

# EFFECTS OF ENVIRONMENTAL FACTORS ON CONSTRUCTION PROJECTS TIME AND COST PERFORMANCE

ADEBIYI R. T.<sup>1</sup>, BABALOLA M. O.<sup>2</sup>, AMUDA-YUSUF G.<sup>1</sup>

e-mail: [taibatranti@vmail.com](mailto:taibatranti@vmail.com), [adebivi.rt@unilorin.edu.ng](mailto:adebivi.rt@unilorin.edu.ng)

<sup>1</sup>DEPARTMENT OF QUANTITY SURVEYING,  
UNIVERSITY OF ILORIN,  
ILORIN, NIGERIA

<sup>2</sup>DEPARTMENT OF QUANTITY SURVEYING,  
OBAFEMI AWOLowo UNIVERSITY, ILE-IFE, NIGERIA

## ABSTRACT

*The delivery time and cost of a construction project is a key factor and source of concern to project stakeholders in the Nigerian construction industry. It is apparent that environmental factors are a major contributor to construction time and cost overruns. This study examines the influence of environmental factors on construction time and cost performance in Lagos state. A total of two hundred and forty-one (241) copies of questionnaire were administered on industry practitioners through convenience and snowballing sampling. A total of twenty-six (26) environmental factors were identified and grouped under six categories. The magnitude of the mean scores of each item was adopted to rank them in order of importance. The results of the study revealed that cost of government policy is the most significant factors affecting time overrun with a mean score of 4.7552 followed by project team commitment with a mean score of 4.4772. Similarly, instability in government and importation of materials and equipment are considered as the most significant factors affecting cost overruns. However, the significant factors identified from this study can be used as parameters for developing strategy for reducing the impact of environmental factors on on construction time and cost*

**Keywords:** Construction, Environmental Factors, Project Delivery, Project stakeholders, Time and Cost Overruns.

## INTRODUCTION

The construction industry sector is the backbone of the economic growth and social-economic development of a nation (Nguyen, Ogunlana and Lan, 2004). It interacts with nearly all other sectors of a nation's economy as well as other

fields of human endeavours. Unfortunately, the intrinsic complexity, uncertainty and dynamics of most construction projects create difficulties for the clients and contractors in terms of project duration and cost (Chan and Chan, 2002; Akanni, et al., 2015). The duration and cost of construction projects right from

inception to completion is assuming greater importance in the construction industry (Nkado, 2007). Studies have shown that the performance of this sector must be improved if it is to be able to fulfil the expectations of the governments and people for enhanced economic prospects and improved quality of life (Ofori, 2014).

Apparently, time, cost, quality and participant satisfactions have been identified as the main criteria in measuring the overall success of construction project delivery (Walker, 2007). A construction project is commonly acknowledged as successfully delivered when it is completed on time, within budget and in accordance with specifications and stakeholders' satisfaction (Ashworth, et al., 2013; Ogunsemi, 2015). According to Lim and Mohammed (1999), clients and contractors are very much concerned with construction project performance to achieve project objectives in terms of time, cost, and quality performance safety and so on. Once they achieved their aspiration, the project is considered to be successfully delivered. Al-Momani (2000), Faridi and El-Sayegh (2006) and Dvir, Raz and Shenhar (2008) are some of the studies that considered cost and time as the most important of the clients' project objectives. Lambropoulos (2005) argued that private clients ranked time as the most important of the three criteria, while cost is considered the least important. On the other hand, public clients

placed more importance on quality and secondly on cost, while time is the least important (Ashworth, et al., 2013). A project that does not meet any of these objectives is considered to have failed.

Construction projects experience time-delays and cost overruns during their implementation phase. An examination of the records of more than four thousand construction projects by Morris and Hough (1998), for example, showed that projects were rarely finished on schedule time or within the allocated budget. Other researchers have also observed that time and cost overruns are common place in the construction industry worldwide (Assaf, Al-Khalil, and Al-Hazmi, 1995, William, 2001; Chan and Chan, 2002; Vandevoorde and Vanhoucke, 2005). Time and cost have been typically used as the key criteria for examining project success, (Love, Tse and Edwards, 2005). Walker and Shen (2002) in a major review of project management theory established that the environmental factors interfere with planned progress of construction projects. The less predictable the environmental factors and greater their potential effects, the more they must be taken into account in managing the development of construction projects (Hughes, 1999).

This study explores the effects of environment on the industry clients' project objectives of time and cost. While there has been some research reported that concerns influence of

environment on project performance in Nigeria (Akanni, et al., 2015; Ogunsemi, 2015; Jagboro, 2016). These studies have largely ignored the effects of environment on the clients' value criteria of time, cost, and quality as well as stakeholders satisfaction. Despite the emphasis of previous studies on the need to consider effect that external environment could have on the clients' objectives in project delivery.

Some scholars have suggested that factors like political instability and recession in the construction industry might not be as critical a determinant of project performance (Akanni, et al.,). The argument in this article is that this and other environmental factors may not have a strong impact on performance and, thus, are often insignificant and not reported. However, if the importance of all the factors is considered from the perspectives of highly experienced industry practitioners, then it will assist industry stakeholders to develop strategies to minimise the most critical factors in order of importance. Similarly, Ogunsemi (2015 ) observed that efforts that have been undertaken on understanding how the relationship between specific industry characteristics impact project delivery have not yielded significant empirical results. other studies have also caution that future research should be more explicit as to the influence of environmental factors on time and cost and note that: the effect of the

environmental factors on project performance generally has been neglected (Babalola & Adesanya, 2008); to date most research on construction project delivery has concentrated on "main effects" on project performance without much consideration to differing environment in which the projects are executed, specifically external environment. The degree and relative importance of the external environment on project delivery remains a subject of debate. The main aim of this study therefore is to examine the influence of environmental factors on construction project time and cost in construction project delivery in Lagos State. The study will rank these factors in other of importance from the perspectives of industry practitioners. To achieve this, the study is divided into five sections, the first section provide the introduction to the study followed by the result of previous studies reviewed. The third section contains the research methodology, data analysis and discussion of findings is contained in the fourth section and lastly the conclusions and recommendations.

### **The Influence of Environmental Factors on Construction Time and Cost Overruns**

Schwartz (1995) defines the environment as surroundings; external conditions influencing development or growth of people, animal or plant; living or working conditions. Environmental factors describe all

external influence on the construction process. Thus, a construction project as a temporary organization or work place for people is influenced by a variety of opportunities and constraints within the environment. Environmental factors exacted the great influences on project delivery. The general environmental factors to which construction projects respond consists of economic, political, physical, social and cultural aspects (Akanni, et al., 2015). Lester (2007) identified political, economic, social, technical and legal as the factors influencing project. Hughes (1999) identified factors that constitute environment of projects as political, legal, institutional, cultural, sociological, technological resources, economic, financial and physical infrastructure. However, some factors within the environment posse greater challenges to projects, management and organizational structure than other. These should form the focus for the management of the environmental factors.

Project delivery in construction industry is strongly affected by developments in the political environment. In the course of a project, the government may change and impose additional import, export or exchange restrictions, impose penal working conditions or even cancel contracts altogether. For overseas construction contracts in countries with inherently unstable economies or governments, sudden coups or revolutions may require the whole

construction team to be evacuated at short notice. Such a situation should have been envisaged, evaluated and planned for as part of the political risk assessment when the project was first considered. Changes to fiscal and interest movements must be constantly monitored so that representations can be made to government or the project curtailed. Other factors which can affect a project are availability of capital for financing contract, interstate taxes, importation of materials and equipment's, temporary embargoes, materials shipping restrictions such as only being permitted to use conference line vessels and special licenses.

To succeed, a construction project must respond to the prevailing social/cultural changes in the environment under which it operates. These social/cultural changes which relate to the peoples' attitudes, culture, beliefs, religion, customs, values, norms, expectations and degree of intelligence/education are usually dynamic because they change along with the level of awareness of the people. According to Lester (2007), many projects and indeed most construction projects inevitably affect the community in whose area they are carried out. It is vital therefore to inform the residents in the affected areas as early as possible of the intent, purpose and benefits to the organization and community of the project. Some projects cannot be started without first being subjected to a public enquiry, environmental impact

assessment, route surveys or lengthy planning procedures. There are always pressure groups that have a special interest in a particular project and it is vital that these are given the opportunity to state their case while at the same time informing them of the positive and often less desirable implications. The ability to listen to their points of view and give sympathetic attention to their grievances is essential.

One of the fundamental requirements of a contract and by implication is a project legal feasibility (Lester, 2007). In other words if it is illegal in a certain country to build a brewery, little protection can be expected from the law. The relationships between the contracting parties must be confirmed in a legally binding contract which complies with the laws (and preferably customs) of the participating organizations. The documents themselves have to be legally acceptable and equitable and unfair and unreasonable clauses must be eliminated. Where supplier of materials, equipment or services are based in countries other than Nigeria, the laws of those countries have to be complied with in order to minimize future problems regarding deliveries and payments. In the event of disputes, the law under which the contract is administered and adjudicated must be written into the contract together with the location of the court for litigation. The land use act, planning regulations and attitude of judiciary to construction

dispute are identified factors affecting construction project delivery Lester (2007) and Chitkara (2011).

The location of the project clearly has an enormous influence on the cost and completion time. According to Ashworth (2002), site location may be a congested inner-city site with problems of development associated with space, access and proximity of adjacent buildings and structure. Alternatively, it may be in the home of the countryside presenting its own distinct characteristics and difficulties, perhaps in terms of the delivery of construction materials or the availability of labour. The value of site will be influenced by its location in different parts of the country and the type of development that is permissible. The same type of plant or factory can be constructed in Sahara Desert, UK, China or even on an offshore platform, but the problems, costs and construction times can be very different. Lester (2007) considered rainy season, weather, flood, erosion, geological condition, access road and site condition when deciding to carry out a project in a particular area.

## **RESEARCH METHODOLOGY**

This research was carried out in two stages. Firstly, literature survey of the environmental factors affecting construction project delivery was first identified through comprehensive literature review and interviews with industry practitioners (Architects,

Quantity Surveyors and Engineers). Pilot study was used to modify and improve the drafted questionnaire before sending to it out to respondents. The identified factors were used as basis for designing the pilot study which was administered to ten (10) pre-selected industry practitioners. The purpose of pilot study was to establish whether the sampling frame and technique are effective as well as to test the adequacy of the instruments (Creswell, 2012). A questionnaire was designed with the objective of determining the more important environmental factors that affect construction project delivery (Time and cost performance). A total of twenty-six (26) factors were identified. The 26 factors were further grouped into six different categories. The categories are: economic factors; building technology; political; legal; social/cultural and project site location factors as categorised earlier by (Akanni, et al., 2015). These groupings comprehensively covered all the variables that needed to be considered in the construction project delivery.

Secondly, a questionnaire survey approach was employed to determine and rank these factors according to the magnitude of their mean rating. The questionnaire was structured into two sections. Section one of the questionnaires, requested respondents to provide information relating to their background and years of construction experience. In section two, respondents were asked to rate on a five-point

Likert scale where 1 represents “not important” and 5 “extremely important” the 26 variables identified as environmental factors affecting construction project delivery. The target population were the Architect, Quantity Surveyors and Engineers working in client, contracting and consulting types of organisations in Lagos state. Lagos state was selected as the study area because it is a major commercial hub in Nigeria where about 35% of the construction activities in the country is being executed. A convenience sampling technique was first adopted for the administration of the final survey questionnaire. However, because of the slow response rate, the sampling technique was supplemented with snowball sampling technique. These techniques were adopted because of the nature of the study which requires the opinion of highly experienced industry practitioners for reliable response. A total of 338 questionnaires were administered to the target population. The response rate of the questionnaire was about 71% (241 useable responses) which is higher than the normal 20 – 30% for survey in the construction industry as suggested by (Elhag, et al., 2005). The data obtained for this study was analysed by the use of Statistical Package for Social Sciences (SPSS) version 20. The descriptive statistic was adopted to rank the importance of environmental factors on construction project delivery

through the magnitude of their mean Scores.

### **Data analysis**

The results obtained from the descriptive analysis was summarised in tabular form for clear understanding. The decision on the results of the descriptive analysis were based on two approaches, the demographic was based on percentage and the critical issues concern the environmental factors was based on mean scores. However, each of the two approaches is presented in the Tables below.

### **Respondents Background**

Table 1 shows the profession of the respondents that participated in this study. However, the result shows that 22% of the respondents are Quantity Surveyors (QS), 48% of the respondents are Engineers and 26% of the respondents are Architects. The result shows that 5% of the respondents have 0 to 5 years of working experience, 18% have between 6 to 10 years of working experience and 24% of the respondents have between 11 to 15 years of working experience, 36% of the respondents are have 16 to 20 years of working experience and 17% of the respondents are within 20 to 30 years of working experience. This indicates that majority of the respondents that participated in this study are experienced professionals. On education qualification, The result shows that 13% of the respondents are HND holder, 30% have BSc, 40% have

MSc while 2% are Ph.D holders. This implies that majority of the respondents that participated in this study have the required educational qualification.

### **Environmental Factors Affecting Time and Cost**

The analysis of the variables identified as environmental factors affecting time and cost of construction project delivery from the perspectives of the respondents is discussed in this section. The analysis was carried out from the perspectives of the industry practitioners (Architect, Quantity Surveyors and Engineers) engaged in clients, contracting and consulting types of organisations in Lagos state. The objective of this section is to determine the impact of environment on time overrun of construction project delivery. The study will also determine study combined the perception of b overrun. A two-way sample t-test was used to determine whether the mean rating of a sample is significantly different from the population mean  $\mu_x = 0$  (Ellison et al. 2009). In this analysis  $\mu_0$  was fixed at 3 because on the rating scale adopted, 3 is the midpoint (moderately important). Therefore, drawing from the table of critical values of t-distribution, when the degrees of freedom = 240 (i.e 241 - 1), and the level of significance for 2-tailed t-test is set at 0.05, the t value is 1.984 meaning that if the calculated t-value is smaller than 1.984, the variable is considered insignificant (de

Silva et al. 2004). The result of the t-test is shown in Table 1 and 2.

Furthermore, based on the explanations offered in the previous paragraph, it can be inferred that only sixteen (16) out of twenty-six (26) factors identified are actually important to be considered as environmental factors affecting time overruns on construction project delivery. The five most significant factors according to the magnitude of the mean rating in order of importance are: government policy; project team commitment; capital for financing; importation of materials and instability in government. This is presented in Table 1.

**Table 1: Respondents Perceptions of Environmental Factors Affecting Time Overruns**

<b>Environmental Factors</b>	<b>Mean</b>	<b>t-value</b>	<b>p-value</b>	<b>Rank</b>
<b>Economic Factors</b>				
Cost of borrowing	3.0166	.219*	.827	17
Capital for Financing Contract	4.3859	17.349	.000	3
Supplies of materials	4.2241	28.341	.000	8
Fluctuation in price of materials and labour	3.8714	20.851	.000	10
Foreign exchange rate	4.2739	33.050	.000	6
<b>Construction Technology Factors</b>				
Shortage of labour	3.7261	12.229	.000	11
Plant/equipment parts	4.0249	12.389	.000	9
Importation of materials	4.3361	30.952	.000	4
Strike by the labour force	3.5353	6.921	.000	13
Delivery of materials and equipment	4.2241	27.584	.000	7
Project Team Commitment	4.4772	32.687	.000	2
<b>Political Factors</b>				
Instability in Government	4.3237	43.828	.000	5
Government Policy	4.7552	51.742	.000	1



<b>Environmental Factors</b>	<b>Mean</b>	<b>t-value</b>	<b>p-value</b>	<b>Rank</b>
Legislation	2.2448	-16.680*	.000	21
Election	3.0041	.043*	.966	18
<b>Legal Factors</b>				
Planning regulations	3.6515	8.463	.000	12
Land use Act	3.2490	2.510	.013	16
Attitude of Judiciary to dispute	1.2988	-29.338*	.000	25
<b>Social/Cultural Factors</b>				
Outbreak of hostilities	1.3859	-36.500*	.000	24
Illegal customary dues	1.2490	-49.956*	.000	26
Hidden obstruction	1.4855	-28.085*	.000	23
Outbreak of epidemics	1.7012	-23.379*	.000	22
<b>Project Site Location Factors</b>				
weather flood and erosion	3.2490	3.534	.000	15
Site condition	3.3112	4.398	.000	14
Geological condition	2.8091	-2.908*	.004	20
Act of God	2.9461	-.751*	.453	19

<sup>a</sup>n = 241; df = 241 at 95% confidence level. Items are rated on 5 –points Likert scale (1-not important; to 5= extremely important)

\*insignificant environmental factors

Similarly, Table 2 shows the results of analysis of impact of environmental factors on cost overrun. Drawing from the illustration on Table 2, it can also be inferred that only fourteen (14) out of twenty-six (26) factors identified are actually important to be considered as environmental factors affecting cost overruns on

construction project delivery. The five most significant factors according to the magnitude of the mean rating in order of importance are: instability in government; importation of materials; foreign exchange rate; project team commitment and fluctuations in prices of materials.

**Table 2: Respondents Perceptions of Impact of Environmental Factors on Cost Overruns**

<b>Environmental Factors</b>	<b>Mean</b>	<b>t-value</b>	<b>p-value</b>	<b>Rank</b>
<b>Economic Factors</b>				
Cost of borrowing	3.9876	12.466	.000	9
Capital for financing contract	4.1618	12.771	.000	6
Supplies of materials	3.8382	18.349	.000	10
Fluctuation in prices of materials	4.2573	28.823	.000	5
foreign exchange rate	4.2822	33.885	.000	3
<b>Construction Technology Factors</b>				
Shortage of labour	3.1411	1.255	.211	15
Plant/equipment part	2.4855	-8.659*	.000	18
Importation of materials and equipment	4.3568	30.128	.000	2
Strike by the labour force	2.0871	-11.365*	.000	22
Project Team Commitment	4.2614	16.537	.000	4
Delivery of materials and equipment	3.3154	3.498	.001	13
<b>Political Factors</b>				
Instability in government	4.4772	45.816	.000	1
Government policy	4.1037	13.792	.000	7
Legislation	2.3320	-8.879*	.000	20
Election	4.0913	16.734	.000	8
<b>Legal Factors</b>				
Planning regulations	2.1618	-14.301*	.000	21
Land use Act	1.6598	-23.628*	.000	25
Attitude of judiciary to dispute	1.8216	-20.932*	.000	24
<b>Social/Cultural Factors</b>				
Outbreak of hostilities	2.0747	-13.731*	.000	23
Illegal Customary dues	2.7593	-2.229*	.027	16
Hidden obstructions	1.6515	-23.242*	.000	26
Outbreak of epidemics	2.3942	-6.612*	.000	19
<b>Project Site Location Factors</b>				
weather flood and erosion	3.2656	3.783	.000	14
Site condition	3.5726	7.835	.000	12
Geological condition	3.7510	10.080	.000	11
Act of God	2.6224	-3.364*	.001	17

<sup>a</sup>n = 241; df = 241 at 95% confidence level. Items are rated on 5 –points Likert scale (1-not important; to 5= extremely important)

\*insignificant environmental factors

### **Discussion of Results.**

The results obtained are as presented in Table 1 (significant factors affecting time-overrun) and Table 2 (significant factors affecting cost overruns) in construction project delivery. These factors are further discussed under broader headings as earlier categorised prior to survey as economic, construction technology, political, legal, and social/cultural and project site location factors.

#### **Economic Factors**

There is a total of 5 environmental factors in the category of economic factors as can be seen in Tables 1 and 2. The magnitude of their mean varies between 3.0166 to 4.3859 and their overall ranking also varies between 3<sup>rd</sup> to 7<sup>th</sup>. In this category 4 out of the 5 factors are considered important from the perspectives of the respondents. The ranking shows that capital for financing contract has the highest impact under this category having ranked 3<sup>rd</sup> overall. On the other hand, however, cost of borrowing is considered as having less impact on construction project time. Cost of borrowing ranked 17<sup>th</sup> overall with a p-value of 0.827 ( $p > 0.05$ ) therefore not statistically significant. Other factors that are considered important and needed to be taking into consideration by project team are: foreign exchange which ranked 6<sup>th</sup>; supplies of materials ranked 8<sup>th</sup>; and fluctuation in the price of materials

and labour. This finding is consistent with the work of (Akanni, et al., 2015) as these 4 factors were also identified in their study.

However, on the impact of economic factors on cost overruns, all the 5 factors are considered significant as shown in Table 2. The mean score of the factor ranges from 3.8382 to 4.2822 and the factors ranked between 3 to 10. Meanwhile, the result considered foreign exchange rate which ranked 3<sup>rd</sup> as having the most significant effect on cost performance of construction projects; followed by fluctuation in the prices of materials which ranked 5<sup>th</sup>; capital for financing ranked 6<sup>th</sup>; cost of borrowing ranked 9<sup>th</sup> and supplies of materials ranked 10<sup>th</sup>. These shows that the factors identified under economic factors have effect on both time and cost overruns of construction project.

#### **Construction Technology Factors**

The category of construction technology has a total of 6 factors. The result shows that all the 6 factors are considered important. The p-value of the factors are all statistically significant ( $P < 0.05$ ) and ranked between 2 to 13 overall. Under this category, project team commitment is the most important factor and ranked 2<sup>nd</sup> overall. Importation of materials ranked 4<sup>th</sup>; delivery of materials and equipment ranked 7<sup>th</sup>; plants/equipment parts ranked 9<sup>th</sup>; shortage of labour ranked 11<sup>th</sup> and strike by labour force ranked 22<sup>nd</sup> overall.

Surprisingly, regarding cost overrun (see Table 2) only 4 out of the 6 factors are considered important. The factors are: importation of materials and equipment which ranked 2<sup>nd</sup>; project team commitment 4<sup>th</sup>; materials and equipment 13<sup>th</sup>; shortage of labour 15<sup>th</sup>. Importation of materials and equipment is considered as the most important factors affecting cost overrun under this category.

#### **Political Factors.**

The category of political factors has 4 performance factors. Instability in Government ranked 1<sup>st</sup> overall. This is followed by Government policy which ranked 7<sup>th</sup> overall; election 8<sup>th</sup>; and legislation is considered as having less impact on time overrun. Similarly, under cost overrun, the 3 factors identified above are all considered as affecting cost overrun. Government policy is considered as having the highest impact among the political factors.

#### **Legal Factors**

However, only 2 out of 3 factors are considered under this category of elemental factors as significantly affecting time overrun in construction project. The 2 factors are planning regulations; and land use Act. On the contrary, all the 3 factors are considered as less significant regarding cost overrun. Meanwhile, social/cultural factor which is the fifth category are considered as having no

effect on construction project time and cost.

#### **Project Site Location**

In the category of project site location, there are 4 factors but only 2 of the factors are considered as having significant effect on time overrun. The 2 factors are site conditions, weather, flood and erosion. These factors are directly related to the project location where the construction activities are executed. On the other hand, factors such geological condition and Act of God are considered less significant. Additionally, regarding cost overrun in this category, 3 factors are considered significantly affecting cost overrun. The 3 factors are geological condition, site condition and weather, flood and erosion.

#### **CONCLUSION AND RECOMMENDATIONS**

The impact of environmental factors on time and cost overrun on construction project delivery in Nigeria was evaluated to ascertain its effects on project delivery. The total of twenty-six factors affecting time and cost overrun were identified from literature survey and interviews of industry practitioners working in clients, contracting and consultancy types of organisations. These 26 factors were grouped into six categories. Interestingly, only 16 out of the 26 factors are considered as affecting time overrun as shown in

Table 1. Similarly, only 14 out of the 26 factors are considered as having effect on cost overrun as illustrated in Table 2. This implies that the remaining factors are considered as having less significant effect on both time and cost overruns of construction project delivery in Lagos state.

Meanwhile, there should be adequate planning and strategy must be developed to mitigate the side effect of natural factors like weather, floods erosion, site condition and geological condition before the commencement of the construction projects. A proactive management strategy should be developed for effective materials supplies and also importation of materials and equipment. There should be consistency in the Government policy and also stability of Government for effective project delivery in Nigeria. This study contributes immensely to the body of knowledge in the areas of impact of environmental factors on time and cost overrun in Nigeria. This study demonstrates that environmental factors should be taken seriously as a problem militating against effective project delivery in Nigeria.

However, the ranking is only based on the magnitude of mean score of each individual factor identified. Therefore, further research should be carried out to establish the level of agreement among project team members in the ranking of the factors. Apparently, the significant factors identified from this study can be used

as parameters for developing strategy for reducing the impact of environmental factors on construction time and cost.

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