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Impact of Climate Change on Cost of Building Projects in Nigerian Construction Industry

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Abstract

Climate change is adversely affecting the building industries and is really slowing down the speed of projects in Nigeria, impacting negatively on the cost of executing a project. The study aimed to evaluate the various effects of climate change on the built environment, investigate how climate change can affect productivity in building projects in Nigeria and evaluate the negative impact of climate change in building projects. The study obtained both primary and secondary data. Quantitative data were obtained through the administration of one hundred and ten structured questionnaires which were distributed across various building projects based on systematic sampling spread across the states. Descriptive analysis was adopted for the study. Results obtained from the study revealed that most construction projects in Nigeria are vulnerable to weather-related issues and most of the times, wet conditions. The study also showed some of the greatest factors in which it has on cost of maintenance of facilities that might have been affected through these weather-related issues. The study recommends that plants and equipment should be properly stored to avoid damage during wet conditions and that the safety officer should always ensure that workers are not exposed during wet and windy conditions.

Keywords: Climate change, Cost, Built environment, Building industry, Projects

INTRODUCTION

Climate change refers to the increase in the average global temperature resulting from the elevated concentrations of greenhouse gases, including carbon dioxide (CO2), methane (CH4), water vapour (H2O), ozone (O3), nitrous oxide (N2O), chlorofluorocarbons (CFCs), and hydrofluorocarbons (HFCs) (Oruc et al., 2024). The greenhouse effect originated from human activities that commenced with the Industrial Revolution in 1750, leading to an approximate 40% increase in atmospheric carbon dioxide (CO2) concentration, rising from 280 ppm in 1750 to 406 ppm by early 2017 (Dobkotwitz et al., 2025). The anthropogenic condition arises from human activities, including the combustion of fossil fuels, coal, oil, and natural gas, as well as deforestation, changes in land use, soil erosion, and agriculture (Dobkotwitz et al., 2025; Shaw et al., 2024; FAO, 2014). Technology has allowed building designers to anticipate the resilience of designs against various weather-related challenges; however, it has also increased the financial implications of natural disasters (Kutty et al., 2024). A primary requirement of construction is to safeguard individuals residing and working within buildings from weather conditions (Shao et al., 2023; Camilleri et al., 2010). Climate change results in the degradation of buildings and can impact all building elements if not adequately managed, thereby increasing the risks associated with the initiation of construction projects.

Climate change impacts the construction sector in Nigeria. Due to the consequences impacting the project life cycle, the

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construction industry must enhance its effectiveness to address these challenges. In 2001, a researcher articulated that climate change is anticipated to affect all facets of building performance, design, standards, and regulation (Singh et al., 2025; Sarieh & Khaled, 2017). Climate change directly impacts the construction sector through weather and climate variations, while also inducing indirect effects such as site programming, delays, increased expenses, labour safety, material costs, and delivery issues.

Statement of Problem

Climate change directly impacts the construction sector through weather and climate conditions, while also indirectly affecting site programming, delays, additional expenses, labourer safety, material costs, and delivery (Dahal et al., 2025; Camilleri et al., 2010). All construction projects are influenced by climate change, which significantly impacts various phases of the project life cycle (Milanovic et al., 2025; Sawalhi & Mahdi, 2015). Kutty et al. (2024) identify specific climate factors that warrant investigation in the fields of civil engineering, building design, and construction. The parameters include temperature, relative humidity, wind direction and speed, flood conditions, rainfall, and sunlight exposure. Climate change is significantly hindering the progress of construction projects in Nigeria, adversely affecting costs and leading to claims during project execution. Weather-related challenges in Nigeria, including rainfall, sunlight, storms, and extreme temperatures, increasingly jeopardise building components such as substructures, superstructures, and finishes. Key factors that weather events are anticipated to influence include concrete curing, structural damage leading to increased costs, heightened insurance claims, delays in project delivery, and the requirement for the use of towers, cranes, and scaffolding (Kutty et al., 2024; Kalfas et al., 2024). Flooding represents a significant issue in Nigeria, attributable to factors including inadequate drainage systems, poorly designed gully channels, and obstructed canals. Research (Rocha & Zambon, 2025; Yahia et al., 2024; Kutty et al., 2025) has examined climate and its effects on the built environment in Nigeria; however, there is limited knowledge regarding the cost implications of climate change on the construction industry in Nigeria.

This study examined the cost implications of climate change on the construction industry in Nigeria, particularly concerning high-rise building projects, complex commercial buildings, and various residential and industrial structures in Lagos State. The research employed an exploratory approach to establish a knowledge base for construction management practitioners in the field.

Study Area

The State is situated in the southwestern region of Nigeria, on the narrow plain of the Bight of Benin. Lagos State is situated at approximately 20°42’E and 320°2’E longitude, and between 60°22’N and 60°2’N latitude. It is bordered to the North and East by Ogun State, to the West by the Republic of Benin, and extends over 180 kilometres along the Guinea Coast of the Bight of Benin on the Atlantic Ocean. The territorial extent and political jurisdiction include the city of Lagos and the four administrative divisions of Ikeja, Ikorodu, Epe, and Badagry (Figure 1), collectively known as IBILE. This area covers 358,862 hectares or 3,577 square kilometres, representing 0.4% of Nigeria's total land mass of 923,773 square kilometres.

RELATED WORKS

Olufemi, Okocha, and Olatoye (2014) define weather as the atmospheric conditions at a particular time and location. Examples of weather elements include temperature, cloudiness, humidity, precipitation, and winds. Thunderstorms, tornadoes, and monsoons occur in certain regions during specific seasons. Climate refers to the long-term patterns of weather that characterise a specific region. The climate of the New York metropolitan region is characterised as temperate, featuring evenly distributed rainfall throughout the year, cold winters, and hot summers. (Xu et al., 2025) Climate change is characterised by the increase in the average global temperature resulting from elevated levels of greenhouse gases. Joseph et al. (2025) and Chen et al. (2023) concluded that future building performance, design, standards and regulations, as well as climate change, are anticipated to significantly influence various aspects of building performance and construction practices. The researchers acknowledged that varying climate impacts necessitate distinct actions and

responses, emphasising modifications in design and construction practices. Chen et al. (2023) estimated that climate change impacts both natural and designed landscapes in buildings, consequently diminishing the aesthetic quality of these structures. Kuman et al. (2024) indicated that rainfall has a minimal effect on indoor construction activities, such as interior finishing and equipment installation, but significantly influences groundworks, earthworks, and framework construction. It has been observed that temperatures below 0°C adversely affect the hardening process of concrete due to the presence of frozen cement. The researchers indicated that temperatures exceeding 25°C may lead to quality issues in concrete placement and reduced productivity in framework operations. Consequently, partial finishing work may also decline as temperatures rise during midday. Wen and Albert (2017) estimated that workmanship quality may decline rapidly due to high temperatures, highlighting the significant concerns regarding labour productivity in the construction industry, which faces various workforce-related challenges.

In numerous construction projects in Nigeria, excessive occupational heat stress impacts individuals and affects work productivity and performance. Dunne, Stouffer, and John (2013) estimated that environmental heat stress has significantly reduced global labour capacity during peak months, with a projected further reduction of 80% by 2050, based on assessments of productivity loss derived from physiological models of heat exposure. Zander et al. (2015) estimated that productivity could decline by 11-27% by the end of the century in warmer regions, such as the Northern states. Altinsoy and Yildmin (2015) observed that labour productivity in the construction industry is anticipated to significantly decline due to the substantial rise in heat energy. A study by Mohammed and Wedawatta (2014) examined various companies with experience in hot weather conditions in the Middle East, utilising exploratory, semi-structured interviews for data collection. The analysis concluded that managing projects in extreme hot weather conditions is crucial for future planning and scheduling of site activities (Mohammed & Wedawatta, 2014).

Impact of Climate Change on Cost of Construction Works

Climate change is attributed to two primary factors: natural processes and human activities. Nigeria is currently facing detrimental climate conditions that adversely affect the welfare of its population. Climate change will adversely impact the Nigerian economy, evidenced by a notable decline in agricultural and construction productivity, alongside an increase in illness, morbidity, and mortality rates (Usman & Dije, 2013). Olaniyi et al. (2016) indicated that climate change may result in a loss of 6 to 30 percent of Nigeria's GDP by 2050, amounting to an estimated USD 100 billion to USD 460 billion, according to studies by the Department for International Development. Chen et al. (2024) identify various climate factors that should be taken into account in civil operations, building constructions, and building designs. The primary climate factors include weather temperature, soil temperature, angle and intensity of sunlight, relative humidity, wind direction and speed, precipitation, and sunlight exposure. Climate factors cannot be diminished in these items. While barometric pressure and similar factors are acknowledged as elements of climate, their influence on design and civil operations is minimal.

Sarieh and Khaled (2017) indicate that alterations in the perceived risk of damage within building projects may lead to an increase in insurance premiums. Liao et al. (2025) and Xu et al. (2025) indicated that increased flooding is a probable cause of building damage. The potential for heightened damage from tropical cyclones is significant, with the increase in damage likely to be substantial. Insurance costs for liability related to indoor air quality (IAQ) issues, including occupational health effects, diseases, and absenteeism, may rise with increasing temperatures. Munich (2010) conducted a survey of insurance claims from 1950 to 2004, demonstrating a significant increase in major weather-related natural catastrophes during this period. From 1994 to 2004, the frequency of weather-related disasters was nearly threefold compared to that of the 1960s. He also noted that the costs associated with natural disasters and building insurance claims were previously offset by raising premiums across a broad client base. Insurance companies are increasingly meticulous in evaluating the vulnerability of assets they insure at the local level.

Available evidence indicates that climate change will be global in scope, with its impacts disproportionately affecting developing countries due to their limited coping capacities (Yahia et al., 2024; Olaniyi et al., 2016). Carbon charges would directly raise fuel and energy costs, as well as the costs of building materials, particularly aluminium, steel, concrete, and glass (Chen et al., 2023; Kuman et al., 2024). The rise in energy costs attributed to carbon charges is expected to be minimal, making it difficult to envision how slight increases in energy expenses would incentivise energy efficiency improvements. In high-rise buildings, material selection is primarily influenced by cost and structural requirements. The extensive replacement of steel and concrete with timber may present challenges, including increased costs or technical feasibility issues (Sarieh & Khaled, 2017). Sarieh and Khaled (2017) indicate that construction site offices will experience rising electricity and energy costs due to carbon charges, resulting in an elevated annual net operational energy use per square metre for lighting and HVAC. The impact of climate change has resulted in significant financial expenditures for the Nigerian government. The Federal government allocated $3 billion from the ecological fund between 2014 and 2016 to tackle ecological issues and environmental hazards (Olaniyi et al., 2016)

METHODOLOGY

The study examined the effects of climate change on the built environment, evaluated its impact on productivity in building projects in Nigeria, and assessed its negative implications for construction projects. Data were collected from both primary and secondary sources. The primary data medium involved the design of a structured questionnaire, which was distributed to targeted professionals in the industry, including quantity surveyors, architects, engineers, and builders. The secondary medium comprised the collection of data from published materials, including textbooks, journals, and articles. Interviews were conducted with several on-site workers, including the Artisan and Foreman. The collected data were analysed using descriptive statistics. The presentation and analysis of data utilised frequency distributions and percentages derived from all respondents. The respondents indicated their level of satisfaction or dissatisfaction using selected quality performance criteria rated on a 1 to 5 Likert-type scale. The effects of climate change on the built environment and its negative impact on building projects were assessed using a five-point Likert scale: ‘1’ for strongly agree, ‘2’ for agree, ‘3’ for neutral, ‘4’ for disagree, and ‘5’ for strongly disagree. The impact of climate change on productivity in construction projects was assessed using a Two-point Likert scale, with '1' indicating Yes and '2' indicating No. Descriptive statistics were employed to assess the values of the independent variables within the data set. Univariate analysis utilising frequency distribution tables facilitated the examination of individual variables in isolation, such as the distribution frequency of each characteristic of respondents, predominantly consisting of nominal or ordinal data.

Table 1. Effect of climate change during wet condition.

Factors	Mean	Rank
Changes the designs of construction projects	2.29	1
Exposes workers to illness	2.27	2
Affects the use of cranes and scaffolds	2.21	3
Leads to absenteeism amongst workers	2.21	4
Leads to an unsafe working condition	2.14	5
Causes delay in construction programme completion	2.12	6
Damages plants and equipment	2.09	7
Creates delay on supply of materials	4.18	8
Makes excavation works and earthworks more difficult	1.98	9
Imposes greater impacts on strength of materials	1.92	10
Affects concrete casting	1.70	11
Leads to unfavourable site condition	1.67	12

Table 2. Effect of climate change during dry condition.

Factors	Mean	Rank
Causes delay in construction programme completion	4.34	1
Affects the use of cranes and scaffolds	4.30	2
Changes the designs of construction projects	4.27	3
Creates delay on supply of materials	4.25	4
Leads to absenteeism amongst workers	4.23	5
Leads to an unsafe working condition	4.20	6
Exposes workers to illness	4.18	7
Makes excavation works and earthworks more difficult	4.18	8
Leads to unfavourable site condition	4.14	9
Affects concrete casting	4.10	10
Damages plants and equipment	4.10	11
Imposes greater impacts on strength of materials	4.05	12

RESULTS AND DISCUSSION

Results

Out of the 110 numbers of questionnaires that were distributed to the respondents in some of the construction industries, 20 numbers were being filled by Architects, 24 numbers by Civil / structural engineers, 26 numbers by Builders, 28 numbers Quantity surveyors, and 12 numbers were filled by other members of the industry. This represents that 89.1% from the respondents who are practitioners and is good enough to draw inference for this study. The findings show that 58.2% of the respondents are between the ages of 21-30, 32.7% are between 31-40yrs, and 5% are over 40yrs. It also illustrates the marital status of the respondents with a percentage of 50.9% for singles and 49.1% for the married respondents. It is also shown that the academic qualification of respondents with HND, fall within the percentage of 50.9%, and those with B.Sc, have the percentage of 32.7%, M.Sc with 10.9% and others which is seen to be the least percentage with 5.5%.

The respondents with less than 10yrs of experience in the industry are 76.4%, those with 11-20yrs of experience have the percentage of 18.2%, 21-30yrs of experience are 3.6% and one with over 30yrs of experience with a percentage of 1.8%. It also shows that 30.9% of the total respondents of this study work in consultancy firms, 56.4% which has the highest percentage work in contracting firms while 12.7% of the total respondents work in client organizations.

Effect of Climate Change in Wet Condition

Table 1 illustrates the mean of the statistical distribution of variables which provides the results of the effect of climate change on construction site during wet condition. The table illustrates the descriptive analysis of variables. From the analysis in Table1, it was observed based on the response given by the respondents that wet condition changes the design of construction project which the mean score stated (2.29), followed by the fact that it exposes workers to illness (2.27), leads to absenteeism amongst workers (2.21) and that it leads to an unsafe working condition (2.14). But some of the respondents strongly believed that wet condition leads to an unfavourable site condition which developed a mean score of 1.67 and that it affects concrete casting (1.7091) during site activity. Hence, to a large extent the respondents perceived that wet condition impacts greatly on the strength of materials hut has a mean value of 1.92.

Effect of Climate Change in Dry Condition

Table 2 illustrates the mean of the statistical distribution of variables which provides the results of the effect of climate change on construction site during dry condition. The table illustrates the descriptive analysis of variables. From the distribution of mean scores in Table 2, it was observed that the respondents strongly disagreed on the fact that dry condition causes delay on construction program completion (mean = 4.34). Also, the respondents strongly disagreed on the fact that dry condition affects the use of cranes and scaffolds with a mean value of 4.30, followed closed by changes in the design of construction project (4.27). The results show that professionals disagreed that dry condition creates delay in the supply of materials to the construction site (4.25) and that it leads to absenteeism amongst workers (4.23). The least on the rank is that it impacts on the strength of materials (4.05) which was also a disagreed factor by the respondents on dry condition.

Effect of Climate Change in Windy Condition

Table 3 illustrates the mean of the statistical distribution of variables which provides the results of the effect of climate change on construction site during windy condition. The table illustrates the descriptive analysis of variables. Table 3 presents the mean scores indicating respondents' perceptions of the effects of windy weather conditions on construction activities. The results show that professionals generally agreed that windy conditions have several disruptive impacts on construction projects. The findings indicate that the highest-rated factor was that windy conditions change the design of construction projects (mean = 4.11), followed closely by damage to plants and equipment (mean = 4.05) and worker absenteeism (mean = 4.02). These results reflect a general agreement that windy conditions have significant impacts on construction activities. At the lower end of the ranking, unsafe working conditions (mean = 3.40) and unfavourable site conditions (mean = 3.62) were perceived as less critical, although mean scores still indicate that respondents tend to agree that these are relevant concerns.

Climate Change Effect on Productivity

Table 4 illustrates the mean of the statistical distribution of variables which provides the results of how climate change affects productivity. The table illustrates the descriptive analysis of variables. From the mean scores in table 4, the respondents slightly supported the fact that climate change creates fluctuation on plants and equipment (mean = 1.58), followed by heat stress affect working conditions (mean = 1.49). The results show that professionals slightly agreed that heat stress can cause severe illness that could lead to absenteeism amongst workers (mean = 1.43). The findings show that slightly agreement on climate change can cause fluctuation on the cost of labour (mean = 1.42) followed by climate change can cause conflict between a client and a contractor which could lead to an abandonment of a construction project (mean = 1.32). The results reveal that the respondents greatly supported the fact that climate change can create delay in handing over a project to a client (mean = 1.07) followed by climate change brings about extension of time of a construction project (mean = 1.06) and also agreed that climate change increases the cost of maintenance of facilities on site (mean = 1.09).

Table 3. Effect of Climate Change during Windy Condition.

Factors	Mean	Rank
Changes the designs of construction projects	4.10	1
Damages plants and equipment	4.05	2
Leads to absenteeism amongst workers	4.01	3
Creates delay on supply of materials	3.92	4
Affects concrete casting	3.90	5
Imposes greater impacts on strength of materials	3.83	6
Affects the use of cranes and scaffolds	3.81	7
Makes excavation works and earthworks more difficult	3.81	8
Causes delay in construction programme completion	3.80	9
Exposes workers to illness	3.78	10
Leads to unfavourable site condition	3.62	11
Leads to an unsafe working condition	3.40	12

Table 4. Climate change effect on productivity.

Factors	Mean	Rank
Climate change creates fluctuation on cost of plants and equipment	1.58	1
Heat stress affect working conditions	1.49	2
Heat stress causes severe ill that could leads to absenteeism of workers	1.43	3
Climate change creates fluctuation on cost of labour	1.42	4
Climate change causes conflict between a client and a contractor	1.32	5
Climate change creates fluctuation on cost of materials	1.23	6
Can climate change results in variation	1.20	7
Climate change increases the cost of executing a construction project	1.14	8
Climate change affects the strength of materials which could to poor design	1.12	9
Climate change affects the productivity in construction projects in Nigeria	1.12	10
Heavy downpour results in postponement of construction activities on site	1.11	11
Climate change poses more threat on structures	1.10	12
Climate change influences the choice of materials, labour and plants	1.09	13
Climate change results into claims	1.09	14
Climate change increases the cost of maintenance of facilities on site	1.08	15
Climate change brings about extension of time in handing over a project	1.07	16
Climate change creates delay in handing over a project to the client	1.07	17

Table 5. Negative impact of climate change.

Factors	Mean	Rank
Imposes damage on roof structures	4.10	1
Damages plants and equipment	4.05	2
Causes damages on equipment	4.01	3
Affects the topography of the soil	3.92	4
Leads to flood in th e construction site	3.90	5
Affects the soil condition of the site	3.83	6
Creates more threat on foundation and other building elements	3.81	7

Negative Impact of Climate Change

Table 5 illustrates the mean of the statistical distribution of variables which provides the results of how climate change affects productivity. The table illustrates the descriptive analysis of variables. From the result in Table 5, the respondents strongly agreed that climate change imposes damage on roof structures (mean = 1.76) followed by climate change damages plants and equipment (mean = 1.76). Also, the respondents strongly supported that climate change causes damages

on structures (mean = 1.70). The findings indicate that the respondents strongly agreed that it af-fects topography of the soil (mean = 1.63) and agreed that it leads to flood in the construction site (mean = 1.61). The professionals generally agreed that it affects the soil condition of the con-struction site (mean = 1.60) and creates more threat on foundation and other building elements (mean = 1.58).

DISCUSSION OF FINDINGS

Respondents during the in-depth interviews revealed that excessive rainfall in most projects in Nigeria creates some changes in the design of building projects in order to withstand extreme weather effects. One of the most commonly reported factors in previous studies is that wet conditions frequently lead to unfavourable site conditions, which in turn slow the movement of materials and workers, and that it affects concrete casting i.e. in most construction activities, most concrete casting works are always postponed due to bad weather because heavy down pour can affect the strength of concrete. Thus, the findings align with Chen et al. (2023), which indicates that rainfall quantity is a critical factor to consider in building design, particularly in ceiling design. In regions with significant rainfall, building ceilings should be designed as gable roofs to minimise water erosion, reduce potential damage, and prevent water accumulation on the roof. Otherwise, the negative impacts of rain and its infiltration into structures would increase. Understanding rainfall rates, particularly for the design of structures such as dams (including the estimation of maximum probable rainfall), is essential for determining spillway dimensions and related factors. Furthermore, designing surface water disposal systems for urban areas during rainfall necessitates an understanding of the maximum urban flood associated with the return period. Therefore, the effect during windy condition is in agreement with previous researches by Sharma & Mundal, (2024), Peter et al. (2023), Xuepeishan (2016) and Mohammed and Wedawatta (2014).

The finding in the second objective is that the respondents are not in support of the fact that climate change creates fluctuation on the cost of plants and equipment. This is true because in previous studies (Chen et al., 2023; Yahia et el., 2024; Camileri et al., 2013), it was never indicated that climate change created a rise and fall of plants and equipment. Although, no previous study has based an idea of climate change impact on cost of plants and equipment. The most important factor in this view is that it creates and extension of time which is somewhat in accordance with that of wet condition in the previous explanation as corroborated by Peter et al. (2023), Anthony et al. (2016) and Fatile (2013). Moreover, this is also stated in the JCT 98 (Joint Contract Tribunal, 1998) that a contractor can claim for an extension of time if faced with weather related issues. Thus, every extension of time being granted can result into a delay in handing of a Project. Hence, this view is not in line with previous study.

CONCLUSION

This study employed a quantitative methodology. This research aimed to furnish construction management professionals with insights into the cost implications of climate change on construction projects in Nigeria. The primary aims of this research were to examine the diverse impacts of climate change on the built environment to ascertain its potential consequences on building productivity, which may result in cost implications. The study observed that most construction projects in Nigeria are vulnerable to weather related issues and at most times, wet conditions (i.e. rainy season), when proper management measures and design standards are not put in place, there is tendency of resulting into an extension of time which is somewhat increasing the cost of execution very massively. Works should follow proper schedule in accordance with weather forecast which at time does not give an adequate result. Climate change has a very high impact on cost of executing a building project in Nigeria which have been drawn from the following results listed above. The study also showed some of the important factors in which it has on cost of maintenance of facilities that might have been affected through these weather-related issues. The key factors anticipated to be influenced by changes in rainfall include concrete curing, structural damage resulting in significant costs, increased claims for insurance companies, delays in project handover to clients, as well as excavation and earthwork activities. The lifecycle phases most impacted by various climate change factors include the effects of extreme weather events on the execution phase,

the closing phase, and the planning and design phase, as well as the influence of rainfall on both the execution and planning and design phases. In conclusion, the research emphasised the necessity of establishing robust mechanisms and strategies aimed at mitigating or adapting to the impact of climate change on the costs associated with construction projects in Nigeria. Strategies can be implemented at the managerial level to optimise the various factors associated with climate change.

Based on the findings, the study recommends that plants and equipment should be properly stored to avoid damage during wet conditions and windy conditions, the use of substandard materials should be avoided, proper maintenance should be done on facilities affected by climate change to avoid damage and roofs should be designed with adequate slope and load capacity to withstand heavy rainfall and wind loads. Errors being noticed during or after construction that could be easily affected by climatic conditions should be corrected quickly and the safety officers should always ensure that workers are not exposed to wet condition and windy conditions.

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