Determination Of The Significance Level Of Environmental And Economic Effects Of The Road Failure Of Onitsha-Enugu Expressway Southeastern Nigeria On The Road Users.

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ABSTRACT

Considering the implications of the problem of road failure to man and the failure of Onitsha-Enugu Expressway which has been lingering for many years now, this work was borne with the aim of evaluating the stand of the road users on the Economic, Health and Environmental effects of the road failure of Onitsha-Enugu Expressway on them. To this effect, population of the road users was determined by volumetric analysis and their opinions were harnessed using questionnaire survey method. The data obtained was analyzed using Student-T test in which the available options were grouped into 2, namely agree and disagree. The test was done separately for economic, health and environmental effects respectively. It was found that there exist differences in the percentage of agreement and disagreement for each effect with the percentage of respondents in agreement being greater in all. The statistical analysis confirmed that there is significant difference. The work therefore concluded that the failure of Onitsha-Enugu Expressway has significantly negative economic, health and environmental effects on the road users. The work thus recommended an immediate intervention of the government to hasten the contractors and all concerned to repair this failed road in order to minimize these negative effects.

1.0 Introduction

1.1 Background to the Study

A road pavement is supposed to be a continuous stretch of asphalt lay for a smooth ride or drive. Visible cracks, potholes, bulges and depressions may punctuate such smooth ride. The punctuation in smooth ride is generally regarded as road failure. According to the Federal Ministry of Works and Housing (FMW&H 1992), failed roads are characterized by potholes, polishing / pavement surface wash, block and longitudinal cracks, drainage collapse, depressions / sinking of roadway, over flooding of the carriageway, gullies and trenches, rutting and raveling all of which are evident along the Onitsha -Enugu expressway under study confirming it's failure.

Cedarholm, Reid and Salo (1981); and Hagans, Weaver and Madej (1986). in their study of the Cumulative effects of logging road sediment were of the opinion that surface erosion from roads can produce chronic sources of fine sediment which can diminish salmon and steelhead spawning success. According to them, roads constructed next to streams are chronic contributors of fine sediment, particularly if they are used in winter months, thus serious environmental effects like siltation may be encouraged. Lecocq and Shalizi (2009) also supported that environmental effects of road failures are real. Air pollution by dust particulates is one of the issues raised.

The FMWH (1992); Paul and Radnor (1976); and Oglesby and Garry (1978) disclosed the expenditure for repairs and maintenance of roads in Nigeria 1986, the United States of America for 1975 and 1978 fiscal years respectively, reporting that the cost constitute a significant percentage of the respective year's budget for

highways and road construction in the respective countries.Considering the available figures, they maintained that the problems of road maintenance is better seen than exaggerated thus road failures has economic effects. Moreover, infrastructure services raise the productivity of other factors of production (Kessides, 1993). A few authors have explicitly modeled the nonlinearity of infrastructure's impact on output, growth, or production costs. As can be seen in the works of Ajayi (1995); Fernald (1999); and Röller and Waverman (2001). Acording to Romp and de Haan, (2005) and Hurlin (2006); Infrastructure services are mostly provided through networks, a fact that implies a nonlinear relation with output. roads, rail, and water/sanitation are also networked services, so the impact of new investments on growth, output, or firm costs will depend on the overall state and extent of the network. Aigbedion *(*2007) and Ibrahim (2011), suggested that if the problem of road failure is minimized, the heavy revenue spent in the repair as was proven in their data analyses can be channeled into some other projects to better the economy.   The economic effects of current investment trends in surface transportation infrastructure in America,   shows that *in 2010 alone,* deficiencies in America's roads, bridges, and transit systems cost American households and businesses more than **$129 billion,** including approximately $97 billion in vehicle operating costs, $32 billion in delays in travel time, $1.2 billion in safety costs, and $590 million in environmental costs. (http://www.smartgrowthamerica.org/2011/07/28/new-study-reveals-the-economic-impact-of-americas-failing-transportation-infrastrucuture/). Andrew (2004); (Hutton and Haller 2004); Fay, Danny, Quentin and Tito (2005); Aworemi (2009); and Calderón and Servén (2010) were all of the opinion that all the effects of road failure boils down to man as his health, time, movement, comfort and resources are at stake.

According to the recent study of Onuoha and Onwuka (2014), the present condition of most of the roads in the Precambrian basement complex of south western Nigeria and the sedimentary terrain of the southeast and the entire Niger-Delta region has stimulated the interest of various stakeholders in the usage and maintenance of our road ways. Several thousands of lives and properties worth several million dollars are lost as a result of frequent motor accidents, caused by failed highway pavements in Nigeria A typical example of road whose failure bugs the mind of regular users is Enugu-Onitsha Express Road. Almost every section of the road has failed, resulting to the following:

- *Loss of lives and properties, human injuries etc. through accidents.*

- *Retardation of the rate of economic growth and development in affected areas.*

- *Environmental pollution and degradation.*

- *Impedance of human movement and the flow of economic activities.*

- *Encourages armed robbery along affected areas.*

Also rehabilitating these roadways has become a financial burden on the Federal, State, and Local Governments. In the light of the foregoing therefore, it becomes a necessity to estimate the level of these effects of road failure on the road users particularly now that the impacts are multiplying and marshal out modalities to mitigate these problems.

1.2 Aim and Objectives

This work is aimed at evaluating the Environmental, Economic, and Health effects of the road failure of Onitsha-Enugu Expressway on the road users.

To achieve this aim, the following objectives will be pursued:

1. to sample the road users and gather their opinions on the environmental, economic and health effects of the road failure on them,

2. to analyze the opinion of the road users on the issues at hand so as to determine whether or not the road failure affects their environment, economy and health significantly and

3. to suggest some solutions for the mitigation of road failure and the associated effects.

1.3 Research Hypothesis

1. H_0: The failure of Onitsha-Enugu Expressway does not affect the road users in significantly.

1.4 Description of the Study Area

The Onitsha-Enugu Expressway under study is situated within longitude 6^o45^lE to 7^o30^lE and latitude 6^o00^lN to 6^o30^lN. For clarity of the location, see Fig.1 (the Map of Nigeria showing the study area).

Fig. 1: Map of Nigeria Showing the Study Area.
(Source: Modified web map http://www.ngex.com/nigeria/places/states/enugu.htm).

1.5 Research Methodology

The study adopted a survey design which employed the use of a well structured questionnaire to gather information on the impacts of the road failure on the road users. This in turn was collated into data which was analyzed using some statistical tools. The questionnaire was structured into three sections, (Sections A, B and C). Section A was geared towards ascertaining information on personal data which provides the background information to determine whether the respondents can offer reliable information necessary for the study. It comprises questions on age, sex, educational attainment, nationality and occupation. Section B was hinged on how long the respondent has been using the road and through which means. Section C is the main target of the questionnaire survey treating issues on the impact of the road failure on health of the road users and economy of the area.

To determine the sample size for the questionnaire distributed, the population of the road users must be ascertained, and to this effect, a target population of users passing through the failure points was sought. To determine the number of users passing through at least a point of failure on the road, a volumetric analysis of the vehicles and other automobiles using the road was conducted. After a field observation, it was noticed that some variations exists which include:

- Variation in volume of traffic at the 3 major cities cut across by the road (Enugu, Awka and Onitsha)

- Variation in the volume of traffic at different times of the day (like in the morning hours, afternoon and evening hours) having the peak periods at mornings and evenings for Mondays to Fridays and afternoon and evenings on Saturdays.

- Variation in volume of traffic across the week days.

- At nights especially from 10:30pm till 4.30am the traffic volume tends to zero.

In order to accommodate these variations the volumetric analysis was done in form of automobile count for 3 months in the three major cities cut across by the roadway at Omagba Geust Hall near Borromew Round about in Onitsha, At ABS bus-stop near Aroma junction in Awka and at Ekochin Bus-stop near Ninth Mile Flyover in Enugu. Each month lasted for 7 days running through the 7days of the week from Monday to Sunday at the different cities selected, 7 days in each city that is 21 days in all.

Due to the difficulty in the counting of the first 2 days, and to ensure accuracy, the video camera method was adopted. Here a video camera was mounted at a stationary point focusing the roadway and after like two hours, based on the capacity of the camera, it will be withdrawn and the counting done in a more relaxed state at home. This way, every automobile that passed the point of focus within the coverage time was covered not minding its speed. Also two hours was taken in the morning, afternoon and evening respectively for the counting to accommodate the volume variations within the different hours of the day. After the whole analysis, and calculations the result is as below:

- ❖ Population passing through at least one point of failure for the whole 21 days = 2,268, 840 persons

❖ Population passing through at least a failure point on the road per day = 108, 048 persons for 24 hrs.

❖ Population passing through at least a failure point on the roadway per hour = 4, 502

According to Nwanna (1981) If the population is a few hundreds, a 40% sample will do, if many hundreds, a 20% sample will do, if a few thousand, a 10% sample will do, for several thousands, 5% sample, if up to hundred thousand or more, 0.5% or 0.25% can do, it can be fewer considering the circumstances surrounding the research and the nature of the population (homogeneous or heterogeneous).

Thus considering the size of the population, a 0.25% sample was adopted. The 0.25% of the total population passing through at least a point of failure on the roadway per day was calculated (0.25% of 108, 048) to be 270.12. Thus 270 questionnaires were distributed to people to source for information on the subject matter at locations where the proper respondents could be found considering the fact that they cannot fill it while the vehicle are moving. For the purpose of increasing the reliability of the respondents and authenticity of data, due to the inability of the researcher to reach out to the road users or access them while the vehicle is moving, the opinion pool was conducted at the Enugu-Awka motor parks at Onitsha, Enugu-Onitsha motor parks at Awka, Awka-Onitsha motor parks at Enugu and the Nnamdi Azikiwe University motor park in Awka, the purpose being to capture the actual road users for respondents.

- Method of Data Analysis: the data collected through the questionnaire responses were collated and analyzed using relevant statistical tools.

- Method of Data Presentation: the collated data was presented in a tables and pie charts also the result of the analyses were presented in tables for easy comprehension.

2.0 Results and Discussion

2.1 Presentation, Analyses and Discussion of Questionnaire Data

Before the questionnaire was adopted as an authentic and reliable tool for data generation, a reliability test was done as follows:

Reliability Test and Item Analysis Using Likert Scale Analysis by Coding

Table 1: Case Processing Summary

		N	%
Cases	Valid	270	100.0
	Excluded	0	.0
	Total	270	100.0

Source: Author's Field Work (2012).

Table 1shows the number of respondents used for the field survey which is 270 persons/respondents. None of the respondents was excluded in the analysis.

Table 2: Reliability Statistics Table

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.993	.993	30

Table 2 shows the reliability of the research tool which could be interpreted thus, a value less than 0.6 implies weak tool and value more than 0.6 is an indication of strong and reliable research tool. In this research, the value of Cronbach's Alpha is 0.993 which implies the tool is reliable and can be used for research purpose. The last column of table 4.4 shows the number of questions used in the field survey tool, questionnaire.

Table 3: Item Statistics

	Mean	Std. Deviation	N	Decision
Q6	2.8519	.50305	270	
Q7	4.7815	1.34980	270	
Q8	3.5630	1.36666	270	
Q9	2.2667	.62417	270	
Q10	3.2667	1.06446	270	
Q11a	2.4556	1.25394	270	Agree
Q11b	2.6593	1.38050	270	Agree
Q11c	2.6000	1.32013	270	Agree
Q11d	2.2741	1.41121	270	Agree
Q11e	2.3593	1.34986	270	Agree
Q11f	2.5407	1.37294	270	Agree
Q11g	2.3000	1.27996	270	Agree
Q12a	2.2370	1.30886	270	Agree
Q12b	2.4741	1.42380	270	Agree
Q13a	2.4667	1.41579	270	Agree
Q13b	2.2741	1.26096	270	Agree
Q13c	2.4963	1.28690	270	Agree
Q14a	2.2333	1.17644	270	Agree
Q14b	3.0889	1.25231	270	Agree
Q14c	2.4852	1.42917	270	Agree
Q15a	2.2111	1.32037	270	Agree
Q15b	2.3259	1.18748	270	Agree
Q16a	1.9444	1.25275	270	Agree
Q16b	1.5963	.91456	270	Agree
Q16c	1.8259	1.26259	270	Agree
Q16d	1.9667	1.19276	270	Agree
Q17a	2.5963	1.47972	270	Agree
Q17b	3.1370	1.25832	270	Disagree
Q17c	3.7889	1.21479	270	Disagree
Q17d	3.2556	1.57509	270	Disagree

Source: Generated from Statistical Analysis of Authors Fieldwork Data.

Table 3, shows the mean response of each question in the questionnaire. Based on the coding values used, the last column shows the decision for each question to be either agree or disagree. The decision is disagree if the mean response is less than mean of the coding value and agree if the mean response is greater than mean of coding values.

Table 4: Summary of Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means (Grand Mean)	2.611	1.596	4.781	3.185	2.995	.415	30
Item Variances	1.610	.253	2.481	2.228	9.804	.222	30

Source: Generated from Statistical Analysis of Authors Fieldwork Data.

Table 5: Alternative Cronbach's Alpha if Item Deleted

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q6	75.4704	1180.406	.396	.991
Q7	73.5407	1120.911	.792	.991
Q8	74.7593	1111.589	.888	.992
Q9	76.0556	1157.042	.870	.991
Q10	75.0556	1138.737	.758	.992
Q11a	75.8667	1111.462	.973	.992
Q11b	75.6630	1107.258	.927	.992
Q11c	75.7222	1107.391	.970	.992
Q11d	76.0481	1103.533	.947	.992
Q11e	75.9630	1105.456	.970	.992
Q11f	75.7815	1104.127	.968	.992
Q11g	76.0222	1111.382	.953	.992
Q12a	76.0852	1109.149	.958	.992
Q12b	75.8481	1100.813	.969	.992
Q13a	75.8556	1101.299	.969	.992
Q13b	76.0481	1111.444	.967	.992
Q13c	75.8259	1109.074	.976	.992
Q14a	76.0889	1117.397	.961	.992
Q14b	75.2333	1112.291	.964	.992
Q14c	75.8370	1100.129	.972	.992
Q15a	76.1111	1110.389	.934	.992
Q15b	75.9963	1116.361	.965	.992
Q16a	76.3778	1119.864	.870	.992
Q16b	76.7259	1142.609	.823	.991
Q16c	76.4963	1119.091	.872	.992
Q16d	76.3556	1119.048	.926	.992
Q17a	75.7259	1097.181	.969	.992
Q17b	75.1852	1119.616	.869	.992
Q17c	74.5333	1129.135	.781	.991
Q17d	75.0667	1096.226	.917	.992

Source: Generated from Statistical Analysis of Authors Fieldwork Data.

Table 5 shows the value of Cronbach's Alpha if one of the items is deleted. In the table, none of the items has value greater than the computed Alpha value if deleted which implies all questions are significant in the research and the research tool is reliable for the research purpose.

2.2 Presentation of Questionnaire Data.

Table 6: Occupation of The Respondents

Occupation	Total Number
Civil Servants	56
Commercial Driver	52
Academicians	23
Students	101
Businessmen	26
Others	12

Source: Generated from Authors Fieldwork Data.

Figure 2: Pie Chart Showing Occupation of the Respondents in Percentages

In as much as we work very hard to design a questionnaire with questions that will help tackle the issue of the research, there is need to also have a sound quality and good quantity of respondents who will enhance the drive for authentic data towards accuracy. Figure 2 is a Pie Chart showing the occupation of the respondents as percentages of the total population of the respondents as recorded in Table 6. 37% of the respondents were students, 21% civil servants, 19% commercial drivers,110% businessmen, 9% academicians and 4% has their occupation not included in the list of occupations presented. The implication of this is that majority of the respondents will read the questions easily and understand it better considering that about 60% of the respondents are students, civil servants and academicians many of which have their own vehicles. Having a reasonable percentage of commercial drivers also adds to the reliability and authenticity of the data generated from the questionnaire this agrees with the reliability test done earlier.

Table 7: Educational Attainment of Respondents

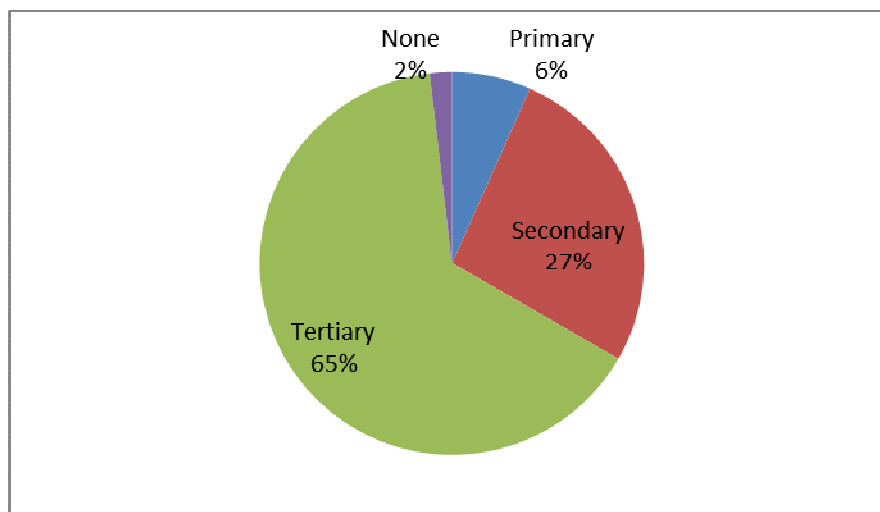| Level of Education	Number Respondents
Primary	18
Secondary	72
Tertiary	175
None	5

SOURCE : Author's Fieldwork (2012)

Figure 3: Pie Chart Showing The Educational Attainment of The Respondents in Percentages.

The level of education of the respondents is one of the key factors in determining the rationality of answers they will be able to give. Figure 3, is a percentage presentation of the information contained in Table 7. 65% of the respondents passed through the university, while 27% of the respondents passed through secondary school. Only about 6% were just primary school leavers while 2% of the respondents could not indicate there educational status. The implication of this is that the data generated from the questionnaire survey will be highly reliable considering the educational status of the respondents involved. That is the respondents will be able to read and understand the questions contained in the questionnaire and provide very rational answers which will be dependable for drawing conclusions and taking decisions on the subject matter this also agrees with the reliability test result earlier presented.

Table 8: Age of Respondents

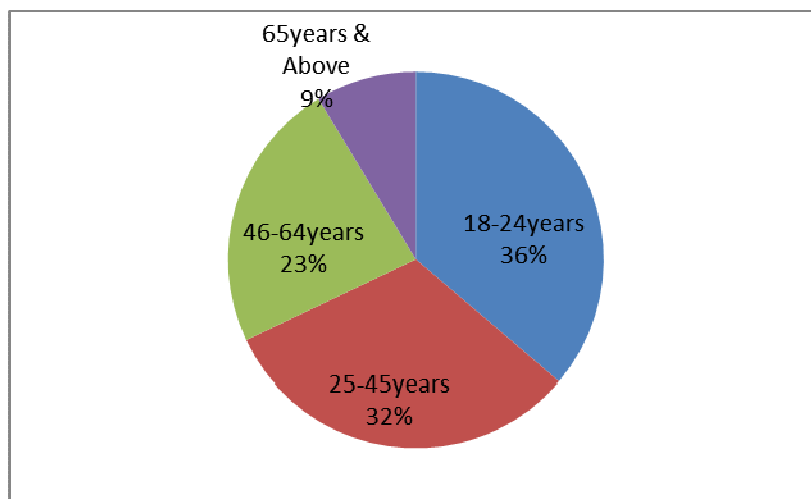| Age	Percentage Response
18-24years	96
25-45years	84
46-64years	62
65years & Above	23

Source : Author's Fieldwork (2012)

Figure 4: Pie Chart Showing the Age of Respondents in Percentages

Table 8 contain the age distribution of the respondents within certain specified age brackets. These age brackets of the respondents were arranged according to their percentages of the total population in Figure 4. 36% of the respondents fell within the age bracket of 18-24years, 32% fell into the age bracket of 25-45years, 23% are between 46-64years and only 9% were above 65years. Considering the earlier discussions about the educational status of the respondents, it is clear that many of the respondents are young graduates with about 68% been in the most active stage of their lives and over 80% falling into the age bracket of the Nigerian labor force (18-64years). The respondents by their ages are ripe / matured enough to reason the causes and effects (economic, health and environmental) of the road failure as contained in the questionnaire.

Table 9: Frequency of Road Usage by the Respondents

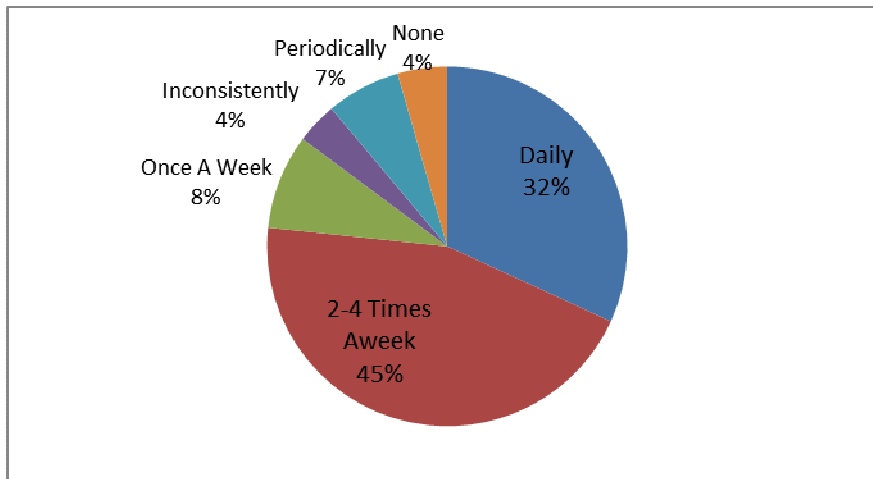| How Often	Number Of Respondents
Daily	86
2-4 Times A Day	121
Once A Week	23
Inconsistently	10
Periodically	18
None	12

Source : Author's Fieldwork (2012)

Figure 5: Pie Chart Showing Frequencies of the Road Usage by the Respondents in Percentages.

The frequencies of road usage as recorded in Table 9 and presented in percentages in Figure 5, showed that 32% of the respondents use the road daily, 45% use the road 2-4 times a week, 8% use the road once a week, 7% use the road periodically, 4% use the road inconsistently while 4% did not indicate their degree of usage of the road. Seeing that over 80% use the road at least once a week, with about 50% of this fraction using it daily, it implies that the respondents must have enough knowledge of the road, its problems and the effects of the road failure, thus can make reasonable contributions. This is in accordance with the result of the reliability test and the description of figures 4.2 and 4.3.

Table 10: Rate of Repairs of Vehicles Plying the Route

How Often	Number of Respondents
Very Often	54
Not Regularly	20
Rarely	18

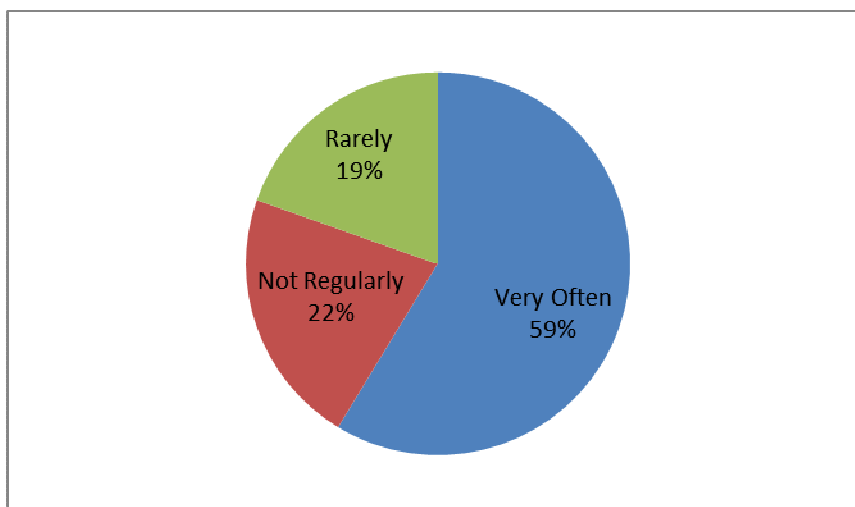Source : Author's Fieldwork (2012)

Figure 6: Pie Chart Showing the Rate of Repairs of Vehicles Plying the Route in Percentages.

Table 10 shows the rate of vehicle repairs by vehicle owners. It should be noted that this question is optional thus out of a total number of 270 questionnaires received only 92 respondents reacted to this question and they to be the only vehicle owners or drivers using the road among the respondents. Figure 6 expressed the content of Table 10 In percentages from which it can be clearly seen that 59% of the drivers and vehicle owners who are respondents said that they repair their vehicles very often, 22% repairs their vehicles not regularly while only 19% said they rarely repair their vehicles what this implies is that most vehicles plying the route undergo regular repairs which goes to say that the bad nature of the road is negatively affecting the efficiency and serviceability of the vehicles using the road. Even the few persons that said they rarely repair their vehicles may likely be using the road rarely. This supports the responses given to questions 12a and 12b in the questionnaire as can be seen in Table 11 were most of the respondents agreed that the bad state of the road negatively affects the life span and efficiency of vehicles.

Table 11: Percentage Distribution of Number of Respondents with respect to their opinions for questions 11a to 17d

Issues Raised		SD		D		N		SA		A	
11a	Bad nature of the soil is a factor of the road failure	18	7%	45	17%	58	21%	70	26%	79	29%
11b	Poor construction materials is a factor of the road failure	14	5%	86	32%	62	23%	10	4%	98	36%
11c	Stress from heavy vehicles is a factor of the road failure	21	8%	58	21%	64	24%	46	17%	81	30%
11d	Old age of the road pavement is a factor of the road failure.	36	13%	28	10%	15	6%	86	32%	105	39%
11e	Incompetence of the contractors is a factor of the road failure.	22	8%	53	20%	20	7%	80	30%	95	35%
11f	Failure on the side of the government is a factor of the road failure.	29	11%	58	21%	18	7%	90	33%	75	28%
11g	Inadequate maintenance is a factor of the road failure.	18	7%	53	20%	6	2%	108	40%	85	31%
12a	The road failure affects the life span of the vehicles	22	8%	40	15%	18	7%	112	41%	78	29%
12b	The road failure affects the efficiency of the vehicles	28	10%	56	21%	31	11%	56	21%	99	35%
13a	The road failure affects cost of commodities negatively	40	15%	32	12%	26	10%	88	33%	84	31
13b	The road failure affects the quality of perishable goods	18	7%	41	15%	30	11%	89	33%	92	34%
13c	The road failure causes massive destruction of goods.	22	8%	50	19%	41	15%	76	28%	81	30%
14a	The bad nature of the road aggravates certain body illness	19	7%	19	7%	54	20%	92	34%	86	32%
14b	The bad nature of the road causes miscarriages	51	19%	40	15%	92	34%	56	21%	31	11%
14c	The bad nature of the road retards the movement of safety vehicles	41	15%	29	11%	39	14%	72	27%	89	33%
15a	The bad nature of the road increases dust particles in the air especially during dry seasons.	25	9%	39	15%	2	1%	106	39%	98	36%
15b	The bad nature of the road contaminates the air and increase the carbon dioxide content of the atmosphere due to burning of more fuel.	19	7%	24	9%	62	23%	86	32%	79	29%
16a	The bad nature of the road increases the rate of accidents.	25	9%	18	7%	0	0	101	37%	126	47%
16b	The bad nature of the road increases the loss of lives and properties	6	2%	14	5%	2	1%	91	34%	157	58%
16c	The bad nature of the road encourages robbery at bad spots	23	9%	13	5%	18	7%	56	21%	160	59%
16d	The bad nature of the road reduces travel comfort for road users.	17	6%	13	5%	46	17%	62	23%	132	49%
17a	The government is to be blamed for the road failure.	40	15%	49	18%	36	13%	52	19%	93	35%
17b	The contractors are to be blamed for the road failure.	18	7%	129	48%	46	17%	26	9%	51	19%
17c	The road users are to be blamed for the road failure.	69	26	150	55%	8	3%	11	4%	32	12%
17d	Everybody is to be blamed for the road failure.	81	30%	72	27%	14	5%	41	15%	62	23%

Source: Generated from Authors Fieldwork Data.

Table 11 represents the percentage response from the respondents on the questions contained in the section C of the questionnaire. SD stands for Strongly Disagreed, D for Disagreed, N for No Idea, SA for Strongly Agreed

and A for Agreed. It should be noted that the percentage recorded for N (No Idea) is the sum of the respondents that did not indicate any answer for the question and those that selected N and the fractional percentages were rounded up to the nearest whole number. The different issues raised in the questionnaire were tested individually with befitting statistical tools using the questions that pertains them to generate data. The issues of interest includes; Economic Effects, Environmental Effects, Health Effects and Causes of the road failure.

2.3 Statistical Analyses:

2.4 2.3.1 Test of Economic Effect

In this section, questions 13a to 13c were used and appropriate statistical tool was used to test for the significance of economic effect of road failure on the road users. The statistical tool: Student-T test in which the available options were grouped into 2, namely agree and disagree. T-test was used as the number of questions used was less than 30 which are 3 questions, as we are to test the responses of respondents on the available questions not the number of respondents.

Table 12: Grouping of responses of respondents on economic questions

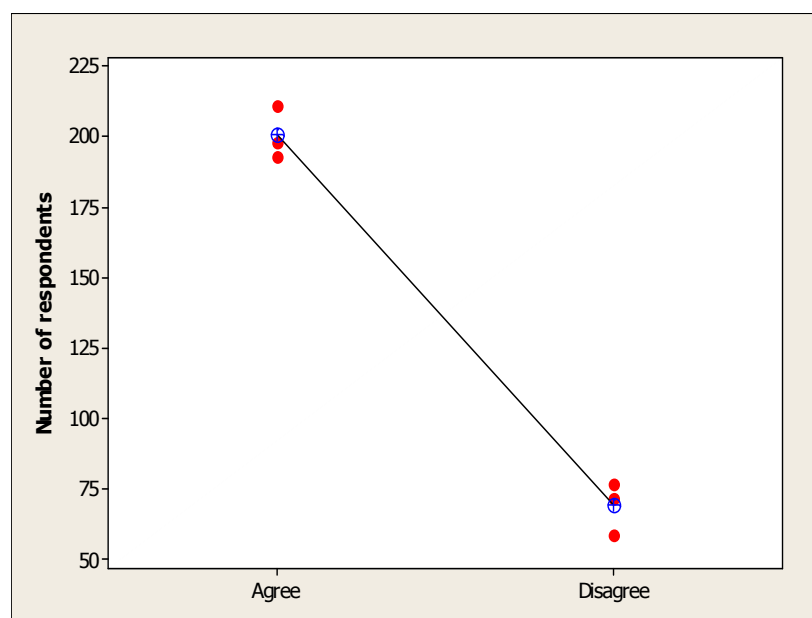| Question		Agree	Disagree
13a	The road failure affects cost of commodities negatively	172	72
13b	The road failure affects the quality of perishable goods	181	59
13c	The road failure causes massive destruction of goods.	157	72

Figure 7: Individual Plot of Agree and Disagree

Hypothesis
H$_0$: there exists no significant difference in between the groups of interest
H$_1$: there exists significant difference in between the groups of interest
Level of Significance: 5% (0.05)

Decision Rule: Accept the null hypothesis if the p-value of the test is greater than 0.05, otherwise, reject.

Two-sample T for Agree vs Disagree

	N	Mean	StDev	SE Mean
Agree	3	200.67	9.29	5.4
Disagree	3	69.33	9.29	5.4

Difference = mu (Agree) - mu (Disagree)

Estimate for difference: 131.33

95% CI for difference: (110.27, 152.40)

T-Test of difference = 0 (vs not =): T-Value = 17.31 **P-Value = 0.000** DF = 4

Both use Pooled St Dev = 9.2916

Conclusion: the p-value of the test is less than 0.05 which implies that there exists enough evidence to reject the null hypothesis and conclude that there exist significant difference between the group that agree that road failure has economic effect on road users and those that do not. Literarily, this implies most of the respondents agreed that road failure has negative economic effect on the users.

2.3.2 Test of Health effects

Table 13: Grouping of responses of respondents on health questions

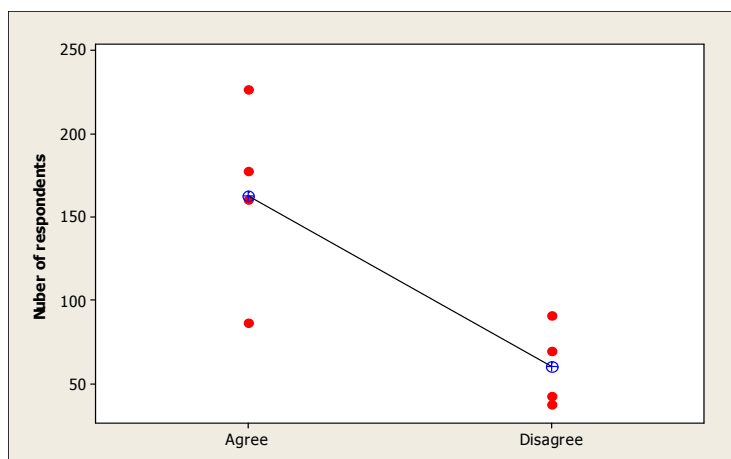| Question		Agree	Disagree
14a	The bad nature of the road aggravates certain body illness	178	38
14b	The bad nature of the road causes miscarriages	87	91
14c	The bad nature of the road retards the movement of safety vehicles	161	70
16a	The bad nature of the road increases the rate of accidents.	227	43

Figure 8: Individual Plot of Agree and Disagree

Hypothesis

H_0: there exists no significant difference in between the groups of interest

H_1: there exists significant difference in between the groups of interest

Level of Significance: 5% (0.05)

Decision Rule: Accept the null hypothesis if the p-value of the test is greater than 0.05, otherwise, reject.

Two-sample T for Agree vs Disagree

```
           N   Mean  StDev  SEMean
Agree      4   163.3  58.0    29
Disagree   4   60.5   24.7    12
```

Difference = mu (Agree) - mu (Disagree)

Estimate for difference: 102.8

95% CI for difference: (25.6, 179.9)

T-Test of difference = 0 (vs not =): T-Value = 3.26 **P-Value = 0.017** DF = 6

Both use Pooled StDev = 44.5977

Conclusion: the p-value of the test is less than 0.05 (p-value = 0.017) which implies the existence of enough evidence to reject the null hypothesis and conclude that there exist significant difference between the group that agree that road failure has negative health effect on road users and those that do not. Literarily, this implies most of the respondents agreed that road failure has negative health effect on the users.

2.3.3 Test of Environmental effect

Table 14: Grouping of responses of respondents on environmental questions

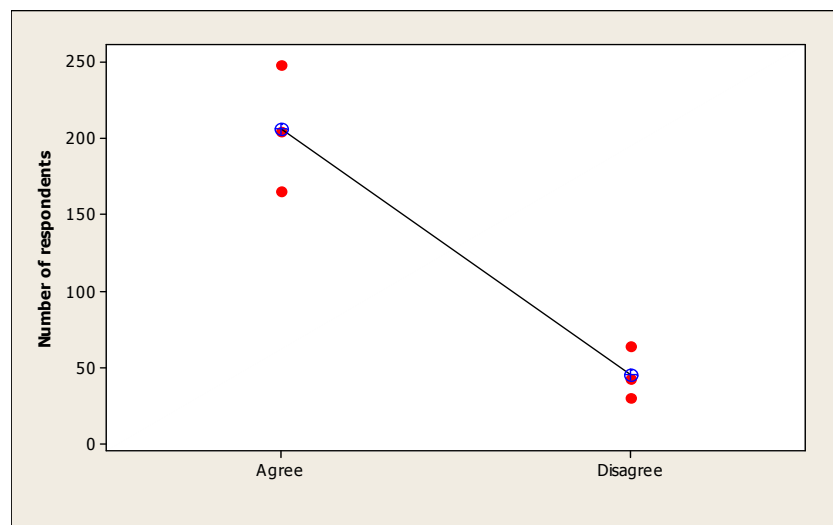| Question		Agree	Disagree
15a	The bad nature of the road increases dust particles in the air especially during dry seasons.	204	64
15b	The bad nature of the road contaminates the air and increase the carbon dioxide content of the atmosphere due to burning of more fuel.	165	43
16b	The bad nature of the road increases the loss of lives and properties	248	20

Figure 9: Individual Plot of Agree and Disagree

Hypothesis

H_0: there exists no significant difference in between the groups of interest

H_1: there exists significant difference in between the groups of interest

Level of Significance: 5% (0.05)

Decision Rule: Accept the null hypothesis if the p-value of the test is greater than 0.05, otherwise, reject.

Two-sample T for Agree vs Disagree

```
            N    Mean   StDev   SE Mean
Agree       3    205.7  41.5    24
Disagree    3    45.7   17.2    9.9
```

Difference = mu (Agree) - mu (Disagree)

Estimate for difference: 160.0

95% CI for difference: (88.0, 232.0)

T-Test of difference = 0 (vs not =): T-Value = 6.17 **P-Value = 0.004** DF = 4

Both use Pooled StDev = 31.7700

Conclusion: the p-value of the test is less than 0.05 (p-value = 0.004) which implies the existence of enough evidence to reject the null hypothesis and conclude that there exist significant difference between the group that agree that road failure has negative environmental effects and those that do not. Literarily, this implies most of the respondents agreed that road failure has negative environmental effects.

3.0 Conclusion and Recommendations

3.1 Conclusion

From the above result of analyses and findings, it becomes very clear that the failure of Onitsha-Enugu Expressway has negative environmental, economic and health effects on the road users.

3.2 Recommendations

Sequel to the findings and conclusion of this research so far, it becomes very necessary to fight the problem of road failure without any waste of time so as to mitigate its negative impacts on the road users. To this end, this section recommends some practicable modalities to enhance the serviceability of our roads as stated below:

(A)   **Planning and Design Stage:** The following are important before and during the planning and design of any highway pavement:

1.   Proper screening and selection of contractors before signing of contracts to avoid awarding contracts to unqualified contractors.

2.   Proper study of the area to be cut across by the pavement route ascertaining the geological, geomorphological, hydrological, geotechnical properties of the area and making sure that they are accommodated in the planning and designing of the pavement.

3.   Design of new roads must be based on exhaustive study of anticipated number of vehicles that would use that road on a daily basis. This is because the more the number of vehicles, the bigger the thickness of asphalt used. Sometimes, due to poor preliminary investigation and projection, roadway designers underestimate the anticipated number of vehicles that will use a roadway leading to poor design. When more vehicles than anticipated start using the road after construction, pavement failure results because the asphalt thickness is not strong enough to carry the excess vehicle load.

4.   Inclusion of contractors warrantee and a follow up to that so the contractors will seat up and do quality jobs to avoid paying extra for repairs after construction.

(B)   Construction Stage:

1.   Efficiency in construction practices like Soil Compaction, Consolidation, Cross Hauling, Soil Modification and Stabilization should be ensured where and when necessary to reduce soil mobility, settlement and shrinkage factors.

2.   Ensuring total execution of plan and design. Plans which have overstayed without being executed, should be reviewed before implementation (construction proper) to accommodate present problems of the area in question.

3.   Use of good quality construction materials, adequate manpower, equipment supply and expertise and the inclusion of adequate drainage facilities to ensure pavement stability especially in areas with troublesome geology.

(C)   Post Construction Evaluation and Monitoring:

1.   Quality Determination: The application of field investigation methods like the use of Trial Hole, Use of Deflectograph Result, Laboratory testing of materials, field observation and many other ways of ascertaining the status of the failed pavement may go a long way to aid the planning of maintenance measures and condemn shoddy jobs on time.

2.   Effective Maintenance Programme: There should be routine or preventive maintenance, periodic maintenance, and disaster maintenance or major repairs of our roads. In view of the efforts of the Federal Road Maintenance Agency (FERMA) to rehabilitate failed segments of the highways across the country, it is imperative that adequate consideration is given to the causes of the failures so as to ensure that sufficient safeguards are incorporated in their subsequent rehabilitation.

3.   Establishment of an Active Maintenance Crew. We should establish road maintenance crews trained to recognize, evaluate and patch cracks once they appear. They should be patrolling major roads about two times a week and potholes or cracks detected during such patrols should promptly be patched. This arrangement may sound expensive, until one considers what is been spent annually to reconstruct roads after they have been allowed to deteriorate badly and the negative effects of such situations.

(D)   Role of the Governmental:

1.   Pronouncement of severe punishment for dishonest inspectors and contractors caught in bribery and other corrupt acts for others to learn their lesson.

2.   Awards by Government to outstanding contractors who distinguished themselves by quality Jobs.

3.   We need to establish a construction ethics committee staffed by men and women of integrity who would have the authority to hear complaints against contractors and against government workers also.

4.   Government to establish an anti-corruption team made up of men and women of integrity who will not request the contractors to "grease their palms" in order to become lenient in enforcing specification.

5.   Establishment of contractors accountability program where genuine complaints are lodged against contractors for non-performance, poor performance, dereliction or repudiation, it is recorded against the said contractors. For continuous record of such offences, the contractor is barred from bidding future contracts for a period of time thus weeding out non performers and creating a contractor pool of proven performers.

6.   Establishment of a well-equipped library and a design office by the Federal Highways Department is recommended.

7.   Establishment of Highways data bank of unit rates for works in road projects, based on the rates of competent contractors could greatly assist Government in its assessment and final choice.

8.   Government should make the payment of there contractors very effective supervising the process to avoid fund diversions and late payments resulting in the delay of the work as in the case of the Onitsha-Enugu Expressway.

Putting all these into practice the problem of road failure and the associated negative effects will be minimized.

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