



Impact of 64-Kilometer Owerri-Umuahia Road Dualization on Communities and Environment in Imo State, Nigeria

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ABSTRACT: The objective of this study is to evaluate the economic, social, and environmental consequences of road dualization on the 64-kilometer Owerri-Umuahia road, in Imo State, Nigeria using appropriate techniques such as baseline surveys, data collection through surveys, interviews, and questionnaires. Data obtained reveals that 30.75% of respondents agreed that the Owerri-Umuahia road dualization had a positive impact on reducing traffic congestion. Based on the traffic criteria, the travel volume, congestion frequency, and travel time are 35.6%, 38.5%, and 20.0% enhanced with a consistency ratio of 0.00819. Statistical analyses and reliability assessment methods, such as Cronbach's alpha and Analytic Hierarchy Process AHP are used to ensure data validity and internal consistency. The study highlights the importance of inclusive infrastructure development that caters to the diverse requirements and viewpoints of the local populace. Despite concerns about insufficient engagement between government officials and local communities during the planning phases of infrastructure projects, road dualization is widely approved by residents, with the majority expressing satisfaction. Tangible improvements are observed in road quality, traffic management, safety measures, accessibility to amenities, environmental impact mitigation, and localized economic activities.

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Due to its role in promoting trade and transportation, an efficient road network continues to be essential to the economic prosperity of any nation. Road construction is an important aspect of transportation infrastructure and they're actually one of our country's biggest infrastructures. They're essential for the transfer of resources and services from one place to another. With good road construction, there is a great tendency for the economic growth of a nation. Most developing nations like China, Singapore, Taiwan, etc. have experienced tremendous achievements in road construction and poverty reduction over the past few years (Zhou *et al.* 2022). Transport infrastructural development remains a major tool for achieving the aspirations of the newly introduced economic

principles of the Federal Government of Nigeria, the National Economic Empowerment and Development Strategy (NEEDS). However, the condition of Nigerian roads has not ceased to amaze discerning observers and in effect, the roads have been ranked among the worst in the world. A significant portion of post-independence studies on transport systems have been devoted to examination of successive Nigerian government's budgetary allocations and development in the transport sector in general. Increasing level of traffic congestion is an inescapable result of strong economic activity and life in urban areas. Realistically, large metropolitan regions lack the resources, citizen support, and ultimately the space to provide for uncongested automobile travel. About half of

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congestion delay occurs in areas where demand has reached or exceeded capacity; the other half is due to incidents including weather, accidents, stalled vehicles and roadside distractions (Ibrahim *et al.* 2019). Single carriage way has a limitation in terms of increase in traffics which is not in favour of rapid urbanisation. Our highway plays every significant role in transportation engineering, there is a need to update, manage and upgrade our traffic system in emerging urban areas so as to boost our local economy commerce and the entirely city system (Onyeneke, 2018). Effective dualization or road widening of these urban highways will impact on the economy of the region as it will provide opportunities for interconnectivity both within the nation and within neighbouring states, supporting development in trades, markets, industries and agriculture (Labalan, 2022). The dualization of existing highways, which boosts their carrying capacities, is one method for decreasing congestion aside from building new roads. The majority of the time, development has covered the pre-existing roads with various types of buildings and infrastructure. As a result, in order to widen the roadway of the roads, it is necessary to relocate, completely or partially demolish, and alter the services and structures. In addition to the overall environmental impact, this is typically the primary concern, this research concentrated on how the dualization will affect the nearby structures (Ajagbe *et al.* 2019).

Owoputi (2016) examined the role of road development and expansion in traffic management and social economic development of Akure Metropolis the Ondo State capital. The result showed that among others road development parameters were within the range of metropolis city development agents and economic advancement in various beneficial uses of change materials for human settlement and is an agent of all other development in an urban expansion. The study then recommended that in order to reduce traffic congestion and delays at road intersections in the city; road expansion should be encouraged and adequate infrastructure, road furniture's such as off-street parking facilities should be provided which should be complimented with professional traffic human resources.

The objective of this study is to evaluate the economic, social, and environmental consequences of road dualization on the 64-kilometer Owerri-Umuahia road, in Imo State, Nigerian

MATERIALS AND METHODS

Study Area: The Owerri-Umuahia road is a critical 64-kilometer transportation link between the Nigerian cities of Owerri and Umuahia. The road's terrain is characterized by low-lying areas, hills, and valleys,

with lateritic and sandy soils. The road is plagued by several challenges, including poor maintenance, potholes, erosion, landslides, and flooding, which have significant economic and social implications for the region. The road is a major transportation route for people and goods travelling between Owerri and Umuahia and other parts of Nigeria. The poor state of the road makes transportation of goods and services difficult, leading to increased costs and reduced economic activities in the area. Figure 1 shows the map of the road and some selected communities that are connected to the road.



Fig. 1: Map of Owerri – Umuahia road (Source: Google Earth)

Designing the Study: In designing the study on the evaluation of road dualization of Owerri – Umuahia road on the communities and the environment, the following are critical aspect that needs to be able to achieve the study goal (1). Defining the Research Questions: Identifying the research questions that the study aims provide answers. These may include questions related to the economic, social, and environmental impacts of the road dualization on the

communities along the road. (2) Sample Size and Sampling Technique: Determination of the appropriate sample size for the study which is based on the research questions and available resources. Select a representative sample of the communities along the Owerri – Umuahia road using an appropriate sampling technique such as simple random sampling or stratified random sampling. The Cochran's sampling techniques was used and this is given in equation 1

$$n_o = \frac{z^2 pq}{e^2} \quad (1)$$

where, z is the z – score as gotten from the Z-statistic test; e is the margin of error; p is the estimated proportion of population, and $q = 1 - p$

In this study, with a confidence interval of 90%, the p value is 0.1 and the value of q is 0.9. It is assume that the margin of error used is 5%, the corresponding z – score is 1.645, hence the minimum number of the sample size that was to be used in this study is 97. Hence, a total of 400 sample size was used in this study, with 100 respondents collected from each community.

A stratified random sampling technique which involves dividing the population into subgroups or strata based on specific characteristics such as age, gender, income, or location will be used to ensure that the sample is representative of the entire population.

Data Collection Methods: Data collection involves gathering relevant information through various means such as surveys and interviews. In this study, the data was collected by means of surveys and interviews by means of questionnaires that was distributed to the 400 residents of the communities along the road locations. These questionnaires were filled by these residents following the given ethical standards as provided in carrying out such studies.

Data Analysis: Data collected through the survey conducted will be analyzed using statistical and other methods to answer research questions, test hypotheses, and draw conclusions. Some common methods of analysing the data from the questionnaires shared include (1). Descriptive statistics: This involves summarizing the data using measures of central tendency (mean, median, and mode) and measures of variability (range, variance, and standard deviation). It provides a general overview of the data and identifies patterns and trends. (2). Validation of the questionnaire: Reliability analysis is an important step in questionnaire validation. It measures the consistency and stability of the questionnaire items

and ensures that they are measuring the same construct consistently across the sample. The Internal Consistency Reliability (ICR) method which involves assessing the correlation between different items within the questionnaire. The most common measure of internal consistency is Cronbach's alpha was used to check for the validity of the questionnaire.

Multi Criteria Analysis Using Analytic Hierarchy Process (AHP): There were 3 stages involved in the conduction of the analytic hierarchy model which were as a result of previous studies conducted through journals and textbooks, some experts were also interviewed and by the use of questionnaire. The data gotten were then analyzed by the use of excel spread sheet. The AHP model had four elements which are the goal, criteria, sub criteria and alternatives. The goal in this study was to evaluate the impact of road dualization on the community and the environment along Owerri – Umuahia road. The first element being the criteria showed the level of significance of the factors that defines the need for the dualization of the roads. Four criteria that were taken into consideration in this study, and they are traffic flow and congestion reduction, access to essential amenities, safety improvement and environmental impact. Traffic flow and congestion reduction deals with assessing the extent to which road dualization has reduced traffic congestion in the community. This can include factors like reduced travel times, improved traffic flow, and decreased bottlenecks. Access to Essential Amenities involves measure of how the road dualization has affected residents' access to essential amenities such as healthcare facilities, schools, markets, and public services. This can involve assessing travel times and ease of access. And Environmental Impact deals with assessment of the environmental impact of road dualization, considering factors like air quality, noise pollution, and damage to natural habitats. It can also include the effectiveness of mitigation measures such as tree planting and noise reduction.

The sub-criteria for each of the main criteria are as categorized as traffic flow and congestion reductions which include traffic volume, travel time, congestion frequency and public transportation, while for access to essential amenities they are proximity to healthcare facilities, proximity to educational institution, access to market and infrastructural quality. Also for safety improvement the sub criteria are accident rate reduction, pedestrian safety, traffic signage and signals and emergency response access. For the environmental impact the sub criteria are air quality, noise pollution, water quality and waste management. The alternatives being considered in this study were extensive road dualization, limited road dualization

and no road dualization. The criteria and alternatives were assessed through pairwise comparisons to establish the relative importance or weight of one criterion compared to another. Scales 1 through 9 are the best scales in expressing opinions as proposed by the Saaty’s scale, where 1 means equal importance, and higher values indicate one criterion is more important than the other.

In the decision making process, the consistency is a very important parameter, as it is not considered to have low consistency. The determination of the consistency involves multiplying each value in the first column with the first priority element, the value in the second column with the second priority element, and so on. Then each element in each row was then added. The result gotten from the step above is then divided by the respective priority element and then added with the number of elements available, the resulting in the largest eigen value (λ_{max}). The largest eigen value is derived by adding the multiplication of the number of columns by the eigen vector. The limit of inconsistency is measured by using consistency ratio (CR), i.e. comparison of consistency index (CI) with random consistency value (RI). This value depends on the matrix order n and is given by the expression as seen in equation 2

$$C.I = \frac{\lambda_{max}-n}{n-1} \quad (2)$$

If the consistency index (C.I) = 0, then the decision is perfectly consistent. But to determine the extent of the acceptability of the inconsistency, the consistency index must be compared with the Random Index and is as given in Table 2, for the different numbers of variables n.

Table2 Table of the Random Index

n	1	2	3	4	5	6	7	8	9	10
R	0.	0.	0.	0.	1.	1.	1.	1.	1.	1.
.I	00	00	58	90	12	24	32	41	45	49

The consistency ratio (CR) was then determined by applying the relation

$$C.R = \frac{C.I}{R.I} \quad (3)$$

Where: CR = Consistency Ratio, CI = Consistency Index, R.I = Random Index.

If $C.R \leq 0.1$, then the result gotten is accepted and the criteria selected is consistent. Checking the consistency of the hierarchy, if the value is more than 10%, then the judgment data assessment should be corrected. However, if the consistency ratio (CI / IR)

is less or equal to 0.1 then the calculation result can be stated correctly.

RESULTS AND DISCUSSION

Demographic Study: The demographic study aims not only to provide a demographic snapshot but also to uncover valuable insights into how different segments of the population have experienced and perceived the changes brought about by road dualization. By examining various demographic variables, including age, gender, education level, occupation, income, and more, we seek to unravel patterns, disparities, and the nuanced impacts that may have otherwise remained hidden. Moreover, understanding the demographics of the community enables us to appreciate the extent to which road dualization has affected different groups, considering factors such as accessibility, economic opportunities, and environmental concerns. It also allows us to assess the equity and inclusivity of the project and explore potential areas for targeted improvements.

The study's respondents' gender distribution is skewed, with 64.5% male and 35.5% female, and the majority of respondents are between 18 and 60 years old. The respondents' education levels range from no formal education to undergraduate and postgraduate degrees, and the occupational diversity includes students, employed individuals, unemployed individuals, and retirees. The income distribution is wide, with 45.5% of respondents reporting annual incomes greater than 100,000, and the length of residence in the area ranges from less than a year to more than a decade. The diversity of respondents allows for a multi-generational perspective on how road dualization affects different age cohorts, including their mobility, economic participation, and environmental concerns. The study emphasizes the importance of inclusive infrastructure development that caters to the diverse requirements and viewpoints of the local populace.

Challenges Encountered by Residents when the Road was a Single Carriageway: The present challenges that the communities along the present single carriageway of the Owerri - Umuahia road (that is, Nkwo Mgbowo, Umuokpo, Ekwereazu, and Olokoro) were experiencing, were studied by means of the questionnaire that was shared to some members of the residents within these communities. The study analyzed the impact of road dualization on the Owerri-Umuahia road, a 64-kilometer transport link between the Nigerian cities of Owerri and Umuahia. The study employed a multifaceted approach, including baseline surveys, data collection through surveys, interviews, and questionnaires, and the assessment of economic,

social, and environmental consequences. The study revealed that the respondents from all four locations experienced different traffic congestion and safety concerns, with varying degrees of frequency. The respondents from Nkwo Mgbowo, Umuokpo, Ekwereazu, and Olokoru had different perceptions of the impact of road dualization on access to amenities, economic impact, environmental concerns, and impact on property value. The study also revealed that the road's poor state has significant economic and social implications for the region, including increased costs, reduced economic activities, and increased risk of accidents and fatalities. The study calls for inclusive community engagement in infrastructure planning and decision-making, promoting more effective and community-driven projects.

Resident's satisfaction with the Road Dualization: In other to have the level of satisfaction that the residents have on the dualization of the road section another set of questions was shared to the respondents to have a good understanding of how the dualization of the road has impacted on them. Residents in the communities generally perceive the road dualization project as having a positive impact on various aspects, including road quality, traffic congestion, safety measures, and economic activities. The survey results suggest that 34% of the respondents in the communities combined reported being "Very Satisfied" with the overall quality of the road dualization project. Majority of respondents across all locations indicated that the road dualization had a positive impact on reducing traffic congestion, with a significant portion reporting "Strongly Reduced" or "Reduced" congestion. Respondents' opinions on the impact of road dualization on accessibility to amenities were positive, with a significant percentage reporting "Highly

Positively" or "Positively" (scores of 4 or 5). The impact on property values appeared mixed, with some reporting increases and others reporting decreases. However, a significant portion noted "No Change" in property values (score 3). Overall, respondents in communities expressed satisfaction (scores of 4 or 5) with the impact of the road dualization on their community and the environment. *Reliability and Consistency Study:* Internal consistency refers to the degree to which the questions or items within a questionnaire are related to each other and measure the same underlying concept. The reliability of the study was assessed using the results from questionnaires completed by respondents before and after the road dualization project. The Cronbach's alpha internal consistency of the questionnaire for the road before dualization was determined using Excel spreadsheets. The internal consistency of a survey, questionnaire, or test is measured by Cronbach's alpha, which calculates the pairwise correlations between items in a survey. The value for Cronbach's alpha can range between negative infinity and one. A higher internal consistency indicates that the survey is more reliable. The internal consistency of the survey used in this study should be high, indicating that the items in the survey measure what they are intended to measure and are as shown in Tables 3 and 4. Table 3 shows that the Cronbach's alpha for the questionnaire on the effect the road have on the community and the environment before the dualization of the road was 0.8631 which signifies that there is a very good internal consistency. The items are highly correlated and provide a reliable measure of the construct. In Table 4 above, the alpha value is 0.9877 which implies that the internal consistency is excellent and has an extremely high internal consistency.

Table 3: Internal Consistency of the Questionnaire before Dualization of the Road

Item	TCS1	TCS2	AM1	AM2	EI1	EI2	EC1	EC2	PV1	PV2	Total
Variance	1.578	1.774	1.923	1.941	1.776	1.727	1.737	1.649	1.772	1.781	22.733
Sum of Variance											17.658
K											10
Cronbach's Alpha (α)											0.8631

Table 4: Internal Consistency of the Questionnaire after Dualization of the Road

Item	1	2	3	4	5	6	7	8	9	Total
Variance	1.720	1.182	1.584	1.403	1.507	1.559	1.508	1.595	1.607	15.564
Sum of Variance										13.665
K										9
Cronbach's Alpha (α)										0.9877

Multi Criteria Decision Analysis Using Analytic Hierarchy Process (AHP): The results from the analytic hierarchy process performed on the criteria,

the sub criteria and the alternatives are as summarized in Table 5.

The study uses the Analytic Hierarchy Process (AHP) to determine the most important criteria for evaluating

the impact of road dualization on the Owerri-Umuahia road. The results showed that traffic flow and congestion reduction are the most important factors, followed by access to essential amenities, safety improvement, and environmental impact. The consistency ratio obtained from the matrix indicates that the judgments made by the decision-maker are consistent and reliable. The study suggests that any decision related to road dualization on the Owerri-Umuahia road should prioritize traffic flow and congestion reduction. The search results provide additional information on traffic congestion and its impact on roadway performance, the benefits of integrated traffic incident management, and the importance of infrastructure in reducing congestion. The sub criteria of the criteria traffic flow and

congestion reduction was conducted in the pairwise matrix of the sub criteria was travelling volume, travel time, congestion frequency, public transportation. The consistency ratio of 0.00819 obtained from the analysis indicates that the judgments made are consistent and reliable. The weights assigned to each sub-criterion showed that travel volume, congestion frequency, and travel time are equally important, with weights of 35.6%, 38.5%, and 20.0%, respectively. Public transportation has the least weight, with a weight of 5.9%. These results suggest that any decision related to traffic flow and congestion reduction should prioritize reducing travel volume, congestion frequency, and travel time. Public transportation should also be considered, but to a lesser extent.

Table 5 Pairwise Comparison Matrix of Criteria

	Traffic flow and congestion reduction	Access to essential amenities	Safety Improvement	Environmental Impact	Criteria Weights
Traffic flow and congestion reduction	1	6	5	5	0.607
Access to essential amenities	0.167	1	0.500	2.000	0.113
Safety Improvement	0.200	2	1	4.000	0.205
Environmental Impact	0.200	0.500	0.250	1	0.075
Consistency Index					0.0639
Consistency ratio					0.071

With respect to access to essential amenities criteria, which have its sub criteria as proximity to healthcare facilities, proximity to educational institution, access to market and infrastructural quality. Also the consistency ratio of 0.0837 indicated that the judgments made by the decision-maker are same as the others. The weights assigned to each sub-criterion show that proximity to healthcare facility is the most important factor, with a weight of 59.3%. Infrastructure quality, access to market, and proximity to educational institution are also important, with weights of 7.3%, 20.8%, and 12.5% respectively. These results suggest that any decision related to road dualization should prioritize proximity to healthcare, followed by access to market, proximity to educational institution and facility infrastructure quality. For the safety improvement criteria, the sub criteria were accident rate reduction, pedestrian safety, traffic signage and signals and emergency response access. The consistency ratio was 0.0830, the judgments made was consistent and reliable. The weights assigned to each sub-criterion show that emergency response access is the most important factor, with a weight of 54.3%. Traffic signage and signals, pedestrian safety, and accident rate reduction are also important, with weights of 8.7%, 10.0%, and 26.9% respectively. These results suggest that any decision related to safety improvement should prioritize emergency

response access, followed by accident rate reduction, pedestrian safety, and traffic signage and signals. The pairwise comparison matrix showed the sub-criteria for the main criterion environmental impact in the study. The consistency ratio of 0.0918 indicates that the judgments are consistent and reliable. The weights assigned to each sub-criterion show that air quality is the most important factor, with a weight of 50.9%. Noise pollution, water quality, and waste management are also important, with weights of 17.2%, 17.8%, and 14.2%, respectively. These results suggest that any decision related to environmental impact should prioritize air quality, followed by water quality, noise pollution, and waste management. It is important to note that the study did not provide specific recommendations for how to improve air quality, noise pollution, water quality, or waste management. The alternatives pairwise comparison matrix for the main criteria. The consistency ratio of 0.0213 indicated the decision is consistent and reliable. The weights assigned to each alternative show that extensive road dualization is the most preferred option, with a weight of 75.6%. Limited road dualization and no dualization were also considered, with weights of 13.1% and 11.2% respectively. These results suggest that any decision related to road dualization should prioritize extensive road

dualization, followed by limited road dualization and no dualization.

The results of the study show that traffic flow and congestion reduction is the most important criterion, followed by access to essential amenities, safety improvement, and environmental impact. Within the traffic flow and congestion reduction criterion, reducing travel volume, congestion frequency, and travel time are equally important, with public transportation being less important. Within the access to essential amenities criterion, proximity to healthcare facilities is the most important factor, followed by access to market, proximity to educational institution, and infrastructure quality. Within the safety improvement criterion, emergency response access is the most important factor, followed by accident rate reduction, pedestrian safety, and traffic signage and signals. Within the environmental impact criterion, air quality is the most important factor, followed by water quality, noise pollution, and waste management.

Conclusion: The results from this study shows that residents along the Owerri-Umuahia road expressed satisfaction with the road dualization project. The dualized road has a positive impact on reducing traffic congestion, with 30.75% of respondents expressing being "Very Satisfied" with the safety measures implemented along the dualized road. Residents conforms to the environmental impact mitigation measures, with a substantial portion giving scores of 4 or 5. Additionally local businesses and economic activities was perceived positively by a considerable number of respondents.

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