' perceived advantages in terms of comfort, less accident rate traffic hurdle, less passenger waiting time, capacity, fastness and affordability among other factors. This study was carried out in order to study the "Impact of Abuja-Kaduna Rail Transit on Bus Transit, A User Perspective". The study explores the possibilities of using the Rail transit as a viable option for commuters traveling between Abuja-Kaduna. The study measures the amount of shift from Bus transit users to Rail transit. The parameters used in measuring the shift are; safety, trip fare, comfort, waiting time and in-vehicle travel time. In addition, the proportion of passengers using bus transit that are willing to shift to rail transit along shall be determined. The study is expected to contribute immensely to the body of knowledge on transport planning and it will assist other researchers carrying out further studies on the rail sector and as well as the transport system in general.

The mode choice is the choice of the particular mode in the existing situation. For example, a commuter may select any one of the following modes to travel between two nodes; walk, cycle, motor cycle, automobile, bus, railway and ferry service. The choice is entirely based on the productive advantage of the particular mode. Thus, the modal shift involves the growth in the demand of a transport mode at the expense of another, although it can involve an absolute growth in both of the concerned modes. The comparative advantages behind the shift can be in terms of cost (fare), comfort, speed or reliability, safety, waiting time, in-vehicle travel time, etc. [4].

This study differs from the previous in the sense that it focuses solely on the impact of rail transit on bus transit alone. Both socio-economic and trip variables were considered, while, level of service was not adopted in this study because it is a different study on its own.

However, trip purposes which was ignored by the previous researches has been specified by this study, also the waiting time has been considered and quantified in this study.

METHODOLOGY

Study Area

The Abuja-Kaduna rail line is one of the first standard gauge railway modernisation projects (SGRMP) undertaken in Nigeria. The standard gauge line connects federal capital city Abuja with its commercial capital Kaduna, enabling faster movement of goods and people between the two cities. The rail consist of 186km line with standard gauge railway tracks from Idu in Abuja to Rigasa in Kaduna. It has two terminals, at Rigasa and Idu and features both passenger and cargo trains. The passenger trains on the line can operate at a speed between 200km/h and 250km/h and can carry up to 5,000 commuters daily. The cargo trains can carry up to 800tons of goods and will take one and half hours or there about to travel between the two cities.

Data

A survey was conducted through a structured questionnaire and interviews for passengers at Kawo Motor Park in Kaduna, command motor garage in Abuja. For the rail transit, the survey was conducted at Rigasa station in Kaduna and Idu station in Abuja as well as inside the coaches of the train. The survey lasted for six months for commuters of Rail Transit and Bus Transit. Data obtained were analyzed using descriptive statistics such as tabulation, graphs, averages, and percentages in order to investigate the relationship between the variables. Kolmogorov-Smirnov test was used in testing the willingness of the commuters to shift modes from private cars and bus transit to rail transit. Also, a regression analysis was carried out which provide the basis for predicting the values of a variable (dependent) from the values of one or more other variables (independent). The result obtained from the regression analysis was used in determining the utility functions of the three modes in the study area and in turn, in estimating the proportions of mode choice. Finally, a Chi-Square test was conducted in order to estimate the differences in the people's willingness to either to rail transit or continue using their own modes. The statistics were



estimated using SPSS 24 statistical software. From the reliability test conducted, the Cronbach's Alpha value was obtained as 0.69 which is acceptable. Furthermore, validation of the questionnaire was performed by experts who understand the topic under investigation.

To determine the proportion of commuters in the study area choosing a specific travel mode, we use the multinomial logit model expressed as a probability distribution stated as follows;

$$P(k) = \frac{e^{U_k}}{\sum_{i=1}^n e^{U_k}} \quad (1)$$

The calibration of the mode choice can be expressed as follows;

$$U_T = K + TF + WT + IVT$$

i.e. $U_T = 0.551 - X_1(0.007) - X_2(0.055) - X_3(0.061)$ (2)

Where ; K = mode specific constant and

X_1 = Trip fare,

X_2 = Waiting time,

X_3 = In-vehicle travel time

The attributes of the three modes are shown in the table 1;

Table 1: Attributes of the two modes

Attributes	Trip fare (X_1) (N/HR)	Waiting time (X_2) (HR)	In-vehicle travel time (X_3) (HR)
Bus transit	205.96	1.15	2.59
Rail transit	153.55	0.25	1.45

Using the relationship expressed in eqn. 2, the utilities associated with the Bus transit (U_B) and Rail transit (U_R) are computed using the values of each of the attributes from Table 1

$$U_B = -1.512, U_R = -0.626$$

The probability of making trip by each mode based on commuters' willingness to shift is computed as follows:

$$P_{(\text{Bus transit})} = \frac{e^{U_B}}{e^{U_B} + e^{U_R}} = 29\%$$

$$P_{(\text{Rail transit})} = \frac{e^{U_R}}{e^{U_B} + e^{U_R}} = 71\%$$

Given that the approximate population for the entire area of study is 14,200 passengers (approximately 608 trips/day), the corresponding mode share (Q_{ij}) for each mode of transport can be computed as;

$$Q_{ij} (\text{Bus transit}) = 4146 \text{ commuters, } Q_{ij} (\text{Rail transit}) = 10054 \text{ commuters}$$

The impact of rail transit mode on bus transit revealed that the rail transit will attract 71% of the entire population, i.e. 10054. This

Model Calibration

In the selection of variable to be employed in the analysis, three variables from the modes attributes (trip fare, waiting time and in-vehicle travel time) were use in the model calibration as both have significance influence on the mode choice of commuters. In calibrating the model, the utilities of the modes represent the dependent variable while, the characteristics of both the mode and the trip maker (traveler) represents the independent variables.

gives an increment of about 4,854 passengers and the number of trips may increase from 8 to 16 trips/day. It will reduce bus transit mode from 9,000 passengers (i.e. 71% of the population) to 4146 passengers (i.e. 29% of the population), this gives a reduction of about 5,856 passengers and reduces the number of trips from 600 to 460 trips/day.

RESULTS AND DISCUSSION

The demographic distribution of the respondents shows that majority of the respondents (68%) are Male while the remaining 32% are Female. This shows that male commuters travel along Abuja-Kaduna route more than their female counterparts. Result further shows that majority of the respondents 325 representing 74% of the total respondents are between the Age of 18–40 years. 91 respondents representing 21% of the total respondents are between the Age of 41–65 years while 3% of the total respondents are above 65 years and the remaining 2% are below the Age of 18 years. This signifies that majority of the respondents are adult and can give



informed response to the survey questions. In the same vein, result shows that majority of the respondents are married with 324 respondents representing 74% of the total respondents, 23% of the respondents are single while only 3% of the total respondents are divorced. Result shows that, majority of the respondents (87%) are adults and are above primary/secondary level. This comprises Diploma/NCE, HND/First Degree and Postgraduate holders who can reason and give a clear and desired response needed for this study. This is based on their level of education and experience. On the respondent's occupation, 39% of the

respondents are Business Class, 30% are Students, 20% are Civil Servants, 9% are Self-Employed while the remaining 2% are Not-Employed. Finally, the income groups of the respondents indicate that about 30% are upper class/wealthy, 45% are average/middle class while 25% of the respondents are lower class/poor.

Research Question 1: How does Abuja-Kaduna rail transit service determine the willingness of the commuters to shift from private cars and bus transit to rail transit?

Table 2: Determinant of Abuja – Kaduna Commuter Willingness to Shift

	Yes	No	Don't Know
1 Do you own a car?	278 (64%)	159 (36%)	0 (0%)
2 Do you usually make trips?	426 (97%)	11 (3%)	0 (0%)
3 Do you think the new rail transit have gained patronage among commuters traveling along Abuja-Kaduna? In your assessment,	422 (96%)	11 (3%)	4 (1%)
4 Do you consider the rail transit as a good option for commuters traveling along Abuja-Kaduna?	416 (95%)	15 (4%)	6 (1%)
5 Are you willing to shift from your present mode to rail transit?	262 (60%)	162 (37%)	13 (3%)

Result shows that 64% of the respondents owns a car while 36% does not. This indicates that those who do not own a car as well as some who own cars travels along Abuja-Kaduna. While 97% of the respondents usually make trips along the Abuja – Kaduna route, 3% of the total respondents do not usually travel along the route. Furthermore, 96% of the total respondents representing a significant majority are of the opinion that the new rail transit has gained patronage among commuters traveling along Abuja-Kaduna. Similarly, on personal assessment 95% of the respondents consider the rail transit as a good option for commuters traveling along Abuja-Kaduna. Also, 60% of the respondents are willing to shift from

their present mode to rail transit while 37% of the respondents are not willing to shift from their present mode to the rail transit and 3% of the respondents are yet to decide or make up their minds. This shows that there is need to do more by the policy makers to attract more passengers to shift mode. The rail transit operators should improve on their services by extending the rail system service to cover almost all the trips the commuters are making together with improvement of the factors like comfort, the frequency of the trips, etc., as well as extending the rail system to cover more areas (like the city centres). This may influence the commuters to shift to the rail and only consider using other modes occasionally.

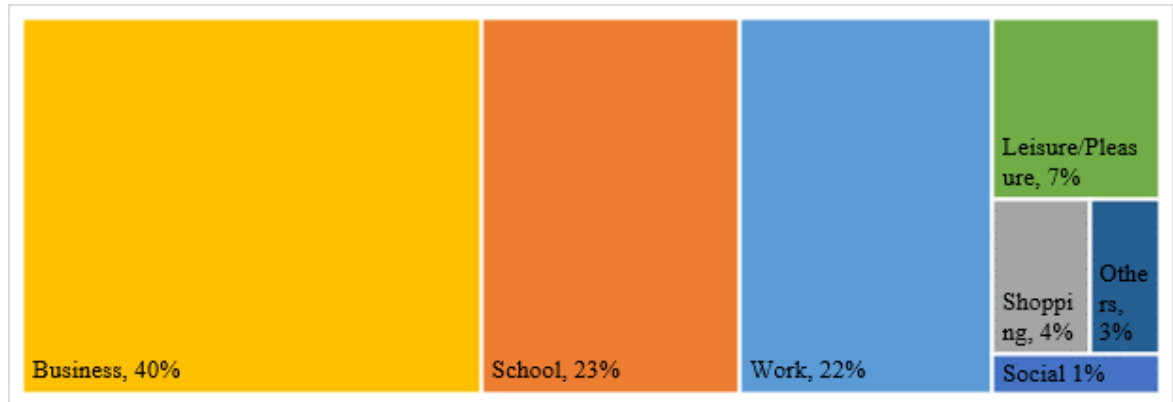


Fig. 1: Purpose of trip usually made by commuters

Fig. 1 shows the purpose of trips usually made by commuters along Abuja-Kaduna road. Results shows that majority of the commuters (40%) usually travel along the route for business purposes. 23% of the commuters usually travels along the route for academic purposes while another 22% of the respondents usually take the route to go to their working places. Only 7% and 4% of the respondents takes the route for leisure/pleasure and shopping purpose respectively. This shows that

more business trips are made on the Abuja-Kaduna road followed by school and work trips, indicating the importance of ensuring a comfortable, safe and cost effective transport system along the route.

Hypothesis 1: Abuja-Kaduna rail transit service does not significantly determine the willingness of the commuters to shift from bus transit to rail transit.

Table 3: One-Sample Kolmogorov-Smirnov Test

Variable	N	Mean	Std. D	p.value
Do you own a car?	437	1.34	0.482	0.000 ^c
Do you usually make trips?	437	1.55	0.323	0.000 ^c
What is the purpose of the trip you frequently make?	437	3.08	1.621	0.000 ^c
Do you think the new rail transit have gained patronage among commuters traveling along Abuja-Kaduna?	437	1.26	0.314	0.000 ^c
In your assessment, do you consider the rail transit as a good option for commuters traveling along Abuja-Kaduna?	437	1.37	0.320	0.000 ^c
Are you willing to shift from your present mode to rail transit?	437	1.62	0.607	0.000 ^c

Result from Table 3 shows the Kolmogorov-Smirnov test (K-S test). Result shows that the average mean and standard deviation for those who own a car was 1.34 and 0.482 respectively. The mean of 1.34 indicates that majority of the respondents are car owners. The mean also indicates that most of the respondents are willing to shift from their present mode to rail transit. The standard deviation of 0.482 indicates that there is little dispersion among the respondents. Result as

shown from the table indicate that all the variables are significant at 5% level of significance, i.e 0.05 > p-value. Therefore, the hypothesis which states that Abuja-Kaduna rail transit service does not significantly determine the willingness of the commuters to shift from private cars and bus transit to rail transit is hereby rejected.

Research question 2: Does safety, trip fare, comfort, waiting time, and in-vehicle travel time

influence the mode choice of Abuja-Kaduna commuters?

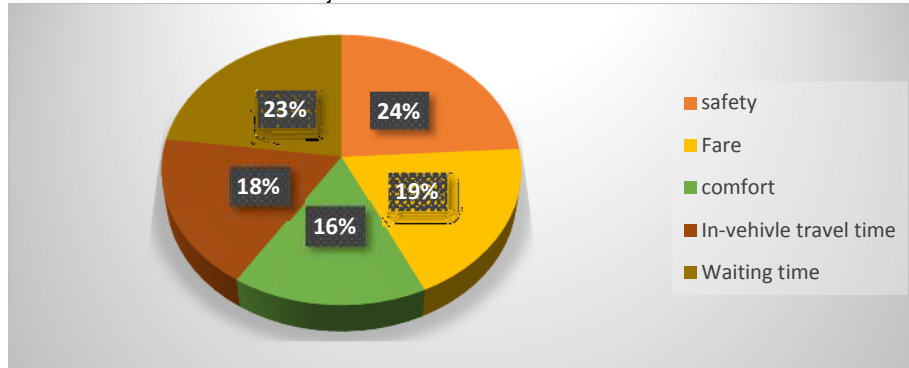


Fig. 2: Respondents reason for choice of a particular mode of transport

Result shows that 24% of the respondent considered safety as the determining factor of the mode of transportation while travelling along Abuja-Kaduna road. While 23%, 19%, 18% and 16% of the respondents respectively considered waiting time, trip fare,

in-vehicle travel time and comfort as the main reason for their mode choice. This shows that the parameters used in getting commuters' response for this study have close agreement with one another.

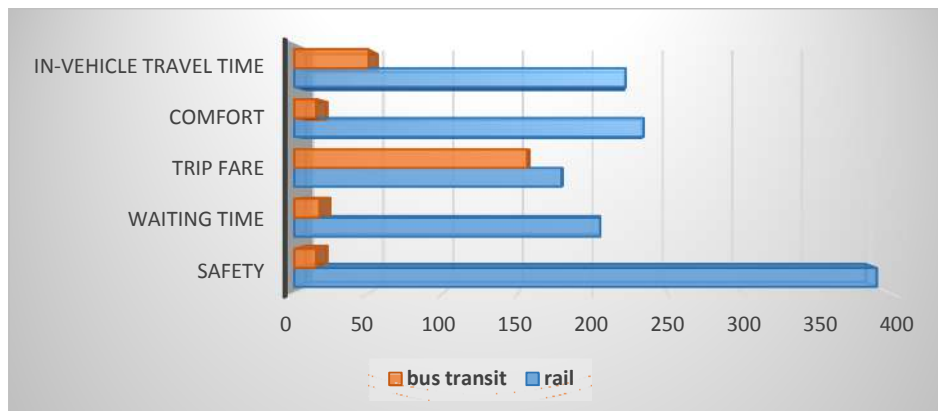


Fig 3: Commuters mode choice based on factors associated with travelling

Result shows that, if safety is considered, majority of the respondents believed that rail transit is the best mode of transportation. Considering in-vehicle travel time, majority of the respondents believed that going by rail transit will be the best mode while only a small unit of the respondents believe traveling with bus transit is considered faster. For comfort, majority of the respondents consider rail transit as the best mode, while only a few considered bus transit as comfortable. Similarly, for trip fare which is affordability, while

majority of the respondents will consider rail transit as being the most affordable, significant commuters also considered bus transit as more affordable. For the waiting time, significance number of commuters considered rail transit as less or no waiting time at all. Very few considered bus transit with less waiting time.

Hypothesis 2: Safety, trip fare, comfort, waiting time and in-vehicle travel time does not significantly influence the mode choice of Abuja-Kaduna commuters.



Table 4: Mean and Standard deviation of factors influencing mode choice

	Mean	Std. Deviation	N
Trip fare	1.97	0.695	437
Waiting time	2.11	0.580	437
In-vehicle travel time	1.98	0.663	437
Safety	2.20	0.760	437
Comfort	2.05	0.558	437

Result shows that trip fare with a mean (weighted average) of 1.97 out of a possible 3 and a standard deviation of 0.695 have significance influence on commuters' mode choice. The mean of 1.97 indicates that most of the commuters are concerned about trip fare. The standard deviation of 0.695 indicates that there is little dispersion regarding trip fare among the respondents. However, result shows

that waiting time with a mean of 2.11 out of possible 3 and with a standard deviation of 0.580, Safety with a mean of 2.20 and a standard deviation of 0.760, In-vehicle travel time with a mean of 1.98 and standard deviation of 0.663 and Comfort with a mean of 2.05 and a standard deviation of 0.554 all influences the mode choice of commuters travelling along Abuja-Kaduna road.

Table 5: Regression Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
	(Constant)	0.551	0.409		-1.702	0.002
	Trip Fare	-0.007	0.073	0.050	-1.886	0.001
	Waiting time	-0.055	0.091	0.480	-3.723	0.000
	In-vehicle travel time	-0.061	0.096	-0.134	-2.686	0.002
F = 42.489, Sig = 0.000, R = 0.81, R ² = 0.66						
a. Dependent Variable: Mode choice						

The regression result as presented in Table 5 shows that the coefficient of correlation R is 0.81 which implies that approximately 81% of the variation in mode choice can be explained by the independent variables (safety, waiting time, comfort, in-vehicle travel time and trip fare). The remaining 19% can be explained by other variables not captured in this study. Also, the coefficient of determination R² was obtained as 0.66 (i.e. 66%) which implies that there is a strong relationship between the dependent and independent variables. The F-test was obtained as 42.489 which indicates that regression model provides a good fit to the data. From the values of T-test obtained, result shows that the values are great enough to justify evidence against the null hypothesis. This implies that the overall

model is significant at 5% level of significance. However, waiting time with a coefficient of -0.055 and a p-value of 0.000, In-vehicle travel time with a coefficient of -0.061 and a p-value of 0.002, Trip fare with a coefficient of -0.007 and a p-value of 0.001 all have significant impact on the mode choice of Abuja-Kaduna commuters. Therefore, the null hypothesis which state that safety, trip fare, comfort, waiting time, and in-vehicle travel time does not influence the mode choice of Abuja-Kaduna commuters is hereby rejected.

Research Question 3: What is the proportion of passengers using bus transit willing to shift to rail transit?



Table 6: Cross tabulation of the proportion of commuters' willingness to shift

Mode	Are you willing to shift from your present mode to rail transit?			Total
	Yes	No	Can't say	
Bus Transit	119 (65%)	56 (31%)	7 (4%)	182 (100%)
Others	17 (65%)	9 (35%)	0 (0%)	26 (100%)
Total	262 (60%)	162 (37%)	13 (3%)	437 (100%)

Result from table 6 shows that 65% of commuters who presently use Bus transit are willing to change to rail transit while only 31% are unwilling to change. Furthermore, 65% of those who uses other modes are willing to change to rail transit while 35% of those commuters are not willing to shift to rail transit. In total, the percentage of commuters willing to shift from their present mode to rail transit has

been found to be 60% while those not willing to shift has been found to be 37%, only 3% of the commuters could not make up their mind.

Hypothesis 3: Abuja-Kaduna rail transit service does not determine the proportion of the passengers using bus transit willing to shift to rail transit.

Table 7: Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.590 ^a	4	0.013
Likelihood Ratio	14.774	4	0.005
Linear-by-Linear Association	8.646	1	0.003
N of Valid Cases	198		

a. 2 cells (22.2%) have expected count less than 5. The minimum expected count is 2.17.

Table 7 shows the results of the chi-square test. The results of chi-square test show if Abuja-Kaduna rail transit service determine the proportion of the passengers using bus transit willing to shift to rail transit. Result shows that the Pearson chi-square value is 12.59 with a p-value of 0.013. This indicates that the result is significant at 5% significant level. Therefore, the null hypothesis which states that Abuja-Kaduna rail transit service does not significantly determine the proportion of the passengers using bus transit willing to shift to rail transit is hereby rejected.

CONCLUSION AND RECOMMENDATION

The study concludes that 65% of bus transit users are willing to shift to rail transit while 31% are not willing to shift to rail transit and 4% of the respondents remain undecided. The coefficient of correlation R was obtained as 0.81 indicating that approximately 81% of the variation in mode choice can be explained by the independent variables used. While, the coefficient of determination R² was obtained as 0.66 which indicating a strong relationship between the dependent and independent variables. Trip fare with a coefficient of -0.007

and a p-value of 0.001 influence commuters' willingness to shift to rail transit. This is followed by waiting time with a coefficient of -0.055 and a p-value of 0.000 and finally, in-vehicle travel time with a coefficient of -0.061 and a p-value of 0.002 also has significant impact on commuters' willingness to shift. From the utility model developed; it was found that the rail transit will attract 71% of the entire population, i.e. 10054. This gives an increment of about 4,854 passengers and the number of trips may increase from 8 to 16 trips/day. reduces bus transit mode from 9,000 passengers (i.e. 71% of the population) to 4146 passengers (i.e. 29% of the population), this gives a reduction of about 5,856 passengers and reduces the number of trips from 600 to 460 trips/day.

The study recommends that; the policy makers should improve the safety of the train by engaging on track inspection exercises (to take care of derailment), provision of on-board condition monitoring system and passenger equipment safety. The comfort of the commuters should be improved by provision of adequate and hygienic convenience both at the station and within the coaches of the train, provision of functional air conditioning system,

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information displays in train, designing of waiting areas etc. There should be increase in the number of stoppages as well as the frequency of the trips (from the present 8) to cover most of the trips made by the commuters. In addition, there should be a provision for express service to cater for commuters willing to avoid stoppages. The study further recommends that the rail transit services be made more accessible by extending its services to the city centers. Finally, trip fare should be complemented with some incentives at certain hours in order to draw commuters closer to the rail. Travelers can be convinced to exchange bus for rail transit by drawing their attention to the fairly low travel cost per kilometer when compared to the real cost of bus transit driving. For instance, (temporarily) subsidizing light rail trips for particular target groups (e.g. large families, low incomes, etc.). In addition, it may be appropriate to accompany the rail network with a car restraint policy to elevate the success of the rail transit even further. Road pricing and higher road taxes may be part of such a policy. Onboard ticket vending machines and vending machines at stations can be good alternatives as well as ticket sales by new technologies such as SMS (Short Message Service), RFID (Radio Frequency Identification) and electronic cash systems. Finally, the operators of the rail transit should ensure strict compliance to the train schedule to reduce the time lost due to waiting at train stations. Constraining the in-vehicle travel time is important to policy makers in making the rail transit more successful by reducing the dwell time at stops by eliminating onboard ticket sales by the driver, this can significantly lower the total run time, also provision of more coaches.

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