Extraction of Underlying Factors Causing Construction Projects Delay in Nigeria.

Abstract

Purpose – The paper aims to establish the most underlying factors causing construction projects delay from the most applicable.

Design/methodology/approach – The paper conducted survey of experts using systematic review of vast body of literature which revealed 23 common factors affecting construction delay. Consequently, we carried out reliability analysis, ranking using the significance index measurement of delay parameters (SIDP), correlation analysis and factor analysis. From the result of factor analysis, we grouped a specific underlying factor into three of the six applicable factors that correlated strongly with construction project delay.

Findings – The paper finds all factors from the reliability test to be consistent. It suggests project quality control, project schedule/program of work, contractors' financial difficulties, political influence, site conditions and price fluctuation to be the six most applicable factors for construction project delay, which are in the top 25 percent according to the SIDP score and at the same time are strongly associated with construction project delay.

Research limitations/implications – This paper is recommending that prospective research should use a qualitative and inductive approach to investigate whether any new underlying factors that impact construction projects delay can be discovered since it followed an inductive research approach.

Practical implications – The paper includes implications for the policymakers in the construction industry in Nigeria to focus on measuring the key suppliers' delivery performance as late delivery of materials by supplier can result in rescheduling of work activities and extra time or waiting time for construction workers as well as for the management team at site. Also, construction stakeholders in Nigeria are encouraged to leverage the amount of data produced from backlog of project schedules, as-built drawings and models, Computer-Aided Designs (CAD), costs, invoices, and employee details, among many others through the aid of state-of-the-art data driven technologies such as artificial intelligence or machine learning to make key business decisions that will help drive further profitability. Furthermore, this study suggests that these stakeholders use climatological data that can be obtained from weather observations to minimize impact of bad weather during construction.

Originality/value – This paper establishes the three underlying factors (late delivery of materials by supplier, poor decision making and Inclement or bad weather) causing construction projects delay in Nigeria from the most applicable.

Keywords: *Construction projects delay*, *Expert survey*, *Positivism, Statistical analyses, Underlying factors.*

Article Type: Research paper.

1. Introduction

The fact that cost and time overruns (or delay), have over the years, been more or less synonymous with construction projects all over the world is well documented in literature (Kumaraswamy & Chan, 1998; Kadefors, 2004; Alaghbari et al., 2007; Toor & Ogunlana, 2008; Doloi et al., 2012; Aziz & Abdel-Hakam, 2016; Famiyeh et al., 2017; Gondia et al., 2020 among many others).

Construction project delay has been defined as a project where key dates or milestones have been missed or where the contractual date of completion must be forfeited, (Van *et al*., 2015). Delay has also been described as an occurrence which may result in the loss of income for the client or owner Haseeb, Bibi & Rabbani, (2011). A delay may also be characterized as a somewhat incremental increase in both overheads and labour costs for the contractor and is deeply detested by all parties involved in a construction project.

The Nigeria construction industry is no exception as many of its projects experiences extensive delay. Although the industry is considered a major backbone of the Nigerian economy - represents 3% of the total economic output of Nigeria (Oladinrin, Ogunsemi and Aje, 2012) and providing employment opportunities for over 7 million people in the country (World Economic Forum, 2019), investigation by several researchers have shown that delay of construction projects in Nigeria has adverse effect on the reputation of the industry's contribution to its economy.

With reference to Aibinu et al., (2002) and Obodoh et al., (2016), the effects of construction delay can be evaluated with respect to its national footprints which with prejudice sway the industry's subsidy to the economy; at an industry level, where delay impact profitability, capital investment and productivity negatively; and at a project level where delay foster cost overruns, dispute among project stakeholders, legal actions, insolvency of organization and great dissatisfaction from the industry's clients on its overall performance.

Major construction projects delay factors in Nigeria have been identified in vast body of literature e.g. poor contract management, materials shortages, inaccurate estimating, and overall price fluctuations by Mansfield et al., (1994); variation order, resource supply problems, late issuance of instruction, inclement weather, acts of God, strikes, labour disputes and civil disturbances by Odeyinka, (1997) and Owalabi et al., (2014); cash flow problems during construction, clients' financial difficulties and poor procurement by Ogunde et al., (2017).

Over the decades, several research methods and recommendations towards mitigating delay of construction projects have been identified. For instance, it is the viewpoint of Mansfield, Ugwu & Doran, (1994); Frimpong, Oluwoye & Crawford, (2003) that contractors should buy construction materials at the early stage of work and be more familiar with effective and efficient material procurement systems/software. Also, according to Owalabi et al., (2014); Alaghbari & Sultan, (2018), clients should adhere to timely payment of progress fee and consider funding levels at the planning stage of project.

Notwithstanding all these delay factors and recommendations towards mitigating delay in construction, delay still strives in the industry. Interestingly, despite all these varying causes/factors of construction delay and their respective delay mitigation strategies/recommendation, there is no amalgamating study that has brought together all these factors to identify the most underlying factors causing construction projects delay in the Nigerian construction industry. Consequently, this study aims to establish the most underlying factors causing construction projects delay from the most applicable factors of construction project delay in Nigeria. The following objectives will be used to achieve this aim:

1. Carry out a systematic review toward gathering the most common factors affecting construction projects delay.
2. Carry out a survey of experts on the aggregated factors to establish the most applicable factors of construction projects delay.

3. Establish the most underlying factors of construction project delay from the most applicable using factor analysis on data derived from Objectives 1 and 2.

This study will lead through a systematic review which establishes the existing state of awareness in section 2, to its analytical approach to data collection and discovery in section 3 in order to accomplish objectives 1 and 2 respectively. Section 4 will detail its result and analysis including more information about how reliability, ranking, correlation and factor analysis have been accomplished in order to fulfil the last objective. Finally, its section 5, 6 and 7 will detail conclusions, limitations and recommendations.

2. Systematic Review

2.1 *Construction Project Delay*

Delay is the most important factor in the general execution of any construction project as it expands cost overruns (Haq *et al.*, 2017). In the construction industry the term delay is comprehensively used giving rise to vast body of international literature definition of the term (Gibbs et al., 2013). They defined delay as any unexpected extension to the entire scheduled period and/ or the occurrence that lengthen the duration of an activity without generally affecting the project duration (cited in Bramble & Callahan, 2004). It is the viewpoints of Assaf & Al-Hejji (2006) that delay can be defined as the time increase beyond the agreed project delivery planned schedule by stakeholders or beyond a legal contract completion date. Also, Bartholomew, (2001) makes an important point arguing that delay is a deceleration of some part of a construction project without a complete halt. Furthermore, delay mean different things to different stakeholders(client, contractor, consultant etc.) and is oftentimes referred to as time or schedule overruns by various scholars (Abdul-Rahman, Takim & Min, 2009; Akhund et al., 2017; Al-Hazim, Salem & Ahmad, 2017; Elawi, Algahtany & Kashiwagi, 2016; Gardezi, Manarvi & Gardezi, 2014; Głuszak & Leśniak, 2015; Orangi, Palaneeswaran & Wilson, 2011). For the client, delay connote loss of revenue or investments at the end of agreed time while to the contractor, a delay can imply an increase in overhead cost (Assaf & Al-Hejji, 2006).

2.2 *Causes/Factors of Construction Project Delay.*

Construction projects includes but not limited to road and highway, residential and industrialized buildings, tunnels and railways, (Senouci & Al-Derham, 2008). However it is rarely the case to complete construction projects within contract time as Flyvbjerg, (2014) indicated that 9 out of 10 global mega projects encounter delay and cost overruns dues to several factors or causes. The top 10 universal delay factors in construction projects are: change orders; delays in payment of contractor(s); poor planning and scheduling; poor site management and supervision; incomplete or improper design; inadequate contractor experience/building methods and approaches; contractor’s financial difficulties; sponsor/owner/client’s financial difficulties; resources shortage (human resources, machinery, equipment); and poor labour productivity and shortage of skills (Zidane & Andersen, 2018).

Quite several vast bodies of international literature have reviewed the causes of delay in both the developing and developed economies of the world. For instance, Venkatesh & Venkatesan, (2017) used qualitative research approach to review 53 causes of construction delay from different countries categorizing them into two: developing and developed countries. Their results displayed the varying nature of the top 10 causes of delay from country to country. Developing countries: delay in payments by clients; delay in drawings, changes & errors in designs; contractor's financial difficulties; deficiencies in planning & scheduling; delay in delivery of materials; change orders; poor site supervision and management; economy, law & order, inflation, political instability; slow decision making by owner; and subcontractor & supplier related causes. Developed countries: weather; delay in drawings, changes & errors in designs; subcontractor & supplier related causes; change orders; slow decision making; delay in approvals; poor site conditions; contractor's financial difficulties; delay in monthly payments from client; and force majeure.

In the United Kingdom (UK), with reference to Sullivan & Harris, (1986) in their interviews and questionnaires as a data collection method, unanticipated delay in large construction project can occur due to the following: variation order, design complexity, delay delivery, bad weather, industrial disputes/strikes, pandemics, physical obstructions and significant contractual disputes. They concluded with recommendations for more team building and a greater integration of skills particularly at the early stages of planning a project. McCord et al., (2015) used questionnaire survey research to examine the relative importance of the causes of delay in housing constructions in Northern Ireland and concluded 4 key factors: deficiencies in site management, ineffective communication strategies, financial crisis and a lack of co-ordination between key stakeholders involved in the construction process. Also, Shebob et al.,(2012) from their literature review and questionnaire survey investigated delay factors in building construction in UK. A total of 75 factors were reviewed and further categorised into 4 main factors related to owners, consultants, contractors and others concluding that a building project might be delayed by 34 to 38 days in the UK. Furthermore, the professionals' perspective on the causes of project delay in construction industry through a critical literature review and a qualitative approach was reviewed by Agyekum-Mensah and Knight, (2017) where 19 causes were identified of which 3: waiting for information; variation orders and ground problems were ranked highest.

Baldwin, J.R., Manthei, J.M., Rothbart, H. and Harris, (1971) studied the causes of delay in the construction industry in the United States of America (USA) using questionnaire survey. They investigated 17 factors: weather; labour supply; material shortage; equipment failure; finances; manufactured items; construction mistakes; design changes; foundation conditions; permits; shop drawings; sample approvals; building codes; subcontractors; contracts; jurisdictional disputes; and inspections. An investigation of root causes of delays in highway construction by Ellis & Thomas, (2002) through questionnaire survey yielded 8 major categories: business practices; procedures; contractors management of scheduling and planning; utilities; differing or unforeseen site conditions; maintenance of traffic; design errors and omissions. Ahmed et al., (2003) used literature review and a questionnaire survey as a tool to produce critical review on the 10 causes of delays in building projects in the Florida region of USA. They includes building permits approval; changes in Specifications; change order; decision during development stage; changes in drawings; shop drawings approval; incomplete documents; design development; inspections and changes laws – regulations. Tafazzoli & Shrestha, (2017) conducted a nationwide questionnaire survey on this issue and after using relative importance analysis presented change orders, time-consuming decision making by the owner, and design errors as the most important causes of construction delays in the USA.

According to the questionnaire survey ranked by weighted average technique from Mishmish & El-Sayegh, (2018), the most frequent causes of claims in road construction projects in the United Arab Emirates (UAE) are variation; contractor's delay and inadequate site investigation before bidding. A survey conducted by Mpofu et al., (2017) revealed that unrealistic contract durations to poor labour productivity, with consultants and clients seemingly shouldering the bulk of the “blame game” are the 3 main causative factors leading to construction project delays in in UAE. Motaleb & Kishk, (2010) made important points, arguing that change orders, financial and other client-related factors are the most significant based on literature review, a questionnaire survey and relative importance method of analysis taken. A series of survey of questionnaires and interview conducted by Ren, Atout & Jones, (2008) discovered that unrealistic project duration, many provisional sums and prime cost, nomination of sub-contractors and suppliers, client’s irregular payment to the main contractor and variations are the top 5 causes of delay contributed by the client. Incomplete drawings, delay in approval of documents, incomplete contract documents, changes in drawings and specifications, and duration of inspection procedure are the major causes contributed by the consultant and preparing the method statements, ill-financed project, inappropriate organization management, unsmooth external and internal communications, and mistakes in construction are the top causes contributed by the contractor. Additionally, Faridi and El-Sayegh, (2006) take a similar view by identifying the top 10 significant factors causing delay in the UAE construction industry using detailed questionnaire survey and relative importance index method.

Doloi et al., (2012) through questionnaire survey, personal interviews and factor analysis, analysed factors affecting delays in Indian construction projects. Their report proved the following as the most critical factors: lack of commitment; inefficient site management; poor site coordination; improper planning; lack of clarity in project scope; lack of communication; and substandard contract. Also, Doloi, Sawhney & Iyer, (2012) argued that lack of commitment on contractor's inefficiency, lack of efficient construction planning and client's influence are the major factors affecting delay in Indian construction projects. It is the viewpoint of Patil et al., (2013) that by using questionnaire survey and relative importance index analysis in Indian transportation infrastructure projects, delay is mostly caused by land acquisition; environmental impact of the project; financial closure; change orders by the client; poor site management and supervision by contractor. Furthermore, by using interviews, literature review, relative importance and importance index techniques, Megha & Rajiv, (2013) identified 59 causes of delay for residential construction projects in Indian which resulted into 9 major ones under the following groups: owner; contractor; consultant; design; materials; equipment; labour and external, while (Subhav Singh *et al.*, 2018) suggested that shortage of materials on site; unforeseen ground conditions; poor procurement planning; problems to access the site; rework; weather conditions; inadequate modern equipment; skilled workforce; and equipment failure are ranked by the contractors and consultants as the main causes of project delays in India.

A discovery through structured interviews and questionnaire survey by Chen et al., (2019) detailed five delay causes for grain bin construction projects in China as: shortage of adequate equipment; poor communication among contracting parties; problems with subcontractors; inadequate experience of the design team and frequent change orders by clients. According to Ji et al., (2018) issue of inefficient structural connections for prefabricated components is found to be the most significant factor and most easily affected by other delay factors. A comparative study of time overruns (delay) through a questionnaire survey was conducted by Chan & Kumaraswamy, (1997) as follows: poor site management and supervision; unforeseen ground conditions; low speed of decision making involving all project teams; client-initiated variations and necessary variations of works. Mahamid, Bruland & Dmaidi, (2012) conducted a questionnaire survey on causes of delay in road construction with results showing top 5 causes as: segmentation of the West Bank and limited movement between areas; political situation; progress payments delay by owner; delays in decision making by owner; and low productivity of laborers. An interview an questionnaire survey conducted by Le-Hoai, Lee & Lee, (2008) yielded 7 factors: slowness and lack of constraint; incompetence; design; market and estimate; financial capability; government; and worker as the causes of delay and cost overruns appropriate with building and industrial construction project.

Mansfield, Ugwu & Doran, (1994) through questionnaire survey investigated the causes of delay and cost overruns in Nigerian construction projects arguing that finance and payment arrangements, poor contract management, materials shortages, inaccurate estimating, and overall price fluctuations are the key causes. A similar stance by Odeyinka HA, (1997) through questionnaire survey categorized the causes of delay into 4 layers: client-caused delay manifesting mainly in terms of failure to meet financial obligations to the contractor due to variation orders; contractor-caused delay manifested in terms of resource supply problems; consultant-cased delay manifested in terms of late issuance of instruction and incomplete drawings and extra contractual delay manifested in terms of inclement weather, acts of God, strikes, labour disputes and civil disturbances. The causes and effects of delay on building construction project delivery time in Nigeria was surveyed by Owalabi et al., (2014) with results showing 15 factors similar to the ones earlier mention via structured questionnaire by Mansfield, Ugwu & Doran, (1994; Odeyinka HA, (1997). Furthermore, Ogunde et al., (2017) through interviews and structured questionnaire studied the cause of delay of construction projects in a megacity (Lagos) in Nigeria. They identified 33 major causes and reported the 3 most important ones as: cash flow problems during construction; clients' financial difficulties and poor procurement.

A study on causes of delay in Australia, Malaysia & Ghana construction project by Shah, (2016) used literature review and questionnaire survey to reveal the most important factors in Australia are: planning and scheduling deficiencies; methods of construction; effective monitoring and feedback process, whereas in Ghana: delay in payment certificates; underestimating of project cost; complexity of projects are the most influential factors. However, in Malaysia: contractor's improper planning; poor site management and inadequate contractor experience are the most principal factors. In Iran Samarghandi et al., (2016) research used questionnaire survey and statistical model to assert that lack of attention to inflation and inefficient budgeting schedule by the owner, inaccurate budgeting and resource planning, weak cash flow and inaccurate pricing and bidding by the contractor and inaccuracies in technical documents by the consultants have the most contribution to delay. It is the viewpoint of Aziz & Abdel-Hakam, (2016) that by using a questionnaire survey, personal interviews and relative importance index, there are no root causes that can be taking for granted to be most or least effective delay causes in road construction projects in Egypt. Furthermore, Kazaz, Ulubeyli & Tuncbilekli, (2012) conducted a questionnaire survey and statistical analysis that shows design and material changes followed by delay of payments and cash flow problems to be the most prevailing factors in Turkey.

As a result, the first step in achieving the aim of this study will be to combine these causes/factors of construction project delays by comparing their individual conclusions based on author(s) and country/regions. Second, as the most widely used technique for detecting causes/factors of construction project delays, this study will utilise a questionnaire survey and a relative important index as part of its research methodology in the following section.

3. Research Methodology

Systematic review of existing literatures on influencing factors of construction projects delay was used to establish the most applicable factors thereby fulfilling the first objective. Twenty-three applicable factors (see Table 1) were consolidated at the end of the review which was pre-empted as search results became repetitive. These factors were used to design a survey in form of questionnaire to fulfil the second objective of this study. The questionnaire was divided into five sections such that each section deals with a specific feature of event under investigation (delay factors). Section A asked the responders to rate how eighteen factors affected the duration of the project. Where a project does not have an official schedule/ program of work indicating the duration of the project, they were asked to use an assumed duration that such a project would have taken, or the duration based on an agreed date of completion with the client.

Section B enquired to what level of detail one factor had, and section C asked for frequency of occurrence of two factors, section D enquired what percentage a responder would give to three factors. All these made a total of twenty-three delay factors. Also, the responders were asked to rate how long the entire project delayed for in the final section E. The questions in each section were designed on a Likert scale with a scale of one to five. The use of questionnaire research signifies independent observation – implies the questionnaire was completed in the absence of the researcher, and since one of the objectives of this study is set out to establish the true (most) applicable factor to construction projects delay makes it a positivist research. Prior to distribution of the questionnaire, pilot testing was conducted by asking group of experts in construction to comment on the representativeness and suitability of the questions.

Highly experienced construction professionals with over five years' experience in construction industries in Nigeria, including contractors (29.4% of total responses), quantity surveyor (11.8% of total responses), architects (7.8% of total responses), technical consultants (26.5% of total responses), technical office engineers (2.1% of total responses), site engineer (2.9% of total responses), procurement managers (1.3% of total responses), among many others completed the questionnaire. In the end, a total of 120 responses were received from a total of 302 questionnaire distributed. The 120 responses were received via Google forms and was extracted and exported into a comma-separated values data file. Using the Cronbach's alpha test, a reliability analysis was done to further confirm the reliability of the responses received.

Furthermore, a significance index of delay parameters (SIDP) was used to determine how important each factor was in relation to construction project delay based on responses of respondents. SIDP was chosen as it allows for the identification of most significant criteria based on responses from respondents, and it is also a useful technique for prioritising indicators evaluated on Likert scales (Obodoh et al., 2016); Ogunde et al., 2017; Rooshdi *et al.*, 2018). To achieve the third objective, a factor analysis was carried out on the variables in order to extract the most underlying factors responsible for construction projects delay. This analysis technique was chosen as it thrives in identifying the unexplained variables that impact the covariation between many data. These variables describe underlying ideas that are difficult to capture with a single variable (Doloi et al., 2012; Kline, 2014; Alaka *et al.*, 2017). The research methodology flowchart is as shown in Figure 1 below:

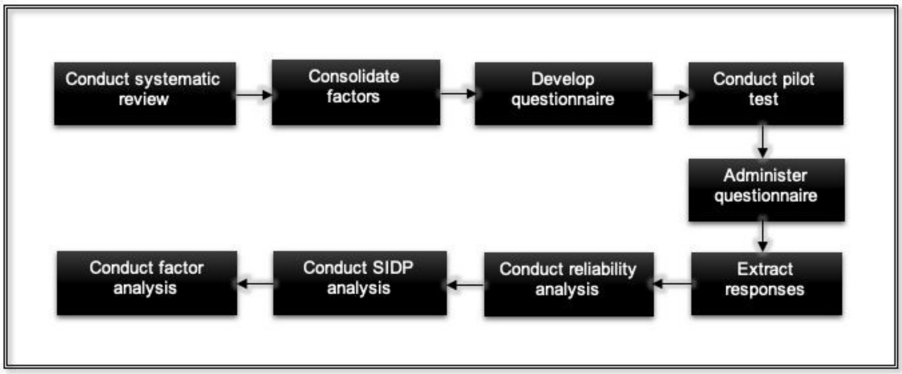

Figure 1: Research methodology flowchart

4. Results and Analysis

First, a reliability analysis was performed to check the reliability of the responses to the questions or factors in the questionnaire. Then, to achieve the second objective, a significance index of delay parameters (SIDP) was subsequently used to determine how important each factor was in relation to construction project delay based on responses of respondents. This was combined with a correlation analysis which showed the level of correlation of each factor as an independent variable, to construction projects delay as a dependent variable. For the third objective, a factor analysis was carried out on the variables in order to extract the most underlying factors responsible for construction project delay.

4.1 *Analysis of reliability of survey results*

To check the reliability of responses of the respondents, responses for all 23 factors were taken through a Cronbach's alpha reliability test. Cronbach's alpha can be written mathematically as:

$$\alpha = \frac{N.c}{v + (N-1).c} \quad ...eq\ 1$$

The key objective of the Cronbach's alpha test is to establish the reliability associated with data derived from a scale by determining the coefficient for the internal consistency of the data. Furthermore, it is to ascertain whether the aggregated factors contribute to measuring the same construct. In relation to this study the construct is the relevancy of the aggregated factors to construction project delay in Nigeria. Although there is no lower limit, the closer the Cronbach's alpha coefficient is to 1, the greater the internal consistency of the attributes (Gliem & Gliem, 2003). A Cronbach's alpha value of 0.7 or greater is deemed symptomatic of strong internal consistency of the attributes in determining the reliability of the construct (Bhatnagar, Kim and E. Many, 2014). However, It is the viewpoint of Nunnally (1978) that for basic research, the Cronbach's alpha should be above 0.8 for responses to an attribute to be taken as being reliable. The result of the test on the 23 factors in this study gave a Cronbach's alpha coefficient of 0.942 illustrating good internal consistency.

To ensure all the factors were contributing to the internal consistency of the data, further analysis was conducted on the 23 factors through inspection of the 'Cronbach's alpha if item deleted' results. If a factor is reducing the overall reliability and consistency of data, its associated Cronbach's alpha coefficient would be higher than the overall coefficient. Consequently, from Table 1, It is evident that factors A18, A19 and A20 have higher associated 'Cronbach's alpha if item deleted' than the overall Cronbach's alpha coefficient in the first run (3rd column). By removing these three factors from the second run (4th column), the Cronbach's alpha coefficient was increased from 0.915 to 0.925. This process was continued until no factor had higher associated 'Cronbach's alpha if item deleted' than the overall Cronbach's alpha coefficient. However, as the internal consistency with all the factors included (0.915) was good enough, it was decided that none of the factors would be removed when undertaking further analysis.

Table 1: Reliability analysis of factors used in the questionnaire.

	Analysis run number	**1st run**	**2nd run**	**3rd run**	**4th run**	**5th run**
	Overall Cronbach's alpha coefficient	0.946	0.947	0.948	0.949	0.952
ID	**Factors**	**Cronbach's Alpha if Item Deleted**				
A1	Equipment breakdown/ Management.	0.944	0.945	0.947	0.948	0.951
A2	Inflation or sudden increase in good/commodities.	0.945	0.946	0.947	0.949	0.952
A3	Labor dispute or strikes.	0.945	0.946	0.947	0.949	0.952
A4	Effective or poor communication among stakeholders.	0.947	-			
A5	Inclement or bad weather.	0.947	0.948	-		
A6	Contractors' financial difficulties.	0.943	0.944	0.946	0.947	0.950
A7	Structural design variations.	0.942	0.943	0.944	0.945	0.948
A8	Late deliveries of materials/equipment.	0.942	0.943	0.944	0.945	0.948
A9	Changed orders/ discrepancies in contract documents.	0.941	0.942	0.944	0.945	0.948
A10	Price fluctuation.	0.940	0.941	0.942	0.943	0.946
A11	Contract management.	0.940	0.941	0.942	0.943	0.946
A12	Decision making.	0.941	0.941	0.942	0.943	0.946
A13	Cash flow during construction.	0.942	0.943	0.945	0.946	0.949
A14	Government regulations.	0.945	0.946	0.947	0.948	0.951
A15	Material procurement.	0.941	0.942	0.943	0.944	0.947
A16	Site conditions-related unforeseen circumstances (e.g., unanticipated groundwater, quicksand, mud, rock formations etc.).	0.940	0.941	0.942	0.943	0.946
A17	Political Influence.	0.942	0.943	0.944	0.945	0.949
A18	Project schedule/program of work.	0.947	0.948	0.949	-	
A19	Site accident.	0.945	0.946	0.947	0.948	0.951
A20	Project quality control.	0.948	0.949	0.950	0.952	-
A21	Late payment.	0.944	0.944	0.946	0.947	0.950
A22	Unskilled laborer.	0.946	0.947	0.48	0.950	0.953
A23	Late delivery of materials by supplier.	0.944	0.944	0.946	0.947	0.950

4.2 *Ranking and correlation of factors with project delay in construction.*

A significance index of delay parameters (SIDP) value was calculated in order to understand which factors contributed the most to construction project delay based on the responses of the respondents. The following equation was used to calculate the SIDP score for each factor. The equation was derived from similar relative importance index formula computed in previous construction studies from vast body of literature on factors of construction delay in Nigeria (e.g. Mansfield et al., 1994; Owalabi et al., 2014; Obodoh et al., 2016) and Ogunde et al., 2017 among many others).

$$\text{SIDP} = \left(\frac{\sum_{n=1}^{T}(R_n)}{TZ}\right) x\ 100 \quad ...eq\ 2$$

Where R in Rn represents the relevance/effectiveness rating from 1 to 5 given by the n^{th} respondent; n = 1, 2, 3, 4, 5 .... T; T is the total number of respondents for that particular factor; and Z is the highest possible delay relevance/effectiveness rating, which is 5.

The factors were ranked, based on SIDP scores, to determine which were perceived to be contributing to construction projects delay the most. A correlation analysis was then carried out as a means of statistically determining the factors (independent variables) that correlate most with construction project delay (dependent variable). This was conducted using the test of Pearson's Correlation test, which can be mathematically written as:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum xy^2 - (\sum y)^2]}} \quad ...eq\ 3$$

The results of the SIDP and Pearson correlation analysis are given in Table 2 below. The 3rd column in Table 2 shows the SIDP values for each factor, the 4th column shows factors ranking / position using the SIDP values, while the last column shows the correlation values from the Pearson correlation analysis. When reading the last column, it should be noted that only the attributes correlation values with an asterisk (*) or double asterisk signs are significantly correlated with construction projects delay in Nigeria.

Table 2: Overall ranking and correlation of factors with project delay in construction.

ID	Factors	SIDP	Ranking/ Position	Pearson Correlation
A20	Project quality control	70.00	1	0.271**
A18	Project schedule/program of work	67.00	2	0.212*
A6	Contractors' financial difficulties.	55.83	3	0.191*
A17	Political Influence.	55.83	4	0.389**
A16	Site conditions-related unforeseen circumstances (e.g., unanticipated groundwater, quicksand, mud, rock formations etc).	55.83	5	0.419**
A10	Price fluctuation.	55.00	6	0.368**
A13	Cash flow during construction.	54.67	7	0.304**
A21	Late payment	54.00	8	0.357**
A12	Decision making.	54.00	9	0.402**
A9	Changed orders/ discrepancies in contract documents.	51.83	10	0.379**
A11	Contract management.	51.33	11	0.490**
A14	Government regulations.	50.50	12	0.180*
A8	Late deliveries of materials/equipment.	50.50	13	0.246**
A15	Material procurement.	50.17	14	0.369**
A2	Inflation or sudden increase in good/commodities.	49.50	15	0.022
A23	Late delivery of materials by supplier	49.17	16	0.419**
A19	Site accident	47.83	17	0.333**
A7	Structural design variations.	47.33	18	0.331*
A22	Unskilled laborer	46.00	19	0.220*

A1	Equipment breakdown/ Management	45.67	20	0.104
A5	Inclement or bad weather.	44.50	21	0.016
A3	Labor dispute or strikes.	42.50	22	0.105
A4	Effective or poor communication among stakeholders.	39.00	23	-0.073

To decide the most applicable factor to construction projects, and complete the second objective of this study, the top 25% (= approximately to the top 6) factor according to the SIDP score were assessed and only the ones of these that are significantly correlated to delay of construction projects were adopted. This selection method gives us six factors as being the most applicable to construction projects delay. They are project quality control, project schedule/program of work, contractors' financial difficulties, political influence, site conditions and price fluctuation during construction (i.e., A20, A18, A6, A17, A16, and A10 respectively, using attributes ID from Table 2). It is clear from this result that the frequency of occurrence of project quality control in the Nigerian construction industry is usually negligible throughout project duration. Similarly, the level of detail of the work schedule / programme of Nigeria's construction projects is usually limited or not frequently updated. Additionally, the issue of contractors' financial difficulties arising from long, late and partial payments remain a major concern in Nigeria's construction projects. Furthermore, excessive political interference is continuously depicted as evident in contract law and legal acceptability, which regulate the majority of construction projects awarded in Nigeria.

4.3 *Factor Analysis*

The fundamental purpose behind factor analysis is to streamline a correlated set of variables into fewer factors (Doloi et al., 2012; Kline, 2014). These compressed factors — once analysed — can then be renamed in order to best reflect the relationship and similarities between the variables within them (Kline, 2014). A pre-factor analysis of the variables revealed Kaiser-Meyer-Olkin (KMO) value of 0.878 and Bartlett's Test of Sphericity values (Approximate of Chi-Square value of 2192.082 with 253 Degrees of Freedom, and a Significant Level of 0.00 – implies the existence of at least one significant correlation between two variables) which are all considered good and proves that the data qualify for factor analysis (Kaiser, 1974; Alaka et al., 2017; Toriola-Coker et al., 2020).

For the first trial factor analysis, as shown in the results in Table 3 below, two of the underlying factors showed mildly significant correlation with another; factors 1 and 4 showed a correlation of 0.318, while factors 2 and 4 had a 0.144 correlation. The purpose of this was to determine whether an oblique rotation may be better suited as the initial assumption was that the underlying factors would have some correlation with one another. Based on these results, exploratory factor analysis (EFA) was carried out using the Varimax rotation as a way of better understanding the orthogonality of the underlying factors.

Table 3: Component Correlation Matrix.

Component	1	2	3	4
1	1.000	0.363	- 0.266	0.318
2	0.363	1.000	- 0.245	0.144
3	- 0.266	- 0.245	1.000	- 0.085
4	0.318	0.144	- 0.085	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

A closer look at the extracted principal factors was taken in order to establish the strength of each one of the underlying factors. According to Tabachnick & Fidell (2019), for a factor to be considered as such it must contain a minimum of three variables. Therefore, of the 4 component factors (see Table 3) which were extracted, it was deemed appropriate to drop component factors 4, as it contained merely 2 variables. This was done to avoid over-estimation. Although this factor (factor 4) possessed eigenvalues greater than 1. A look at the scree plot in Figure 2 may suggest that the point of inflexion occurred prior to it (Gie Yong & Pearce, 2013). Hence, the test was carried out again with the number of extracted factors being limited to 3.

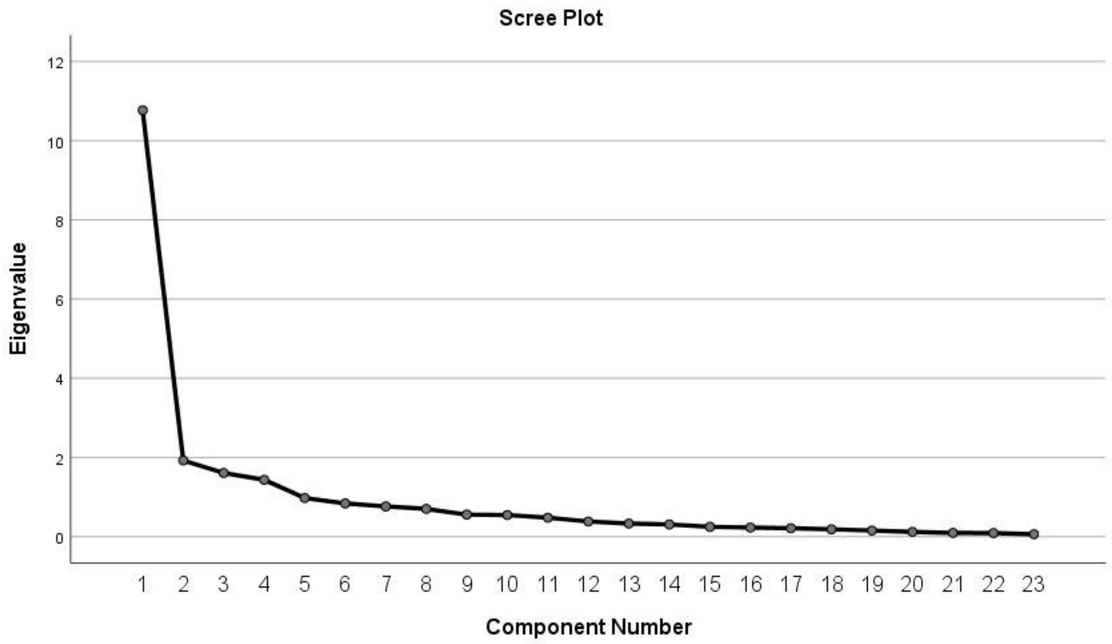

Figure 2: Scree plot of factor analysis.

The extracted factors represented 68.404% of total variance (see the bottom of Table 4's 6th column) as presented in Table 4 below which depicts a good percentage of the representation. As against the percentage of variance (6th column), the varimax rotated solution (8th column) produced values that portray a more evenly representation of the data by the extracted factors after redistribution, thereby giving more credence to the variance of the factors.

Table 4: Factor Analysis for Total Variance

Total Variance									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.768	46.818	46.818	10.768	46.818	46.818	6.269	27.256	27.256
2	1.924	8.363	55.181	1.924	8.363	55.181	4.059	17.648	44.904
3	1.607	6.986	62.168	1.607	6.986	62.168	3.480	15.130	60.034
4	1.435	6.237	68.405	1.435	6.237	68.405	1.925	8.371	68.405
					68.404				

Extraction Method: Principal Component Analysis.

The final result is presented in Table 5. In order to ascertain whether EFA adequately grouped variables into factors which were truly representative, a Cronbach's alpha test was carried out on each of the three component factors, and all yielded a Cronbach's alpha value of greater than 0.7 as presented in the last column of table 6, indicating a good internal reliability between the variables.

Table 5: Result of Factor Analysis

Factor groups	Variables	Component			Cronbach's alpha
		1	2	3	
Factor group 1: Late delivery of materials by supplier.	Late delivery of materials by supplier.	0.810			0.845
	Contract management.	0.790			
	Site accident.	0.781			
	Late payment.	0.734			
Factor group 2: Poor decision making	Decision making.		0.515		0.934
	Site conditions-related unforeseen circumstances (e.g., unanticipated groundwater, quicksand, mud, rock formations etc).		0.493		
	Price fluctuation.		0.522		
	Changed orders/ discrepancies in contract documents.		0.411		
	Late deliveries of materials/equipment.		0.475		
	Structural design variations.		0.421		
	Political Influence.		0.433		
Factor group 3: Inclement or bad weather	Inclement or bad weather.			0.757	0.818
	Effective or poor communication among stakeholders.			0.689	
	Labour dispute or strikes.			0.682	
	Equipment breakdown/ Management.			0.654	
	Contractors' financial difficulties.			0.606	
	Inflation or sudden increase in good/commodities.			0.560	

The factors were inspected to check if any consisted almost all of the six factors ranked as most applicable to construction projects delay in the previous section. Out of the six most applicable factors to construction projects delay, one was found in component 1, two were in component 2 and one was found in component 3. They are 'site conditions (A16)'; 'political influence (A17)' and 'price fluctuation (A10)'; and 'contractors' financial difficulties (A6)' respectively (using attributes ID from Table 3). It is worth noting that the missing applicable factors, which are 'project quality control (A20)' and 'project schedule/program of work (A18)', are quite like 'contract management (A11)' which is present in the factor group 1. It is also worth noting that the 'government regulations (A14) and 'late deliveries of materials/ equipment' (A23) factors, both which are significantly correlated to construction project delay (see Table 2), are also present in factor group 1. Finally, the following interpretation was reached by looking at the underlying connections between the variables inside each factor group: factor group 1 was named 'late delivery of materials by supplier'; factor group 2 was named 'poor decision making' and factor group 3 as 'Inclement or bad weather'. These names were obtained from the components (see Table 6) by utilising the variables with the highest loading factor (0.810, 0.515 and 0.757).

5. Discussion

In this study we found that late delivery of materials by supplier, poor decision making, and inclement or bad weather are the underlying factors causing construction project delay in Nigeria. These underlying factors share a common link with the top factors causing delay in Jordan, Iran, India, Egypt, Turkey, Malaysia and Hongkong (Odeh and Battaineh, 2002; Venkatesh and Venkatesan, 2017; S. Singh *et al.*, 2018). As a result, it may be inferred that these underlying factors are also driving construction projects delay in most emerging nations. This can be explained by the fact that in emerging nations, building materials are primarily imported rather than manufactured locally, and project management methods and procedures are often not world-class. Hence, the Nigerian government is strongly urged to set price levels and offer subsidies for construction supplies in the region as a method of reducing import levels while construction stakeholders are encouraged to receive high-quality, internationally recognised training and qualifications.

As argued by Singh *et al.*, (2018), late delivery of materials leads to shortage of materials on construction site. This shortage of materials can result in rescheduling of work activities and extra time or waiting time for construction workers, thereby can drastically increase the overall duration of construction projects. An increase in project duration has the potential to increase project costs since more money will be necessary to pay for the services of both manpower and machineries for the prolonged period owing to late delivery of materials required for their services. And if the party responsible for ensuring that materials are delivered on time fails to pay for the additional cost, it can lead to conflict or legal action among construction stakeholders. Therefore, policymakers in construction industry in Nigeria should focus on measuring the key suppliers' delivery performance. For instance, as against the current construction business model, where contractors buy all building products via construction material wholesaler (Alaka *et al.*, 2017), these policymakers can create a policy that will mandate contractors to hire a buying party (e.g., a quantity surveyor, a technical planner, etc.) who will choose which products to buy from which suppliers and ensure that these suppliers are producing products that are compliant with construction industry standards right from the design stage. As a result, if suppliers do not have the necessary product data in the correct format, they may not be considered for a project at all.

Furthermore, in line with the findings of this study, Odeh and Battaineh, (2002) and Prasad *et al.*, (2019) highlighted a significant point by arguing that slow/poor decision making by the contractor owing to late/delayed approvals from client is among the top factors causing construction projects delay. Interestingly, the construction industry in Nigeria produces some amount of data daily on every project, for example data produced from backlog of project schedules, as-built drawings and models, Computer-Aided Designs (CAD), costs, invoices, and employee details, among many others presents a window of opportunity for the industry and its clients to examine and gain profits from insights generated from these data. Therefore, the construction industry clients in Nigeria should leverage these data to make key business decisions that will help drive further profitability. This can be done through the aid of state-of-the-art data driven technologies such as artificial intelligence or machine learning which has been widely adopted across other industries like healthcare: guiding in the choice of treatment; education: virtual lectures; transportation: autonomous vehicles, etc.

Finally, inclement or bad weather poses adverse effect to construction projects in Nigeria. For instance, Severe rain on construction sites may make working conditions challenging for workers, who may lose their grip on equipment and machines, resulting in accidents or lose of lives. Dry weather can increase the quantity of dust on site, which can cause machinery to jam and clog. Strong winds can put strain on equipment and cause it to break, etc (Radevsky *et al.*, 2012). To this effect, construction stakeholders in Nigeria are strongly encouraged to use climatological data that can be obtained from weather observations to minimize impact of bad weather during construction.

6. Conclusion

Despite significant mitigating measures, the recurrence of a worldwide issue - construction projects delay remains a huge concern to its policy makers. The Nigeria construction sector is no exception, with many of its projects experiencing significant delays, despite the fact that the industry is regarded as a key backbone of the Nigerian economy. In this study therefore, a premise to extract the underlying factors causing construction project delay in Nigeria became eminent. First, a survey of experts based on twenty-three factors identified from systematic review of existing literature on causes of delay, was developed as a way of determining whether the findings of previous research relating to construction project delay still applied to construction projects in Nigeria. To validate the reliability of the responses received from the survey, a reliability analysis was conducted using the Cronbach's alpha test. Being found reliable, this study further used a significance index of delay parameters (SIDP) analysis to determine how important each of these twenty-three factors were in relation to construction projects delay based on the reliable responses. This SIDP analysis yielded six applicable factors to construction projects delay in Nigeria. Finally, of these six applicable factors, four were present in the three underlying factors discovered through factor analysis. These underlying factors are late delivery of materials by supplier, poor decision making and Inclement or bad weather. Therefore, the policymakers in the construction industry in Nigeria should focus on measuring the key suppliers' delivery performance as late delivery of materials by supplier can result in rescheduling of work activities and extra time or waiting time for construction workers as well as for the management team at site. Also, it is critical that the way decisions are made on projects is organised, orderly, and in controlled manner. Furthermore, this study suggests to the policymakers to use climatological data that can be obtained from weather observations to minimize impact of bad weather during construction.

7. Limitations

It should be noted that a limitation of this study is the sampling method which would have probably resulted in respondents working on the same construction project. However, solace can be taken from the fact that some of these respondents might have worked, or are simultaneously working, on other construction projects since their organizations might be involved in multiple construction projects and have been involved in other construction projects in the past. Also, the sample size of the respondents of this study may not be representative of the total population size of the region, however, this should not invalidate the conclusions because the reliability analysis related to sample size adequacy were positive, hence allowing the analysis to proceed.

8. Recommendations

Delays are costly and can lead to litigation and claims, lowering project owners' viability and delaying the construction sector's development. To improve the situation, all construction industry stakeholders in Nigeria must work together to address the findings of this study. In concrete, they are encouraged to focus on measuring the key suppliers' delivery performance to mitigate late delivery of materials by supplier. Also, they are encouraged to leverage the amount of data produced from backlog of project schedules, as-built drawings and models, Computer-Aided Designs (CAD), costs, invoices, and employee details, among many others through the aid of state-of-the-art data driven technologies such as artificial intelligence or machine learning to make key business decisions that will help drive further profitability. Furthermore, this study suggests that they use climatological data that can be obtained from weather observations to minimize impact of bad weather during construction. Future research should use a qualitative and inductive approach to investigate whether any new underlying factor(s) that impact construction projects delay can be discovered.

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