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FACTORS INFLUENCING THE QUALITY OF ROAD CONSTRUCTION IN JOS METROPOLIS

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ABSTRACT

The state of Nigeria roads is deplorable despite the huge amount of resources allocated to build roads annually. This research studied what influences the quality of road construction in Plateaus State, Nigeria with a view to help stem the high incidences of road failures. Primary information used in this research were sourced from a survey of one hundred (105) project professionals, each possessing a minimum of 3 years of experience. Structured questionnaires based on the Likert-5-Point Scale of Responses were used to capture their opinions on the factors that influence quality of road construction, while secondary information were sourced from a review of literature. Results were analyzed using appropriate statistical tools based on the Statistical Package for Social Sciences (version 16.0). The five most critical factors identified in this research are asphalt mix, thickness of base, quality of materials on site, thickness of wearing course, skill and experience of site staff. The measures to reduce failure of roads identified in the research are use of quality materials, use of experienced staff, adherence to design drawings and specification among others. The research concludes that the use of quality materials and adequate site supervision accordance with the specification will lead to achieving quality performance of roads. The study recommended contractors competence to be checked before awarding contracts. The study also recommended that designs should be made for each road rather than specifying thicknesses for various layers.

INTRODUCTION

In Nigeria, road transport system is the most used means of transportation and indeed in many developing countries. According to the Compendium Report on Road Infrastructure in Nigeria by the Federal Ministry of Works (2013), Nigeria ranks tops compared with other countries in Sub-Saharan Africa in terms of road network. The country has the largest road network in West Africa and the second largest, south of the Sahara with an estimated 200,000km of road network connecting villages to cities, the distant with the near and the inter-land with the urban market. Today, road transportation accounts for nearly 95% of all modes of transport and estimated N200b growing at 10% per annum compared with other developed economies such as South Africa, UK and US, Federal Ministry of Works (2013). Failure of roads in Nigeria is the rule, not the exception (Alex, 2009). Typical pavements exhibit severe potholing and shoulder deterioration because they were not constructed to standard in the first place. History has shown that roads, even if the proper design has been prepared, it is unlikely that the road will be constructed to this standard due to poor quality control resulting in inadequate compaction rates, thicknesses and pavement quality (Alex, 2009). Okigbo (2012) outlined some of the factors that cause this failure: poor design and construction, poor maintenance of already built highways, use of low quality materials in construction, poor workmanship and poor supervision of construction work and the applying of heavy traffic that were not meant for the road. Most Nigeria roads are failing because adequate plan is not made before construction. Poor supervision either due to compromise on the part of the supervisors or due to knowledge base is also a major cause of failure (Afolayan, & Alidoye, 2017). Most of the supervisions of construction work are done by the engineers and other middle level supervisors like the foremen. Some of these supervisors who have low knowledge of the work find it difficult to deliver adequate supervision at the site. Some of the faults on the roadway like depressions, cracks and even pothole can occur due to poor workmanship that resulted from poor supervision. Failures like cracking in rigid pavements are caused by inadequate curing of concrete, settlement, movement or restraint at joints may also lead to the development of cracks and subsequent failure. Most of the roads in the country are designed in the ministries or by consultants some of who are not within the environment of the road work. This leads to a situation where preliminary studies of the environment that will help the design and construction decisions are not done. This leads to poor understanding of the road environment which subsequently leads to poor road design and construction.

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Farouq, Anwar, Baba, Labbo, and Aliyu (2017) stated that the work of road construction and maintenance in the country is left at the mercy of expatriate companies that need to understand the local terrain and situation of our roads to enable them construct appropriately. This information can be provided by the local professional bodies that have more knowledge of the local environment. The professional bodies can even act as checks and monitors to the construction firm on road work in the country (Okigbo, 2012).

LITERATURE REVIEW

Quality in construction industry can be defined as the attainment of acceptable levels of performance from construction activities. This performance would be attained when the activity meets or exceeds the requirement of the client. Quality can be defined as meeting the legal, aesthetic and functional requirements of a project according to Arditi and Gunaydin (1997). According to Jegun and Kothai (2017), Quality in construction projects as well as project success can be regarded as fulfillment of customer's expectation. One of the important aspects of project delivery process is the management of quality of the product or service a construction company provides. The project specifications generally outlines the quality standards for the project and therefore becomes a part of the contract between the project owner and the contractor. The construction project quality is managed by a program which has two different elements. One is the quality control (QC) program and the other is the quality assurance (QA) process. The quality control element defines how the contractor expects to manage the quality requirements of the project as defined by the specifications. And the quality assurance element define the steps the contactors will take to ensure it. Quality control is important in the construction industry because any project is judged by the final product it produces; a product of high quality will perform better in the condition of its usage and a product of lower quality will fail under same the condition. Successful implementation of quality control management systems can contribute to an increase in product quality, improvement in workmanship and efficiency, decrease in wastage and increased profit (Afolarin 2013). Total Quality Management (TQM) is another concept of managing quality. TQM is an effort that involves every organization in the industry in the effort to improve performance. It permeates every aspect of a company and makes quality a strategic objective. TQM is achieved through an integrated effort among personnel at all levels to increase customer satisfaction by continuously improving performance. High-quality road networks are very important to the socio-economic development of any nation, especially the developing country like Nigeria (Akinleye & Tijani 2017). Quality management principles and tools are critical requirements in construction management practice to accommodate adequately the variability in production, relative to the diverse interests of multiple stakeholders involved in construction projects, and lack of it may result in frequent changes, errors and omissions. According to World Bank report (2011), the survey of Zambian contractors, engineers, and government in 2008 reported that providing materials of lower quality than the contract called for was the single most "unethical" practice in the industry. Oyedele, Jaiyeoba , Kadiri, Flolagbade, Tijani and Salami (2015) studied critical factors affecting construction quality in Nigeria. The results showed that the five most important factors that affected construction quality were low level of skill and labour experience, poor quality of materials delivered to site, poor inspection and testing, poor site installation procedure, and lack of quality assurance. In highway construction industry, quality is a major factor in determining how well a pavement will perform under traffic loading and when subjected to environmental influences. El-Marty, Akal, and El-Hamrawy (2016) identified factors influencing quality performance while studying Management of Highway Projects in Egypt, the most important factors were outlined as: efficiency of the owner's inspection team, availability of experienced staff in the owner's and contractor's teams during the project execution, clarity of responsibilities and roles for each owner, consultant, and contractor, pavement is not designed according to the regional conditions (e.g., soil type, temperature, and traffic volume), and asphalt quality and type used in the construction process. The premature deterioration of asphalt pavement is usually due to failures in construction or human error. This can be due to a number of factors including: insufficient or improperly compacted base below the asphalt, over or under compaction

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of asphalt, improper temperature of asphalt when applied and poor drainage. A pavement is said to be defective, when it can no longer perform this function during its design life. Most roads in Nigerian cities today are characterized by failure of all kinds like potholes, cracks, depression, ruts and bulges on our roads which have adverse effect on both vehicles and passengers. Many have met their untimely death by plying through these failed roads. Studies of past road failures showed some major causes; usage, poor design and construction problems (Levik, 2002), use of substandard material for road construction.

METHODOLOGY

The study investigated the factors influencing the construction of quality roads in Plateau State, Nigeria. Questionnaire survey was adopted in gathering relevant data from parties involved in road construction projects in the state. The population of personnel of road contractors, road consultants and client obtained from Plateau State ministry of works was 81, 39 and 33 respectively. Stratified proportionate random sampling technique was used to select the sample which was 57, 28 and 24 for road contractor, road consultants, and client. The questionnaire was used to elicit the opinion of parties involved in construction project on factors affecting the quality of road construction in the study area. The participants were asked to rank and score the listed factors on a scale of 1 to 5 where 1 is least important and 5 is most important factor. This study identified thirty-five factors affecting quality of road construction, fifteen measures to reduce road failures from literature and presented to the respondents to rank according to their relative importance. Out of the total respondents sampled, 8, 9, 15, 49, 12, 12, were retrieved from contractor, consultant, Government staff engineer, site or supervising engineers, surveyors and technologists respectively. The analysis of data collected was done using the SPSS version 1

RESULTS AND DISCUSSION

Table 1: Respondents Frequency Table of Level of Education

SN	QUALIFICATION	FREQUENCY	PERCENTAGE
1	OND	7	6.7
2	HND	35	33.3
3	B. Sc.	55	52.3
4	Master	8	7.6
	Total	**105**	**100**

From table 1, 52.3 % held Bachelor's Degree, 7.6% of the respondents indicated Masters Degree, 6.7% had Ordinary National Diploma (OND), 33.3% held Higher National Diploma (HND). This shows that respondents were educated and thus were able to respond to research questions. It also infers that the road construction is run by educated professionals.

Table 2: Respondents Frequency Table of Area of Specialization in Road Construction

SN	SPECIALIZATION AREA	FREQUENCY	PERCENTAGE
1	Contractor	8	7.6
2	Consultant	9	8.6
3	Govt. Staff Engineer	15	14.3
4	Supervising Engineer	49	46.7
5	Surveyor Engineer	12	11.4
7	Technologist	12	11.4
	Total	**105**	**100**

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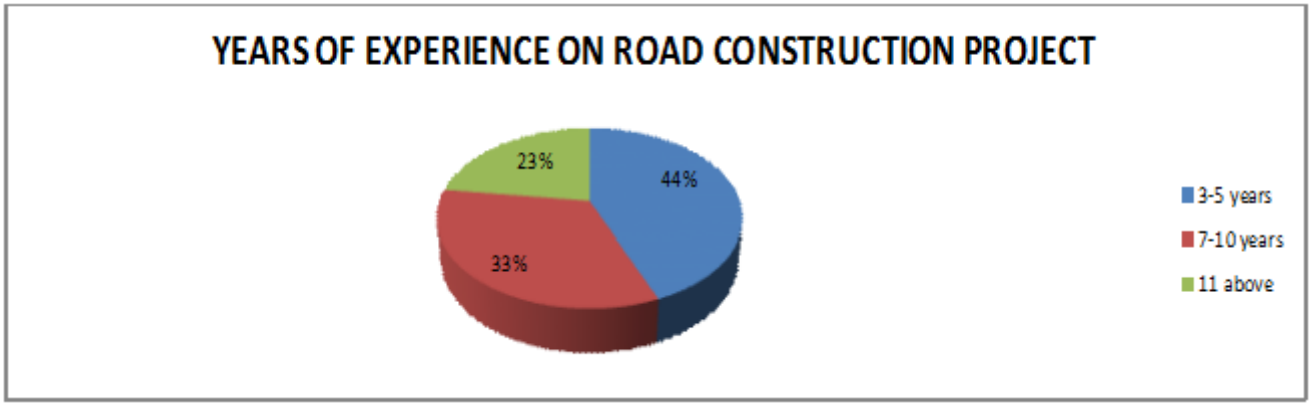
From table 2, it can be seen that 7.6% of the respondents were contractors, 8.6% were consultants, 14.3% worked with government ministry, 46.7% were supervising or site engineers, 11.4% were surveyors and 11.4% were technologists. This shows that most of the persons involved in road construction are trained professionals.

figure 1, 23% were involved in construction projects for more than 11 years, 33% were involved in road construction projects for a period of 7 - 10 years and 44% were involved for a period of 3-5 years. This implies that most respondents were involved in road projects for a significant time to be able to give information on issues relating to road construction. Also, the road construction industry needs to improve on staff retention and reduce staff turn-over so that more experienced staff can continue on road projects as more than 50% of the staff have < or = 10 years' experience.

Figure 1: Years of Experience on Road Construction



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SN	FACTORS	FREQUENCY	WEIGHTED(W)	RII=ΣW/(N*A)	RANK

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1	Material	No effect	Little Effect	Undecided	Great	Very Great		A=5, N=105	
a.	Availability of materials	6	7	45	39	8	8	0.0152	21
b.	Quality of materials on site	0	1	4	45	55	55	0.1048	2
c.	Delay in supply of materials	3	11	50	36	5	5	0.0095	24

SN	FACTORS	FREQUENCY					WEIGHTED (W)	RII=ΣW/(N*A)	RANK
f.	Thickness sub-grade	0	5	14	58	30	30	0.0571	11
g.	Thickness of base	0	1	7	42	55	55	0.1048	2
h.	Thickness of binder course	2	2	16	55	30	30	0.0571	11
i.	Thickness of wearing course	4	4	6	37	54	54	0.1029	4
j.	Asphalt mix	2	0	4	38	61	61	0.1162	1
2	Site Staff								
a.	Skill and experience of supervision	0	0	3	61	41	41	0.0781	5
b.	Inadequate site supervision	0	1	6	61	37	37	0.0705	8
3	Finance								
a.	Delay in payment of contractor	1	9	55	38	2	2	0.0038	26
b.	Poor financial management	2	4	65	28	6	6	0.0114	22
c.	Diversion of contract funds other than for the project	0	4	36	54	11	11	0.0210	18
d.	Poor funding/cash flow problem	3	20	35	44	3	3	0.0057	25
e.	Corruption	0	2	13	51	39	39	0.0743	6
4	Weather								
a.	Climate change	2	12	62	27	2	2	0.0038	26
b.	Poor weather condition	1	8	40	50	6	6	0.0114	22
5	Management Factors								
a.	Poor project planning / control	1	8	29	40	27			
b.	Communication between client and contractor	14	23	30	26	12	27	0.0514	13
c.	Inadequate sanctions for highway failure	0	2	13	64	26	12	0.0229	17
d.	Familiarity with project	1	4	11	68	21	26	0.0495	14
e.	Good leadership	0	7	40	49	9	21	0.0400	16
f.	Accountability	1	12	61	28	3	9	0.0171	20
g.	Monitoring of projects	8	15	29	42	11	3	0.0057	26.5

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6	Design								
a.	Inadequate design	1	3	5	57	39	11	0.0210	18
b.	Poor mix design	0	1	24	54	26	39	0.0743	6
c.	Flaws in specification	0	0	11	62	32	26	0.0495	14
	Total	52	171	745	1356	726	32	0.0610	9

From Table 3 under material factors, the asphalt mix is most influential on the quality of road as it has a Relative Importance Index (RII) of 0.12. The second most important factor under material is quality of materials on site and the thickness of base as they both have RII of 0.11. The third most influential factor under materials was thickness of wearing course with RII value of 0.10, the next is expansive sub-grade with RII value of 0.07. Others are testing of road materials with RII of 0.06, thickness of sub-grade and thickness of binder course with both having an RII of 0.057, availability of materials has 0.015 RII value and delay in supply of materials has the least influence under materials with RII of 0.009 respectively. Under site staff factors, skill and experience of supervision has the most influence with RII of 0.078 while inadequate site supervision has the least effect under site staff with RII of 0.071. Finance factor has corruption as the most important factor on quality of road construction with RII of 0.074, the second most influential is diversion of contract funds other than for the project with RII of 0.021, the third on rank under finance factor is poor financial management with RII of 0.011. The least influential factor under finance is poor funding/cash flow problems with RII of 0.006. Weather factors has poor weather conditions as the most important and climate change as least important with RII of 0.011 and 0.004 respectively. Under management factors in Table 7, poor project planning/control is the most influential factor on quality of road construction with RII of 0.051, followed by inadequate sanctions for highway failures with RII of 0.05. The third most influential factor under management factors is familiarity with project with RII of 0.04, the fourth most influential is communication between client and contractor with RII of 0.023. The last two on rank under management factors are good leadership and accountability with RII of 0.017 and 0.006 respectively. Under design factors, inadequate design is the most influential factor on quality of road construction with RII of 0.07, flaws in specification is second most influential under design with RII of 0.06, followed by poor mix design with 0.05 as RII value. The results in Table 3 therefore shows asphalt mix as the most influential factor under all the six categories that affects the quality construction of roads with RII of 0.12. The second most influential are quality of materials on site and thickness of base as both have a RII of 0.10. The third most important factor contributing to quality of road construction is thickness of wearing course with RII of 0.10. Skill and experience of supervision with RII of 0.08 is the fourth in rank on quality construction of roads. Fifth most important factor is inadequate design with RII of 0.07. Material factor is therefore the most important factor that influences quality of road construction from the survey.

SN	MEASURES	FREQUENCY					WEIGHTED(W)	RII=ΣW/(N*A)	RANK
1	**Site Works**	**No effect**	**Little effect**	**Undecided**	**Great**	**Very Great**		**A=5 N=105**	
a.	Adequate planning	1	3	28	52	21	21	0.0400	7
b.	Good labour supervision	0	0	12	67	26	26	0.0495	6
c.	Use of experienced site staff	0	1	4	63	37	37	0.0705	2
2	**Motivation**								

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a.	Incentive schemes for construction workers Good residential accommodation	1	12	27	46	19	19	0.0362	8
b.	Good residential accommodation	23	38	27	6	11	11	0.0210	12
3	**Ethics**								
a.	Implementation/policing of ethical guidelines	1	9	26	53	16	16	0.0305	10
b.	Anti-corruption training of staff	6	16	58	18	7	7	0.0133	14
c.	Involvement of professional bodies in road construction process	8	18	39	30	10	10	0.0190	
d.	Penalties for substandard construction	1	6	15	51	32	32	0.0610	4
e.	Anti-corruption actions/rules	4	11	62	21	7	7	0.0133	14
f.	Recognition for good conduct	0	1	25	62	17	17	0.0324	9
4	**Quality**								
a.	Implementation of quality assurance	0	6	10	58	31	31	0.0590	5
b.	Use of quality materials	0	0	4	45	56	56	0.1067	1
c.	Initiation of local standards for roads	9	10	48	25	13	13	0.0248	11
5	**Specification**								
a.	Adherence to design drawings and specification	0	0	8	63	34	34	0.0648	3
b.	Extent of change of design during construction	8	16	32	22	7	7	0.0133	14
	Total	62	147	425	682	344			

Table 4: Frequency Table of Measures Contributing to Quality of Road Construction

The improvement measures to reduce failure of roads were categorized under five categories: site works, motivation, ethics, quality, and specification. Under site works, use of experienced site staff is the most important measure to be taken to ensure road failures are reduced and improve the quality of road construction, it has an RII of 0.07. The second most important measure of improvement under site works is good labour supervision with RII of 0.05. Adequate planning has an RII of 0.04, thereby being the third in rank under site works. Under motivation, incentive schemes for construction workers has the highest importance when it comes to motivating workers for productivity, it has an RII of 0.036 while good residential had RII of 0.021. Under ethics measure, penalties for sub-standard construction was the most important measure to improve roads, with RII of 0.061. The second under ethics is recognition for good conduct with RII of 0.032, followed by implementation/policing of ethical guidelines with RII of 0.030. Anti-corruption actions/rules and anti-corruption training of staff both had an RII of 0.013, and are the least influential measures to reduce road failures. Under quality, use of quality materials is the most influential measure to reduce road failure with an RII of 0.11, the second most influential is implementation of quality assurance with RII of 0.06. Initiation of local standards was the least influential under quality with RII of 0.02. Adherence to design under specification is the most influential measure with RII of 0.06, followed by extent of change of design during construction with RII of 0.013. Therefore, from all the five categories of measures, use of quality

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materials is the most important measure to reduce road failures. The second most important measure is use of experienced staff. The thirds most important measure is adherence to design drawings and specification, while the fourth and fifth are penalties for substandard construction, and implementation of quality assurance.

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CONCLUSION AND RECOMMENDATIONS

The five most critical factors identified in this research are Asphalt mix, Thickness of base, quality materials on site, thickness of wearing course, skill and experience of site staff. The measures to reduce failure of roads identified in the research are use of quality materials, use of experienced staff, adherence to design drawings and specification, penalties for substandard construction, implementation of quality assurance, testing of road materials, road maintenance, adequate design among others. The research concludes that the use of quality materials and adequate site supervision accordance with the specification will lead to achieving quality performance of road. Based on the research findings and analysis, recommendations were made which include: Contractors competence should be checked before awarding contracts., policy to motivate site workers with incentives should be made, site engineers must always stay on site to direct the site workers on every section of work until end of working hours. Other recommendations were made that technicians must conduct tests on materials and check equipments before use, training and retraining of construction workers is necessary to ensure quality performance of manpower, kick backs should be eliminated from the construction industry, materials on site should be compacted adequately, designs should be made for each road rather than specifying thicknesses for various layers, authorised agencies should ensure that quality management department should be present in every road construction project, penalties for poor quality works should be enforced by authorised agencies.

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