

RELATIVE IMPORTANCE INDICES OF FACTORS AFFECTING HIGHWAY DURABILITY IN WARRI NIGERIA

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ABSTRACT

Premature deterioration of highways is prevalent in developing countries. This paper investigated some factors affecting the serviceability and durability of highways in Nigeria. It used Warri as a case study because the town readily represents an urban city in Nigeria. Factors investigated include; Faulty design, inadequate maintenance, Excessive axle load, Poor construction practices and drainage systems. The work utilized the quantitative research method by administering structured questionnaire to randomly selected consultants to solicit for information which was statistically analyzed to derive its conclusions. A total of one hundred and twenty (120) questionnaires were distributed out of which one hundred and eight (108) were returned, representing an average response rate of 90%. The results were analyzed using the Relative Importance Index ranking the variables on a scale of 0-1. The result showed that insufficient highway depth was the most important factor with rank of 0.8398. This was followed by poor drainage system and substandard construction materials which ranked 0.8136 and 0.7933 respectively. The least of the factors was poor construction practices with a rank of 0.5225. The paper concludes that if the relevant stakeholders and agencies check these factors, highways in the country will become more durable.

Keywords: Highway, Construction, Pavement deterioration, Maintenance and Durability.

INTRODUCTION

Highway infrastructure is one of the most important facilities needed for the growth and development of a Nation. Abdulkareem and Adeoti (2000) have shown that highway infrastructure

comprises the carriage way, pedestrian facilities, bridges and flyovers, traffic signs, street light installations and drainage system (culverts, gutters, side drains and camber, etc.). A good highway network-

spread across a country is an indication of the level of mobility of humans, goods and services and this contributes positively to the growth of the economy (Anthony, 2014). The ability of highway pavement to resist wear, decay and perform the primary function of conveying vehicles, passengers, goods and services from one location to another in safety and comfort defines its durability (Ajani, 2006).

In Nigeria there are about 200,000 km of roads spread all over the country (Okigbo, 2012). These roads are made up of over 32,000 km of Federal roads (Trunk 'A' roads) spread over the thirty six states and the Federal capital, Abuja. There are also over 30,000 km of state roads (Trunk 'B' roads) and over 130,000 km of local government roads (Trunk 'C'). Each tier of government has the responsibility for planning, construction and maintenance of the network of roads under its jurisdiction (CBN Report, 2003).

Early deterioration of highways shortly after construction or rehabilitation is a common occurrence in Nigeria, with some of the highways not lasting up to half of their design life before various forms of pavement distresses begin to manifest and this has often resulted to frequent road accidents with loss of lives and properties. According to the Federal Road Safety Corps (FRSC, 2010), Nigeria ranks 191 of 192 countries of the world with unsafe roads resulting 162 deaths per 10,000 population occurring from road crashes. High transportation costs of goods and services, high government budgeting and spending on road transportation sector, high maintenance cost for vehicles and

discomfort to motorists are other negative effects of the dilapidated nature of highways in the country (Ajani, 2006).

The durability of highway infrastructures is dependent on several factors. Some of these factors were highlighted by Ebuzoeme (2015). They include; mismanagement by the government, old age of the road pavements, poor maintenance culture, incompetence of the contractor, bad nature of the soil, stress of heavy vehicles and poor road design. Several factors categorized by Caltrans (2001) as load associated (traffic) or non-load associated (environment) may affect the highway durability. The CBN report (2003) reveals that faulty designs and very thin asphalt coatings result in weak highway pavement that can hardly withstand heavy traffic. Highway in the country is the only developed mode for the haulage of bulky goods due to lack of development and maintenance of other modes of transport, hence the excessive stress on the road pavement (Anthony, 2014). Aderinola and Owolabi (2014) revealed in their work that the design method used in Nigeria and some other tropical countries (Road Note 31) did not provide adequate pavement thickness that can withstand the excessive stress of heavy traffic and other factors. Danladi (2013) emphasized that Nigerian highways require proper construction materials and techniques to be durable, however there is need for early detection of failures and the provision of prompt solutions because if the facility is allowed to age without routine maintenance, it would be unsafe to the users and its

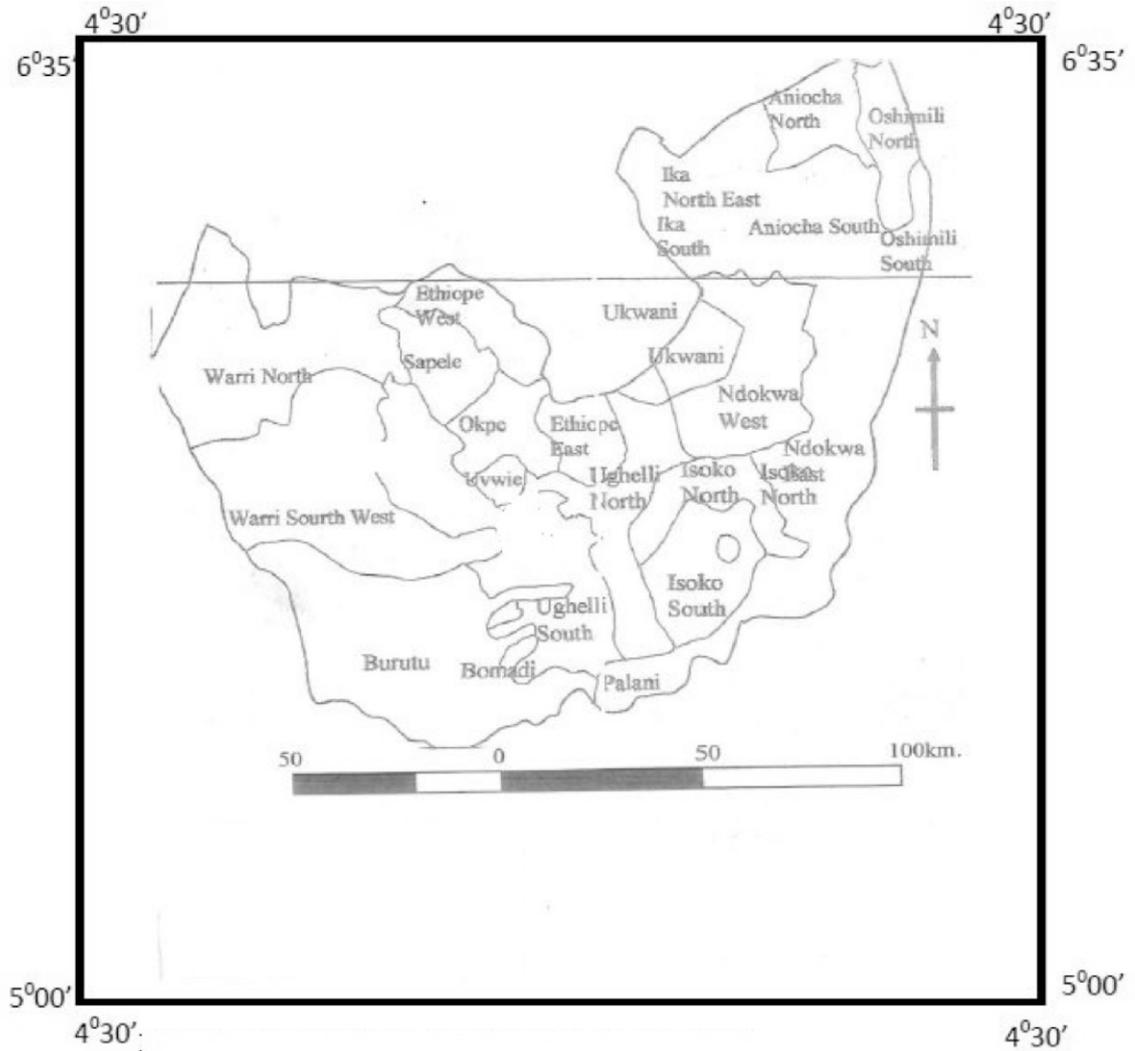
rehabilitation would become expensive (Telimoye, 2001). The result of lack of routine and periodic maintenance of highway facilities is seen in the form of cracks, potholes, rutting and undulating road surfaces. These are exemplified in Figures 1 and 2. These distresses affecting the pavement structure have been classified by Adrox and Woods (2002) under the following headings;

- i. **Structural Failure:** This refers to the loss of the load carrying capacity of the pavement structure. Structural failure is initiated when the pavement structure is unable to transmit the axle loading evenly to the subgrade thus causing fracture or excessive deformation.
- ii. **Functional Failure:** Is the loss of the specified performance standard of the pavement. It also involves failure to provide adequate skid resistance, structural capacity and passenger comfort.
- iii. **Materials Failure:** This occurs due to the disintegration or loss of material characteristics of any of the component materials.

The premature deterioration of highways in Nigeria with its attendant effects necessitated this work with a view to determining the Relative Indices of factors affecting highway durability in the country. The work, hence recommends ways of eliminating these factors.

Warri is located between Longitude 5° 41' 39.58" E to Longitude 5° 46' 11.42" E and

Latitude 5° 31' 12.37" N to Latitude 5° 48' 25.35" N. It occupies an area of 499.81 and drained by an intricately woven network of rivers, creeks, river outlets and canals. Warri is a conurbation of several communities including Effurun, Ekpan, Edjeba, Okumagba and Ugbuwangue. It has a coastline of approximately 160km along the Bight of Benin. It is a low lying plane consisting mainly of recent unconsolidated sediments. The area experiences long raining season and short dry season with mean annual rainfall of about 2,716.89mm and Relative humidity oscillates between 80 and 90% (Aderoju et al., 2014). The rapid urban growth which Warri has experienced stemmed from its position as the headquarters of Warri South local government area and the zonal headquarters of Federal parastatals as well as the oil and gas industry such as Nigeria National Petroleum Company (NNPC), Shell Petroleum Development Company (SPDC), many shipping and allied companies which have provided employment opportunities. The establishment of Warri Refinery and Petrochemical Company as well as the Aladja Steel Complex and its associated companies has no doubt contributed to the rapid population growth as well as the urbanization process (Onokerhoraye, 1980). The city was therefore chosen as the study area for the present work.



Source: Ministry of Lands, Survey and Urban Development, Asaba (2004)

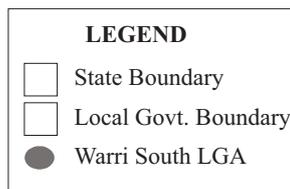


Fig. 1: Map of Delta State showing the study area Warri

Moreover, thin asphalt coatings or low level of road lines which are common features in this city can has been reported to be easily washed away by floods (Abdulkareem, 2003). To maintain a good highway pavement that will be able to

withstand the effects of heavy traffic and environmental factors, proper and well maintained drainage system is very important, as it allows flow of water from the road surface and keep the subgrade dry (Agbonkhese et al., 2013).



Fig. 3: Asphalt failure, Airport road, Warri

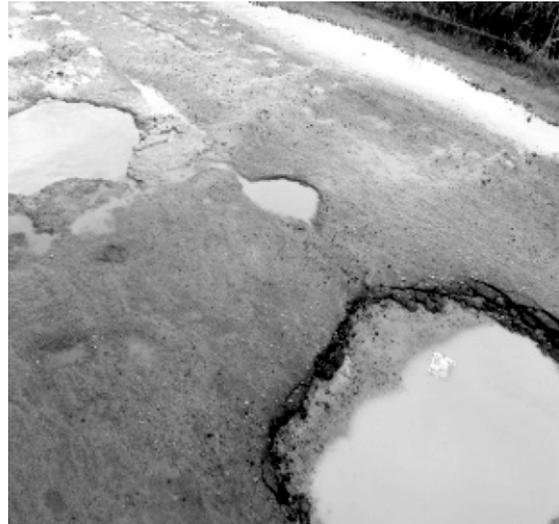


Fig. 2: Potholes on PTI road, Warri

METHODOLOGY

This paper adopted the quantitative research approach to collate data on factors affecting the durability of highways in Nigeria. Closed-ended questionnaire was designed to Oppenheim (1992) and distributed randomly to one hundred and twenty (120) professionals in the highway construction industry which included Civil and Mechanical engineers. The questionnaire incorporated significant

factors on a 4-point scale and other important question. A total of one hundred and eight (108) questionnaires was completed and returned, representing a response rate of 90%.

Relative Importance Index (RII) was used to analyze the collated data. Relative Importance Index is a statistical tool used to compare the relative importance of collected data. Relative importance index, RII has been determined by Popoola (2013) as,

$$RII = \frac{(4n_1 + 3n_2 + 2n_3 + n_4)}{4N} \text{-----(1)}$$

$$0 = (RII) = 1$$

where, n_1 = Number of respondent for agree, n_2 = Number of respondents for agree, n_3 =Number of respondents for disagree, n_4 = Number of respondents for strongly disagree, N=Number of respondents.

3.0 RESULTS

The factors evaluated in this study have been randomly selected from the common issues observed leading to the deterioration of road infrastructures in developing countries. The results are presented in Table 1 and Figure 4.

Table 1: Relative Importance of factors affecting highway durability

S/N	Factors	Strongly Agree	Agree	Disagree	Strongly Disagree	Number of respondent	Relative Importance Index	Rank
1	Inadequate Maintenance of the roads	42	29	18	16	105	0.7310	7
2	Climatic and environmental conditions	43	31	22	12	108	0.7431	6
3	Use of inexperienced labour in construction	21	15	25	41	102	0.5392	14
4	Insufficient highway depth	56	28	19	-	103	0.8398	1
5	Inadequate sanctions for highway failure	37	28	23	20	108	0.6898	8
6	Use of substandard construction materials	46	35	18	5	104	0.7933	3
7	Poor drainage system	48	37	21	-	106	0.8136	2
8	Majority of the roads in Warri are neglected after construction	20	26	31	29	106	0.5873	11
9	Excessive axle loading	39	26	25	18	108	0.7548	4
10	Neglect of the impact of climate change in pavement design and maintenance	20	23	35	24	102	0.5956	10
11	Faulty design	15	23	32	36	106	0.5401	13
12	Poor funding of road maintenance	41	35	19	10	105	0.7476	5
13	Inadequate observation and field control by qualified engineers and technicians during construction	31	28	24	21	104	0.6659	9
14	Poor laboratory and in situ test on soil before construction	16	27	33	31	107	0.5654	12
15	Poor construction practices	12	15	43	30	100	0.5225	15

DISCUSSION

The responses to the questionnaire are presented in Table 1. The table showed a list of the factors which were examined on a 4-point scale for respondents to indicate the level of importance attached to each of the factors. The table showed that 57.41% of the respondents were registered professionals, with the Nigerian Society of Engineers (NSE) having the highest of 30.97%, while the Nigerian Institute of

Safety Professionals represented 2.65%. This revealed that majority of the respondents were active professionals. About 58.33% of the respondents had practiced their profession for over 10 years implying a high experience in highway design, construction and maintenance. The table showed that 93.85% of the respondents had either designed or supervised flexible pavements and 80.43% of the respondents recommended flexible

pavements for highways. Table 1 showed that 62.04% of the respondents had laboratory and in-situ soil testing equipment, while 37.96% do not. The table also showed that 78.05% of the respondents had undertaken quality control of construction materials in their projects. About 66.67% did not incorporate measures to mitigate the effects of climate change in their design, construction and rehabilitation of highways while only 33.33% did. This may be responsible for poor condition of roads as shown in Figure 2.

Figure 4 presents the responses to the factors shown on Table 1 with their

corresponding Relative Importance Indices. Figure 4 showed that insufficient highway depth is the most important factor affecting highway durability in Warri. This is factor may be responsible for the impacts caused on the highways, by the effects of climate change which include flooding. The results of Figure 4 are in agreement with the literature CBN report (2003), Abdulkareem (2003), Aderinola and Owolabi (2014) and Johnnie (2012) which showed that thin asphalt thickness and low level of road line will result to highway pavement that will be unable to withstand heavy traffic and environmental factors.

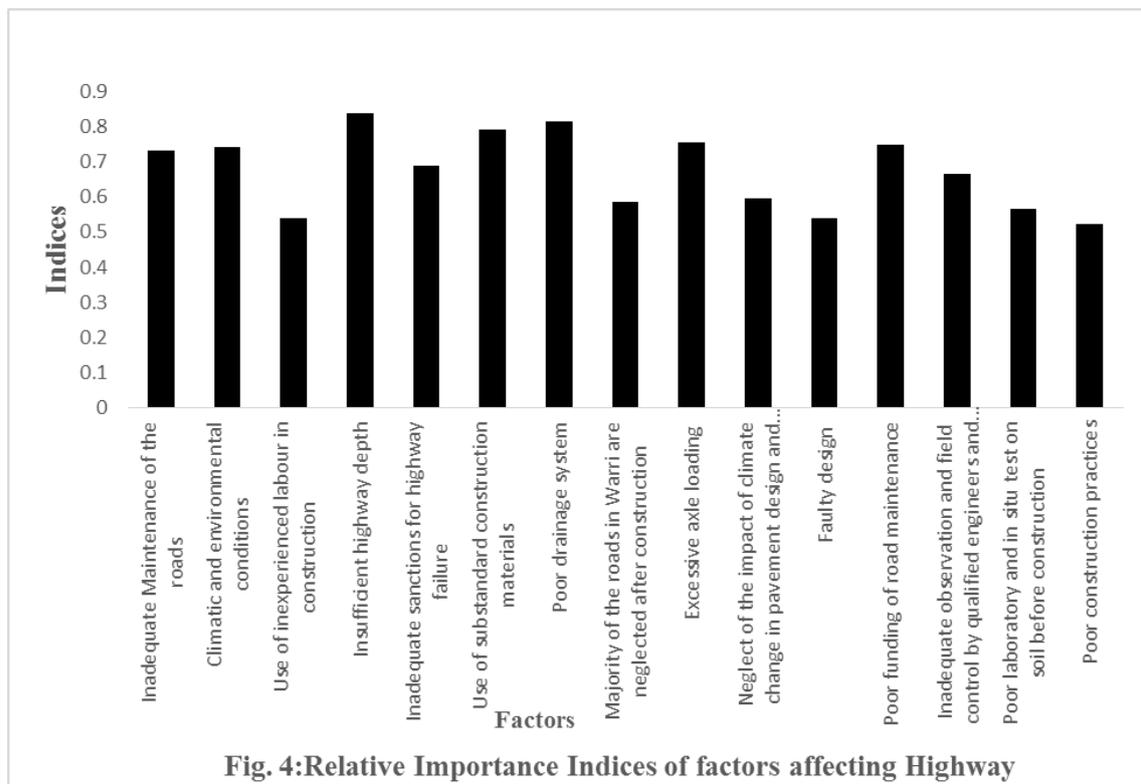


Fig. 4: Relative Importance Index of factors affecting highway durability

CONCLUSION

This study has assessed some factors affecting highway durability in Nigeria, rating the factors in their order of relative importance indices. Amongst the factors considered, insufficient highway depth was the most important factor with a rank of 0.8398 and least was poor construction practices with a rank of 0.5225. When these factors are mitigated by relevant stakeholders and agencies, highways in the country will become more durable.

6.0 RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made;

- i. The roads should be constructed higher than the existing ground, to keep the subgrade above water level. Soil stabilization with appropriate materials should be used to improve the strength of the soil and its bearing capacity, this will also cater for the increasing traffic and excessive axle loads of vehicles plying the roads in Warri.
- ii. A practical highway pavement design method should be adopted in Nigeria that will accommodate Nigeria peculiar climatic, social and economic environment.
- iii. Proper and well-maintained drainage systems should be provided and the public should be enlightened continuously on the need to maintain the drains which will contribute positively to the ability of the road pavement to withstand the effects of traffic and environment.
- iv. The government should revitalize

highway construction and rehabilitation monitoring in the respective ministries to ensure that materials that will be used by the contractors handling road construction and maintenance is of adequate standard that will meet the challenges of the Nigerian environment.

- v. Routine and periodic maintenance of the highways in the country should be a priority of the government to prevent the negative effects of failed highways to the citizens and the economy.

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