Physical Environmental Variables in the Cost of Construction in the Niger Delta Region of Nigeria

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Abstract: *The causative effect on the cost of construction project in the Niger Delta Region of Nigeria was examined in this work. The physical environmental variables constitute a major effect on construction project in the Niger Delta Region of Nigeria particularly due to the terrain in which the Region is situated or located. This however, reduces the intended growth of the industry even though the Region is exposed to a lot of oil exploitation and prospecting activities by multi-national companies. In examining the causative effect of the physical environment on cost of construction project in NDR, ten variables were identified. Method used in the study was identification of target group of professionals who work with contractors and consultants in the NDR randomly and the distribution of 100 structured questionnaires to the respondents. Analysis was done by using the mean square of responses, mode of response and ranking their causative effects to determine severity on cost. The statistics analysis included the use SPSS package and the determination of relative importance index (RII). Out of these variables, the physical location of the project had the most cost effect which was followed by weather condition and land dispute/communal clashes. The construction projects considered were roads and bridges with a minimal value of 500million naira that are called mega.*

Keywords: Physical environment, cost, construction projects, Niger Delta Region (NDR), Niger Delta Development Commission

1. Background

Globally, it is known those the environments in which business are carried out are very dynamic, hence, experiences rapid changes. Lee et al (2001) observed that any organization that fails to adapt and adjust to this dynamic environment would definitely experience survival problems. While Samson and Lema (2005) observed that due to this dynamic environment, contractors have to be capable of continuously improving their performance because of the number of variables that impinge on the cost of construction, such as environmental awareness, limited resources and other several encumbrances in the construction industry. However, ten physical environmental variables were identified as having effect on cost of construction projects in the Niger Delta Region of Nigeria. The geography of the region depicts the difficulties in executing projects, particularly when the features are not quite favourable to project construction. Environmental and soil conditions amongst others were identified by Al-kass and Mazerolle(1996), and cited by Haseebet, al. (2011). A.M.Odeh and H.J. Bahaineh, (2002). Haseebet, al., (2011) rated location under project condition, effect of sub surface condition, changes in government regulations and laws had70% of the respondents, while statutory undertakers (gas, water), weather, natural disasters (earth quake, flood) and rain were rated to have 60% responses. This has been the worries of most developers who intend to improve the region positively to attract investors. The study involves the identification of variables which affect cost of construction; followed by a review of literature of related works by various academic researches that served as the secondary source of data collection, and by the distribution of structured questionnaire to the target group that is, consultants and contractors that engage in executing infrastructural development projects in the nine states that constitutes the Niger Delta Region (NDR) of the Niger Delta Development commission (NDDC).

Study is intended to examine the effect of the physical environment, in which projects are located on the cost of construction in NDR. The effect is indirect, hence no particular attention was given while tendering, even though contractors are usually advised to visit the site before submitting their bids. However, the study is limited to the Niger Delta Region of Nigeria; contractors who are executing mega projects of above N500million and consultants that studied and designed these mega projects. Mega projects in this context are particularly focused on Roads/Bridges. The environment may be construed to have multi facet dimensions, it could be considered as the macro environment which has to do with various externalities, but the work focuses on the internalities which is the physical situation where the projects are sited. The significance of this study is to bring to the fore these physical environmental variables and their effect on cost of construction projects in the Niger Delta Region of Nigeria.

Source:
https://www.google.com.ng/search?q=Niger+Delta+map+of+nigeria&sa
Figure 1: The Map of Niger Delta Region.

It may also be relevant to various academic researches for information that could be used for proper decision-making by management of an organization. The research question was, how does the physical environment of a project site affect the cost of construction projects in the Niger Delta Region of Nigeria? Hypothesis of the study was of null, Ho and the alternative Ha. The null hypothesis Ho was that there is no significant influence on cost of construction projects due to the physical environment. And the alternative Ha was that, the physical environment in which a project is sited has significant effect.

2. Literature Review

Several factors are responsible for micro influences on the cost of construction projects globally, national and in the Niger Delta Region. Gasoline or diesel pricing is dependent on the cost of crude oil, processing and distribution cost, the demand, local currency strength, taxation and shortage of local source of diesel supply. Despite high taxes on gasoline and diesel, some countries subsidized. The direct cost is through the consumption of the fuel and indirect cost through the energy related consumable such as steel, paint, conveyor belt. Distribution network is considered for cost of construction projects in the Niger Delta Region (NDR). This is because the product serves as main ingredient of production/construction; and it is used by various construction equipments like bulldozers, mobile cranes etc., thereby increasing the overhead cost of construction. While considering the physical environment on the cost of construction projects in NDR, nationally and globally, it should be noted that increase in the fuel prices greatly affect the cost of living due to increase in the cost of transportation that affects other sectors causing inflation in the economy. Increase in the cost of petroleum product gave rise to a marginal increase in the cost of all related products and services. The effects of prevailing cost of petroleum products have been succinctly x–rayed as a variable that influence the cost of construction projects. The surrounding environment in which the project is located or sited affects substantially the cost of construction projects. Carr (1989), classified environmental factors as weather, construction demand, social and cultural impact, project location, government policies, level and number of competitors, labourers, nationalities, lack of productivity and cost indices, standard and economic stability. Ubaid (1991) noted that Nigeria has a long wet season with a short dry season where a little rain falls, and alluded that climate of the southern part of Nigeria is affected by geographic location. This was attributed to the fact that the highest relative humidity is reached at the end of wet season in late July to early September and rainfall is irregular, starting from April to October. It was further observed that surface winds are at high to normal speed during most of the year, which are accompanied by a rise in temperature and humidity. Due to these characteristics of weather, there occur loss of productivity and increase in the maintenance cost of equipment. Frimpong et, al.(2003), corroborated to this by stating that if the temperature and humidity are high, workers feel lethargic, hence lose physical co – ordination, thus, project location

and area condition affect cost of construction project in the Niger Delta Region of Nigeria; in terms of time, quality and quantity. The availability of foremen, laborers, harsh working conditions on the site, difficult living condition in the rural areas and traffic congestion in the urban settlement required to be considered seriously. Adenoje (1990), alluded to the above and stated that the geographical location of a construction project has an immense impact. The research revealed that the increase in cost of construction projects emanates from higher wages, materials and other components; coupled with the restrictions in the use of mechanical plants because of the congested urban centres. Projects located in the rural areas of the Niger Delta Region are faced with a lot of geographic challenges exposed to long lengths of temporary access roads, double handling, energy and provision of labourers. Ubaid (1991) noted the presence or existence of theft on construction materials on site. The following therefore were identified as physical variables affecting cost on construction projects in the NDR; bearing capacity of the soil, presence of rock location, ground water, slope and existing conditions such as old foundations, buried as hazardous wastes and were considered to have effect on the substructure cost. For urban centres, there is likely to be underpinning, limitation to access the site and provision of additional security. Neil et, al. (2002), further observed that location difficulties are associated with remoteness, confined site, labour availability, vandalism and site security. Weather condition was identified to be a major cost of increase in cost of construction projects in the NDR of Nigeria. Simon and Lema (2005) classified the effect under cold condition, wet condition, and exceptionally adverse condition of weather that affect the design, construction and performance of the structure. Weather is actually a function of the changes in the atmospheric pressure like the air movement, temperature and humidity. Some changes are considered to be climatic which result to violent storms, while other changes are subtle and posit less effect on the weather. Meteorogists can predict these changes with reasonable accuracies that affect project design and construction process/procedure.

3. Methodology

The approach to the examination of the effect of the physical environment on the cost of construction projects in the Niger Delta Region of Nigeria was via a review of related works by various researchers. This was closely followed by distribution of questionnaire to contractors and consultants spread across the Nine States that constitute the Niger Delta Development Commission of Nigeria (NDDC). Questionnaire was structured in two parts. Part 1 was based on the respondent's characteristics which included bio-data, the profession and cognate experience of respondents and were strictly distributed to professionals in the construction industry with at least five years of experience that had been involved in the study, design and construction of mega projects in the Niger Delta Region (NDR). The second part of the questionnaire was on the identified variables under study, which had significant effect on the cost of construction projects. The five point likert scale was used in prepare the

questionnaire, and a total of hundred questionnaires were distributed randomly across to contractors and consultants who engage in business with the NDDC. Out of which 50 each were distributed to the contractors and consultants respectively. The responses were subjected to statistical appraisal using the mean square, frequency distribution, student test analysis and regressed for the spearman correlation ranking coefficient with determination of f value.

The relative importance index (RII) method was also used to determine contractors and consultants views on the relative causative effect on cost of construction projects in NDR of Nigeria. The RII was computed by Cheng et al (2004), Iyer and Jha (2005), Ugwa and Haupt (2007) as cited by Adnanet, al. (2009):

$$RII = \frac{\Sigma w}{A \times N} \ (1)$$

Where:
w = weight given to each variable by each respondents which ranges from 1 to 5
A = the highest weight i.e. 5
N = the total number of respondents.
The relevant data used are presented in the result and discussion.

4. Results and Discussion

Table 1: Analysis of Responses of Questionnaire

| Description	No. Issued	No. Returned	% Returned
Contractor	50	35	35
Consultant	50	45	45
Total	**100**	**80**	**80**

Questionnaires distributed were 100. Contractors and consultants were given 50 each to respond. Out of the total, responses from contractors and consultants were 35 and 45 respectively which represented 80%. However 15 were not returned/ voided because of wrong filling.

Table 2: characteristics of Respondent

Description	Frequency	Percentage
Engineers	25	31.25
Architects	15	18.75
Quantity surveyor	12	15.00
Estate Valves	10	12.50
Other	28	22.50
Total	**80**	**100%**

Source: Field Survey (2014)

Table 2 above showed the respondents characteristics and the frequency of responses with percentage representation. This is depicted in the pie chart below.
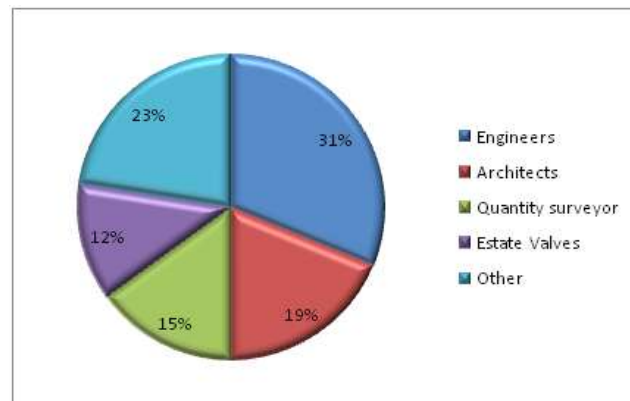
Figure 2: The Pie Chart of the Correspondents

The representation in the pie chart showed the caliber of professionals that responded on behalf of either the contractors or consultants. In the Legend, 'other' represents professionals that are associated in the construction industry. Such professionals include but not limited to lawyers, accountants and builders.

Table 3: Mean Square and Ranking of Variables

Variables	Mean Score	Ranking
Physical location	4.40	10
Weather condition	4.23	9
Land Disputes/ Communal Clash	4.00	8
Underground condition	3.93	7
Topography	3.00	6
Youth Restiveness	2.83	5
Political Situation of Project site	2.60	4
Site Encumbrances	2.00	3
Access to site (Road Network)	1.37	2
Lack of Usage of ICT	1.00	1

Table 3 above showed the mean scores and the ranking of each physical environmental variable that affects the cost of construction projects in the Niger Delta Region of Nigeria. These variables are equally applicable globally and nationally. The variables on their ranking considered the physical location of the project site had very high significance, which was followed by weather condition, land disputes or communal clashes with mean scores of 4.4, 4.23 and 4.00 respectively. The underground condition and topography of the site was rated with mean scores of 3.93 and 3.00 which represented near to very significant to quite significant when juxtaposed on the Likert five point scale. Though the variables such as site encumbrances, political situation of the project site, road network, youth restiveness have significant effect on the cost of projects in Niger Delta Region (NDR), yet the respondents did not rate them as high as the earlier mentioned variables. This judgment may be based on the experiences of the respondents who are professionals handling mega projects in the Niger Delta Region (NDR) for the Niger Delta Development Commission. A conurbation of mean scores of all variables had a weighted average of 3.05 which depicts that the physical environment has a quite significant influence on the cost of construction projects. The figure below is a bar chart showing the distribution of the influence by the variables

of physical environmental factor affecting cost of construction projects in the Niger Delta Region of Nigeria.
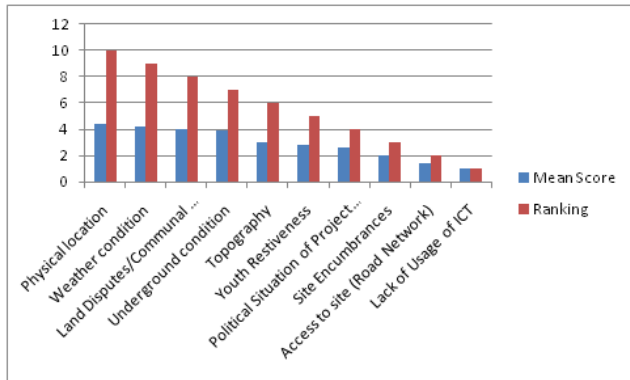
Figure 3: Mean Score and Ranking variables

The mean scores and ranking showed the severity of influence of each variable on the cost of construction in Niger Delta Region (NDR). Though the respondents viewed youth restiveness as quite significant, the authors considered that variable to be highly significant because, it leads to stoppage of work and force marjuere.

Physical Location:

The features of the Region is a major obstacle in executing developmental projects particularly access to site, that is Road network in some project site, there exist double handling of construction materials which escalate the cost of construction projects.

Weather Condition:

This physical environmental variable had mean score value of 4.23 and was ranked next to physical location of the project. The variable has highly significant effect on cost of construction projects in the NDR. The climatic condition allow construction work to be carried out in sequence between the months of October to March each year, because it has seasons, the dry and rainy season.

Land Disputes/ Communal Clashes:

This variable of the physical environment had a mean score of 4.00 which was rated as very significant to the increase in the cost of construction projects in the region. Communal clashes usually results due to acquisition of right of way by the contractor, which may lead to delay in the construction projects if not resolved promptly. In most cases, the clash or dispute is between communities because of claim of ownership of the land in which the project is to be sited despite the fact that there is a land use decree of 1978.

Underground Condition:

The underground condition of a project was rated to have very significant in the cost of construction projects. This leads to the fact that before a project is sited there should be a proper geotechnical study absence of that leads to increase in the cost of construction projects in Niger Delta Region (NDR).

Topography:

The topography of the project site was rated quite significant by the respondents and was ranked 6. Topography contributes very significantly on the cost of construction projects because of the contouring nature or undulation that may require removal or filling to make a uniform level. Topography of a project site actually has a significant cost implication on the contract indirectly.

Youth Restiveness in the Region:

The NDR is quite vulnerable to unrest, principally due to oil exploration and prospecting activities saddled with neglect for accelerated infrastructural development and unemployment saga, therefore the youth are always agitated. This gives a platform for youth restiveness in the region. Accordingly carrying out a construction project in the region attracts some form of volatility on the side of the youth, scrambling for menial jobs that are limited due to its severity, the respondents rated it as quite significant with a mean score of 2.83.

Political Situation:

It is also observed that the political situation of the area of construction project may affect significantly on the cost of construction. Respondents rated it as 2.60 which is quite significant.

Site Encumbrance:

Site encumbrances are quite minor that can be resolved though, delay in the resolution results to time overrun; which affects cost of construction projects.

Access to site (Road Network):

Lack of Road Network in a projects site contributes significantly to the cost of construction projects particularly in the riverine areas of the NDR. These in most cases result to double or triple handling of construction materials and rated with a mean score of 1.37 and ranked as 2 by both contractors and consultants.

Lack of Usage of ICT:

The usage of ICT improves effective project management. Most projects site are not provided with this technology. Thus, embarking on provision of ICT requires additional cost which was not considered when the project was bided for. Cost emanates from provision of network or provision of internet, intranet or extranet services. This variable was rated and ranked as 1 by both the contractors and consultants.

Table 4: Statistical Analysis

R	R Square	Standard Error	f	Unstandardized Coefficient		Standardized Coefficient	t	Significant
				B	Standard Error			
.984	.968	1.000	238.735	2.464	.160	.984	15.451	.009
				-1.736	.503		-3.453	

Source; Statistical Application of SPSS 22

The statistical analysis further revealed that the collective influence of all physical environment variables on cost of construction projects had a spearman's correlation ranking coefficient R of 0.984, R^2 the determination of the relationship to be 0.968 with a standard error of 0.578. However, the analysis of variance ANOVA yielded f-value of 238.735 and the student statistics t-value of 15.451, all of which are greater than table values. Hence, the null hypothesis (Ho) is rejected and the alternative (Ha) is accepted. A model equation can be formulated as follows. $C = \alpha + \beta E_p$; where C is the cost component that is dependent on the variable Ep.

Table 5: The Relative Importance Index, Mean Score, Mean of Mean Scores and Rating of the Environmental variables of both Contractors and Consultants

Variables	MMS	Contractor			Consultant		
		MS	RII	R	MS	RII	R
Physical location	4.40	4.20	0.840	10	4.60	0.920	10
Weather condition	4.23	4.10	0.820	9	4.36	0.872	9
Land disputes	4.00	3.90	0.780	8	4.10	0.820	8
Underground condition	3.97	3.80	0.760	7	4.06	0.812	7
Topography	3.00	3.30	0.660	6	2.70	0.540	6
Youth Restiveness	2.83	3.10	0.620	5	2.56	0.512	5
Political situation	2.60	3.00	0.600	4	2.20	0.440	4
Site encumbrances	2.00	2.50	0.500	3	1.50	0.300	3
Access to site	1.37	2.00	0.400	2	0.74	0.140	2
Lack of usage of ICT	1.00	0.50	0.100	1	0.50	0.100	1
∑	29.40	30.40	6.08	55	27.32	5.456	55

Table 5 showed the Relative Importance Index (RII) which determines the level of significance of each variable on the cost of construction projects in the NDR of Nigeria that highlights the views of the two groups (contractors and consultants) on the causative effects, with their ratings. As shown in table, the severity on cost of construction projects expressed by the two groups is 6.08 and 5.456 respectively. These values are the Relative Importance Index commutatively. Also comparing the mean score for both groups has 10% variance at 90% confidence interval. The groups consideration on the effect of the physical environment on cost of construction projects are relatively important by 0.624 which is about 10% variance between groups. Therefore, the Ha hypothesis should be accepted at 90% confidence interval. The summation ratings of both groups are equal which show the level of concordance. However, this was not examined because the study was based on only two groups.

5. Conclusion

- The identified physical environment variables that constitute the environmental factor affect cost of construction projects in the NDR of Nigeria with a high influence.
- Mean score values and ranking depicts the severity of influence by each variable on the cost of construction projects.

- The spearman's correlation ranking coefficient R is tending to +1 with a coefficient of determination R^2 of 0.964.
- There is a strong relationship between the variables and cost of construction projects in the NDR of Nigeria
- All variables have significant effect on the cost of construction except access to site and usage of ICT. This may be due to level of awareness. However, they are significant to increase in cost of construction in the region.
- The relative importance index of each variable and the views of the respondents showed that the groups are concordant.
- Fundamentally, the physical environmental factor affects the cost of construction projects quite significantly in the Niger Delta Region of Nigeria. Hence, the null hypothesis was rejected.

Acknowledgements

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