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ARCHITECTURAL DESIGN IN THE FACE OF CLIMATE CHANGE: IMPLICATIONS FOR RIVERS STATE'S BUILT ENVIRONMENT

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Abstract

The effects of climate change on architectural design and the built is worrisome issue. Flooding, wind storm among others drastically affects buildings in the state. This sometimes leads to building failures and in extreme cases, complete collapse. This research employed the use questionnaire to analyse the impact of climate change on architectural design and the built environment. The data collected were analyzed using percentages. The study found that climate change and the effect on building the mean of > 2.50 in the items entered and the standard deviation < 2.00 justify that the respondents strongly agree on the direct relationship between climate change and building in Rivers State. The study climate change impact on architectural design and the built environment in rivers state. The research recommends the need for building professionals to obtain basic climatic data from meteorological stations nearer to their proposed site and analyze such data for proper architectural design and to enhance management of the built environment.

Keywords: Climate Change, Architectural Design, Built Environment, Rivers State

INTRODUCTION

The overwhelming influence of climate change ranging from increased temperature to flooding among other effects poses a threat to man's culture and even his very existence. Buildings are usually designed to suit a specific climate, but their lifespan is often not more than a century. Buildings are vulnerable to climate change which in the future can cause a higher risk of collapse, reduction in value resulting from the impact of climate change. Climate agents play an important role in the deterioration of building fabric, and a change in climate is expected to have a significant effect on deterioration. Conceptually, climate change is defined as a change in the state of the climate that can be identified (e,g using statistical test) by changes seen mean and /or the variability of it's properties, which persists for an extended period typically decades or longer (Intergovernmental Panel on Climate Change 2007). There are also prominent views on the impacts of buildings on climate. Aliyu, (2010) for instance, noted that the building industry is a major source of greenhouse gases (GHGs); as giant consumer of natural resources such as forests, solid minerals and water, as well as, the role of poor designing in compounding health risks and excessive consumption of energy. However, according to a report by Ministry of the Environment and Food of Denmark / Environmental Protection Agency, (2020) buildings are mostly vulnerable, because all the climate change indicators such as bush fires, hurricane, flood and other adverse effects have huge consequences for the effective functionality of buildings.

Climate change has become a nightmare to both the developed and developing countries. The current threatening global climate change call for paradigm shift in building construction in developing countries. While the developed countries are retrofitting and remodeling for adaptation, the developing countries are to plan and implement building construction in accordance to present and future climatic predictions. It is time to design and construct buildings in line with climatic features. Though the developed countries have more capacity to mitigate and adapt to climate change, the developing countries can incorporate the climate extremes in planning and implementing development. Building professional are recently undergoing paradigm shift in design and implementation of building (Turnbull, et al, 2020). The built environment includes structures and systems that provide places for people to live, work, and play. It includes buildings, roads, bridges, parks, streets, and systems that provide transportation, water, power, and more. These structures and systems exist in nearly all places where people live and work, but tend to be most concentrated in metropolitan areas.

There are different views on the effect on climate change on the built environment. According to Mona (2017) a changing climate presents a challenge to the planners and designers of the built environment. It is important to bear in mind that small increases in temperature above normal levels can increase hazards dramatically, including the intensity of cyclone wind speeds, bushfires and flash flooding (Mark & Deo 2011) which can lead to increase in building damage. An architect who designs for climate change adaptation (CCA) recognized that the nature of weather events is unlikely to remain the same throughout a building's lifetime. Edi and Edy (2018) argued that buildings are also important to the environment, building acts as a climatic modifier, separating the indoor built environment from the external climate described by the prevailing long-term weather conditions. The climate of a particular location tends to influence the shapes and forms of the local buildings and dictates the types of environmental control required. There is often a distinct correspondence between special architectural features and different climatic zones. Umoh (2000) stressed that climatic regimes has long been recognized as a function of building houses.

Camilleri et al., (2001) was of the opinion that the change in climate is expected to have impact on many aspects of building performance. Thus, it was advised that there is need to identify what impacts climate change they may have on buildings, how serious they could be and what action (if any) could be taken to ensure that performance of building is not compromised. Edi and Edy (2018) argument showed the interrelationship importance between buildings and climate, because of how they influence the other and have direct and immediate environment impact. Globally, the different climatic regions reflected on the architectural design choices and practices. While numerous studies have suggested that buildings contribute to the causes of climate change (Wilby, 2007; Camilleri et al.2010; Berrang-Ford et al. 2011; Janda, 2011; Yi et al. 2016; Fanchao et al. 2017. Audrius and Arvydas (2017), they are, without doubt, affected by the impacts of climate change, hence affecting the functionality of buildings (Aliyu, 2010; Gething, 2011). The emphases is not just aesthetic but resilient and adaptability to extreme climate events like flood, erosion, windstorm due to rising temperature and sea level rise (climate change).Flooding and windstorm events around the world produced a heightened sense of the need to better plan and design buildings and infrastructure to reduce vulnerability to climate extreme events. Mona, (2017) opined that building professionals and designers need to incorporate strategies that consider climate change within their region.

Furthermore, the predictions of climate scenarios suggest regulatory/policy measures on climate adaptation should be taken as quickly as possible to avoid greater costs in the future (Stagrum et al., 2020). Buildings are affected by the physical impacts of climate variability and change. Consequently, countries all over the world are currently ensuring that buildings are climate resilient to reduce direct losses and reduce the indirect costs of disruption. The OECD in 2019 has cautioned that new building project should be planned, designed, built and operated to account for the climate changes that may occur over their lifetimes. The report further showed that existing building may need to be retrofitted, or managed differently, in view of climate change (OECD, 2020). Aliyu, (2010) advised that building professionals (architects, planners, builders and engineers) need to work as team with climatologists/meteorologists in order to address the risks of climate change. Clearly, the built environment and its infrastructures have been noted to be vulnerable to climate change through higher temperatures, erratic and variable precipitation, rise in sea levels and wind actions, which have impacts on the surface of the environment and also varying impacts on the built environment. From the above, this study examined the effect of climate change on the built environment in Rivers State.

LITERATURE REVIEW

Climate Change

Climate change is defined as a change in the state of the climate that can be identified (e,g using statistical test) by changes seen mean and /or the variability of it's properties, which persists for an extended period typically decades or longer (Intergovernmental Panel on Climate Change 2007).Climate Change is evidenced by rise in temperature, fluctuations in rainfall, floods, drought and wind storm (IPCC, 2013). It is caused by both natural and anthropogenic activities like mining, construction, urbanization, agriculture and so on. Human activities bring about change as a result of urbanization, industrialization and change in the standard of living. This advances the normal traditional way of building to mechanized system involving the use of higher machinery. The normal manual process of building production is gradually abandoned for mechanization which increases the change in climate variables, (Iheama, 2017). In the past the pattern of buildings encouraged culture as people valued and used the materials in the environment like mud, timber, fibres down to an advanced level where these muds were fired (put under pressure to increase its strength and durability).

Climate change is not just caused by natural factors; it is also triggered by other anthropogenic activities like agriculture, mining, industrialization as well as construction. Contingency in everyday life makes lasting behavioral change relatively rare, the time lag can be considerable even when there is such great desire to sustain culture, advancement in technology used in construction is very attractive and calls for effectiveness since the targeted time must be met. The natural material like mud consumes a lot of time both in preparation and placement and demands such great skill which has been lost by the present generation since they have never even seen it either prepared or witnessed its placement. This makes it difficult to produce the required number of housing units considering the fact that housing demands is on the increase as a result of urbanization. The urbanized area has more risk of flooding due to excessive rainfall; construction works deter infiltration of water into the soil thereby causing more runoff (Satterthwaite, 2008). Excessive rainfall overwhelms the available drainage systems and the increase in demand or the pressure on the provision of more housing units.

Claudia (2004) opined that flooding, coastal erosion, subsidence, drainage systems require new building techniques and materials in order to resist adverse weather conditions; influences the choice of site, cost of finance/insurance: as a result of this Insurance sector is beginning to factor impacts of climate change into premiums. Kimmo (2005), in ECONO project report opined that climatic factors affect buildings. He buttressed this by saying that the intensity and direction of the wind affects the walls, roofs and groups of building. While, Wilby (2007), reviewed climate change impacts on the built environment, he collated evidence of effects in four main areas: urban ventilation and cooling, urban drainage and flood risk, water resources, and outdoor spaces (including air quality and biodiversity). He therefore, pointed out that built areas exert considerable influence over their local climate and environment, and that urban populations are already facing a range of weather-related risks such as heat waves, air pollution episodes and flooding. According to him, though climate change is expected to compound these problems, building designers and spatial planners are responding through improved building design and layout of cities and not considering the traditional building patterns. For example, green roofs and spaces provide multiple benefits for air quality, mitigating excessive heat and enhancing biodiversity which the thatch roof did not fall to provide except for interest in advanced innovation. Patrick (2014), in his paper on climate change; implications for building, reported that Buildings face major risks of damage considering mostly the mud and thatch house from the projected impacts of climate change, having already experienced a big increase in extreme weather damage in recent decades.

Climate change increases the frequency and intensity of heavy rainfall events, thereby increasing the risk of urban flooding. While addressing infrastructure issues is a necessary component of reducing urban flood risk, individual homeowners can have a significant role in reducing risk through protecting their own homes and reducing their contributions of storm water to municipal sanitary sewers and storm water management systems. However, the barriers of low public awareness will have to be overcome to effectively engage homeowners in urban flood risk reduction.

Measures meant to ameliorate some hazardous effects of climate charge like flood is well noted by the local populace. Urban flooding occurs in urban areas, where the impacts of extreme rainfall are exacerbated by high concentrations of impervious surface, infrastructure, buildings, property and people. Urban flooding can have serious implications for both buildings and infrastructure, as extreme flows of water during heavy rainfall events can damage both overland and underground storm water management infrastructure and road pavements. Flooding has also become the greatest reasons for the numerous gully erosion problems because of concentration and discharge to many unsafe areas. These are mainly due to poor road designs, numerous public and private building springing up and exposing land surface in many built up areas

Flooding

Under a changing climate, an increase in the frequency of drought, extreme rainfall, and high temperatures wind events is expected and we can expect an exacerbation of the health impacts associated with these events. It has been argued that extreme events that currently have return frequencies of 1 in 100 years could have return frequencies of 1 in 5 or 1 in 10 years by prevailing climate change conditions. As temperatures increase, evaporation will also increase and the atmosphere will be able to hold more moisture. Higher amounts of moisture in the atmosphere will result in more severe precipitation. Although the precise impacts of climate change will differ depending on the climatic and environmental characteristics of specific regions, it is often thought that extreme precipitation events could increase in severity by approximately 15 percent. Storm water management infrastructure has traditionally been designed with the assumption that weather and climate conditions are static, and historical climate conditions can be used to accurately predict the future climate. Increasing frequencies of extreme rainfall events caused by climate change will mean that storm water management infrastructure design standards will be less reflective of the frequency and intensity of events that we will experience in the future. Understanding public perceptions of natural hazards is an important part of non-structural hazard management. In comparison to structural approaches to hazard management, which attempt to alter the hazard to reduce risks to population (e.g., building dams and levees to control flooding), non-structural approaches attempt to alter human behaviour to reduce vulnerability.

A commonly applied non-structural measure may be the use of floodplain maps to steer development away from flood prone areas. Non-structural measures also include education programs and actions designed to increase the awareness and risk reducing actions of the individuals who are exposed to hazard risk. Hazard perception studies were first conducted in the 1960s, and throughout this time, a few findings have generally remained constant in the literature. First, people who live in areas subject to hazards are largely unaware that they could sustain damages, personal injury, or death. In most cases, less than half are aware of their exposure to natural hazards.

Second, people who live in hazard prone areas rarely take actions to protect themselves. Many studies have revealed that less than 15 percent of individuals exposed to hazards take actions to reduce their risk of sustaining damages. When people do take action, they generally take inexpensive and less effective actions such as evacuating at the last minute, or moving valuable items to a higher level in their home during a flood event typically of what obtained in some built environment. Vulnerable areas are expected to take precautionary measures which have not be done till now. Perception studies have frequently revealed that people with property prone to flooding rely highly on government built structural mitigation mechanisms, such as dams, levees and floodwalls, to protect them from damages. Studies have also revealed a high reliance on the government for flood protection, and that often the blame for damages caused by natural hazards is placed on government rather than extreme natural events or on those who choose to occupy hazard prone areas. Presently it is suggested that government must build shoreline protection structures along various rivers state the billions of Naira that will go with it notwithstanding. Homeowners are more likely to attribute responsibility to their municipalities than to take action they to reduce urban flood risk.

Climate Change and Building Construction

Risk from flooding due to changes in climate is a combination of the flood hazard coupled with exposure and vulnerability to flooding (Clark, Priest, Treby and Crichton; 2002). According to Clark et al (2002) in the pre-planning stage flood risk affects the suitability of locations for planning construction projects and the conditions under which development is permitted. Commercial viability rests upon considerations such as: possible reduced land price; increased investment in planning consent; increased construction costs; reduced salability, mortgaging and insurability; and long term viability of the built facility. In the planning and design stages flood risk affects the design of the built facility. Under planning conditions specific drainage, building elevation, structural designs and specialized materials may be necessitated. This may represent long term commitments for design and construction companies and importantly their clients. In addition, there are direct financial risks to construction project planning associated with the climate change legislation in terms of changes to local environmental planning guidelines and building standards. Planning guidelines in all the jurisdictions that construction projects operate globally are being amended to reflect climate change risks and adaptation that have direct financial impacts on the value of any construction project. As the standards become more stringent or prescriptive, additional engineering may be required.

Besides, expensive building technologies and changes to building standards in line with climate adaptation risks have financial implications on the design, planning and operational costs of construction projects Carbon Disclosure Project (COP, 2010). The Carbon disclosure project (2010) also highlighted some of the current and/or anticipated significant physical risks caused by climate change and their various effects on construction project planning as follows: Severe weather events: resulting in property damage, impact costs associated with transport

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and delay delivery of construction products and materials, delay site construction activities and programming, increase site construction costs due to increased mitigation measures such as large scale treatment of construction water run-off may result in indirect effects to local economies.

Changing weather conditions will also have profound effects on human health (COM, 2009).

Increased extreme weather events and air temperatures will directly affect the health and safety of all site workers and Laborers; as diseases such as malaria are likely to have wider ranges (Oladipo, 2010), particularly those working outdoors on construction sites and this in turn will delay site construction activities and associated costs. Project planning Rising sea levels, coastal flooding, and erosion: may increase construction project costs associated with additional site flood mitigation measures in either landscaping, storm water engineering or building design, may prevent construction project approval or undermine existing asset values due to changed sea-level rise mapping, will result in demographic shifts which in turn determine feasibility of construction projects. Corresponding to high temperature areas, may cause inadequate water supply. Also, access to adequate water to service construction developments will be the key to determining the feasibility of any proposed construction projects.

Flood prone or low lying land in coastal areas like Lagos are affected by increased extreme weather events, rising sea levels, flooding and inundation, and associated demographic shifts. This may comprise land that was historically reclaimed from swamps and river deltas to flood plains and harbor foreshores. Addressing climate change requires two types of response. Firstly, and importantly, we must reduce our greenhouse gas emissions (GHG) (i.e. take mitigation action) and secondly we must take adaptation action to deal with the unavoidable impacts (COM, 2009). Therefore, governments and policy-makers have a responsibility to understand these climate change impacts and to develop and implement policies that will ensure an optimal level of adaptation.

The global climate change is attributed to the change in the net global atmospheric composition. Locally, the changes in atmospheric composition constitute a serious risk to the quality and sustainability of the materials used in building industry. The pollutants and other aerosols generated in the city form a dome over the city making it hotter and less visible especially in the dry land cities. But even wet cities like Lagos are not exception. Every one of us can observe black spots and shadings on most of our buildings especially those left unpainted for considerable period of time. But even our newly painted buildings are vulnerable to being washed away or faded shortly.

The Built Environment

The built environment, as defined in the previous section, is a multidimensional concept. When examining interactions between the built environment and travel behavior, various elements of the built environment are more appropriately measured at various scales of geography. Past research has typically focused either on the scale of a neighborhood (an area often conceptualized as several city blocks) or broader regional scales (which could be several square miles within a larger city or metropolitan area or even the entire metropolitan area). Studies suggest at least five interrelated and often correlated dimensions of the built environment at the neighborhood scale.

Density is a measure of the amount of activity found in an area. It is usually defined as population, employment, or building square footage per unit of area and may be measured as people per acre or jobs per square mile, for example. The floor-area ratio, defined as the ratio between the floor space in a building (counting the area of each story of the building) and the size of the parcel on which that building sits, is another popular measure of density. Density is perhaps the easiest characteristic of the built environment to measure and is thus widely used.

Land use mix is defined as the relative proximity of different land uses within a given area. A mixed-use neighborhood would include not just homes but also stores, offices, parks, and perhaps other land uses. Measures of land use mix are not standardized. One study used the distance from each house in a neighborhood to the nearest store as a measure of land use mix. Another study used a “dissimilarity index” that divided an area into grid cells and for each cell counted the number of neighboring cells occupied by different land uses. A simple breakdown of the total land in an area into shares of each type of land use is another way to measure land use mix.

Connectivity is defined as the directness and availability of alternative routes from one point to another within a street network. It can be measured, for example, by the number of intersections per square mile or by the ratio between the straight-line distance between two points and the distance along the network between these points. Average block length is often used in planning practice as a measure of connectivity. Scale refers to the three-dimensional space along a street as bounded by buildings or other features (e.g., trees or walls) and is usually described in terms such as human-scale or automobile-scale. It can be measured, for example, by the ratio between building heights and street widths, or the average building setback, the distance from the street to the building. Scale is often depicted graphically rather than measured numerically.

Aesthetic qualities, the qualities that contribute to the attractiveness or appeal of a place, are the most intangible of the five dimensions and are more often described than measured. Factors that contribute to aesthetic qualities include, for example, the design of buildings, including the size and orientation of windows, the location of the door relative to the street, decoration, and ornamentation; landscaping, particularly trees and the shade they provide; and the availability of public amenities such as benches and lighting. Places with desirable aesthetic qualities are often said to have a strong sense of place a clear identity.

Empirical Review

Abugu, Yero, Irene and Odele (2021) examined the relationship between climate change and building construction; identify paradigm shifts in building policies as a response to climate change and to find out climate change mitigation and adaptation strategies in the building sector. These were achieved through the review of literature published in the era of the recent global climate change from late 90s to date. Selection of paper was based on relevancy to the topic and date of publication. Preference was given to papers that link climate change with building sector, especially those that portray paradigm shift. Result showed that there are strong link between climate change and the building sector. As all previous reports reviewed revealed that climate change adversely affect building, a good number also argued that building construction is responsible for climate change mainly in terms of energy use and surface transformation/exposure. Although, there seems to be conflicting ideas on cause and effects between climate change and building construction, there is a general agreement that climate change affects building sector.

Scholars also agree on integration of climatic parameters in building sector. Climate change has become a basis for policy reform in the building sector as many studies recommended knowledge and inclusion of climatic parameters in building planning, design, construction and use. Mitigation and adaptation of buildings to flood and extreme temperature were the common concerns of most studies. Raising of floor, use of local materials, orientation of building in accordance to sun and wind direction are among the mitigation and adaptation options for building construction in the face of changing climate.

Liso et al (2003) aimed at providing an overview of the challenges of climate change impacts on the Norwegian built environment and how the country's climate policy can be used practically to confront and prepare for potential impacts. Their study found that technical regulations and standards were effective government tools for ensuring compliance to building design, construction and land-use, building locations and how buildings were clustered. In the case of Norway, they established; Building Research Design (which spells out solution-in-principle), which serves as design guide and must be monitored. Secondly, there is the need to regulate building locations through land use planning tools and land management, which will help curb the impacts of climate change on the built environment. Gary and Patricia (2015) highlighted that discussion between industry and government policymakers in and beyond Ottawa, Canada about climate change and potential impacts on residential development regulations and corresponding industry practices. They advised that both private and public stakeholders must acknowledge the impacts of urban form on greenhouse gas (GHG) emissions, and, conversely, the impacts of climate change on cities, for any meaningful progress on urban sustainability to ensue. Stagrum et al (2020) examined literature on climate adaptation measures for buildings through a scoping literature review. The study concentrated mainly on journals in the field of climate adaptation of the built environment, then expanded to map the extent of scientific publications about climate adaptation in general. Result showed that the majority of the identified literature was concerned with climate change impacts on buildings in warm climates, with overheating being seen as the greatest challenge. Additionally, few empirical studies are found; most identified research is based on computer simulations or literature reviews. The volume of research on the consequences of climate change on buildings in cold regions is surprisingly small, considering the peculiarities involved.

Yi et al., (2016) investigated the reliability of climate change to influence high rise building. Several sampling methods were utilized to estimate the extreme wind speed. They are, Kernel Density Estimation; Anemometer, Bootstrap Re-sampling Method and Monte Carlo Simulation etc. The wind speed usually has a linear relation to the daily mean temperature. Climate change can be considers to help do a rough approximation of the future wind speed. Onkangi et al., (2018) noted that infrastructure is very vulnerable structurally and financially to extreme weather conditions and events. Using vulnerability and adaptation indicators in the assessment tool, the extent of integration of climate knowledge in planning and implementing infrastructure projects in Kenya was evaluated. The findings indicated that there is great need to initiate early warning systems, incorporate rigorous risk assessments to determine infrastructure vulnerability levels, integrate adaptation measures and strengths for infrastructure and buildings to continue functioning in a changing planet, and avert retrogression and mark-timing development wise. Furthermore, Few et al., (2007) stated that climate change on building identified the following impact such as: mean climatic conditions, increase in the degree of variability and shifts in the ecosystem and increased frequencies of weather elements.

Audrius and Arvydas (2017) evaluated that climate change is expected to have an influence on the energy performance of a residential building in Kaunas, Lithuania, basically due to changes in heating and cooling demand. The temperature data predict of IPCC (Intergovernmental Panel on Climate Change) typically concentrates pathways (RCP) 2.6 and RCP 8.5 were used for the periods of the 2020s (near subsequent) 2050s (middle subsequent) and 2080s (far subsequent), incorporated into hourly Energy Plus. Climate averages of over 30 year period were evaluated. The overall energy consumption shows that the result is small. Changes were detected in all scenarios and periods, from a drop by 8.5 %–10.3 % in total consumption in the 2020s under RCP2.6 scenario to 26.7 %–29.6 % decrease in case of the 2080s RCP8.5 scenario (the decrease by 15 %–15.6 % was observed under RCP8.5 scenario). The number of days when space heating is required decreased due to the sensational decrease, while a slightly increase of a cooling load in a modeled house still does not make it effective over a heating load. Fanchao et al.,(2017) posited that climate plays an essential role in heating energy consumption of buildings because of the right parallel in between the changes in climate conditions and space heating. The Transient System Simulation Program Software was used to affect the heating loads of office buildings to compute the impact in Shanghai, Tianjin and Harbin, and three major climate zones were describe. The implementation of stepwise multiple linear regression determines the impact on heating energy consumption as the key climatic parameters. Dry bulb temperature (DBT) showed that the results is the dominant climatic parameter that influence the building heating loads in all three climate zones across china due to the heat period at daily, monthly, and yearly scales ($R2 \geq 0.86$). Climate endless warming comes in with the winter over the past

50 years, the heat loads decreased by 14.2, 7.2, and 7.1 W/m2 in Shanghai, Tianjin and Harbin, respectively; climate zone noting that the decrease rate in severe cold is more possible

Luo, Yao, Zhang, and Zhou, (2023) used the scenario analysis method to set different working conditions for five different structural systems, and used SimaPro software to evaluate the carbon emissions of prefabricated buildings in order to clarify the carbon emissions of prefabricated buildings under different structural systems, and explore their impact mechanisms in depth. Finally, take the existing buildings in China as an empirical study, the results showed that: 1) the carbon emissions produced by the four common prefabricated structural systems were almost the same. Different structures had different requirements for the combination of components. The carbon emissions of individual buildings would be superimposed according to the carbon emission characteristics of various individual components to form the final total carbon emissions. 2) When the building structure system requires more combinations of components, the greater the amount of transportation invested in the transportation process, the more carbon emissions would be caused. In the calculation of all individual building construction stages, the carbon emissions generated by tower cranes almost exceed the sum of the carbon emissions of all mobile machinery. 3) Prefabricated shear wall structures and prefabricated frame-shear wall structures require a large amount of hoisting of prefabricated shear walls, so the carbon emissions of their mechanical equipment were also the highest.

Adrián Garlati(2013) examined climate change is changing the frequency and anxiety of Extreme Weather Events (EWEs), especially in poor developing countries, and the international community is progressively suggesting the design of adaptation funds to resolve this situation. Measures of vulnerability and submission to EWEs are a critical instrument in guaranteeing a transparent, economical and equitable allocation process in these funds. Latin American countries, which provide little to climate change but are hard-hit by EWEs, urgently need new index to back up their requirement for financial and technical assistance. Using DesInventar data, the paper develops a creative Disaster Exposure Index (DEI) that encloses many disasters' impacts. DEI calculations stipulate an unexpected scenario where some territory usually considered resilient are found to be exposed. The results call for further development of regional indicators to facilitate the international, national and sub national allocation of adaptation funds.

Sarieh Zareaian & Khaled Aziz Zadeh (2013) examined the role of various barometrical factors on civil activities and building construction is of high importance. Existence aware of climatic parameters of construction site including the measures and type of rainfall, temperature, humidity, direction and wind speed, harmful environmental incident including heavy showers, heavy winds, local changeability, glacial times, heavy snow, etc. It is necessary before designing a building. It is literally obvious that considering these items especially extreme values would result in sustainability and strength of the building against desirable provincial climate events and also cause the fall of energy loss at the time of exploitation. Likewise the emphasis of climate factors, knowledge and considering weathering condition and taking necessary measures and reacting at the time of building construction, the unconditional adjustment and correlation of project exercise with the weather forecast would decrease the possible damages and loss. The most exceptional example is the care must be given to flood estimate for dam building workshops on the way of rivers which would prevent locomotive equipment loss and human wound. This study attempts to consider long term climate data and the future of weather condition in order to highlight the major role of weather and climate knowledge in construction operations.

Mohammed, Alshebania and Gayan Wedawatta. (2014) investigated by three interviewees in three different company roles with experience of working in hot weather conditions in the Middle East have been selected .The interviews conducted were exploratory, semi-structured interviews .Therefore, from the analysis the experience of managing projects in such extreme hot weather conditions plays a vital role in future planning and scheduling of site activities. Akanni, Oke and Akpomiemie (2014) focused on the concept of construction project development may be defects without a good philosophy and successful management of the effect of environmental factors determining the performance of such projects. This study intent was to assess the impact of environmental factors on building project performance in the Delta State, Nigeria. The method used for the data collection was structured questionnaire and the target people consisted of clients

(private and government developers) and four classes of professionals who were architects, builders, quantity surveyors and engineers. The tools engaged were Spearman correlation, Kendall's coefficient and Chi-Square. Factors that describes the impact on building project performance were twenty-nine variable and they were classified under the clusters of political, legal, construction specialized and resources, commercial and economic, socio-cultural and physical. The Spearman correlation result were analysis for the time and cost overruns with the determined factors affecting project performance revealed that the clusters of Economic and financial and Political had important relationship with time overrun on p-values of 0.004 and 0.011, respectively, while the cluster of communal and artistic had significant relationship with cost overrun with a p-value of 0.007. The research suggested that stakeholders should take knowledge of the variables under these three clusters for proper management and prevention of cost and time overruns.

Napier (2015) aimed to elaborate double skin façades and complicated the motorized shading systems repeatedly masking a lack of basic environmental philosophy. This article returns to the physics of comfort in buildings and the static strategies which can help achieve this with a low energy and carbon footprint. Passive and active façade design strategies are defined as the basis of a critical tool and a design methodology for new projects. A new architectural sensibility can start the modeling based on the inputs of sunlight, daylight and air temperature in time and space at the early stages of design. Early but sound strategies can be tested and refined using advanced environmental modeling techniques. Architecture and environmental thinking can proceed hand in hand through the design process.

Gary Martin and Patricia Ballamingie (2015) intended to inform discussions between industry and government policymakers in and beyond Ottawa, Canada about climate change and potential impacts on residential development regulations and corresponding industry practices. Ultimately, both private and public stakeholders must acknowledge the impacts of urban form on greenhouse gas (GHG) emissions, and, conversely, the impacts of climate change on cities, for any meaningful progress on urban sustainability to ensue. Section 1 introduces the basic relationships between urban development and climate change. Urban form is directly tied to energy consumption and GHG emissions, mainly through building and transportation energy consumption.

Nabil and Mahdi (2015) examined climatic change impact on construction project lifecycle. The climate changing is over time based on the highly confidence evidence thought the scientific. Now construction industry is facing the one of the challenging climate change factors. As no project is risk free and climate change, the construction project lifecycle is affected by the strong impact in different phases in the lifecycle. This research aimed at providing a platform of specialized for the construction management practitioners about the impacts of climate change on the construction projects lifecycle, determine the most dangerous climate change factors on the construction project lifecycle, and analyze the most affected phase by climate change factors through the construction projects lifecycle. The study depended on the opinions of civil engineers, project managers etc. who have worked in the construction projects in the Gaza Strip. Questionnaire tool was adopted as the main research methodology in order to conclude the desired objectives. The questionnaire included 127 factors in order to obtain responses from 88 construction practitioners out of 98 representing 89.79% response rate about the impact of climate change on the generic lifecycle of construction projects. The results infer the most compelling impact on the construction project lifecycle which is related to the extreme weather events of rainfall change, and temperature change respectively. There was a general agreement between the defendants and the most affected phase by temperature, rainfall, and extreme weather events is the execution phase. The results also asserted with a high return.

Yi Zhang,Keqin Yan, Tao Cheng, Quan Zhou,Liping Qin and Shan Wang (2016) examined simple wind load problem is used to investigate the influence of climate change to reliability analysis of high rise building. Several sampling methods are utilized to estimate the extreme wind speed. They are, Kernel Density Estimation; Bootstrap Resampling Method & Monte Carlo Simulation etc. The wind speed generally has a linear relation to the daily mean temperature. This can help us to do a rough approximation of the future wind speed by considering the climate change. .

Audrius Sabunas and Arvydas Kanapickas(2017) aimed at evaluate the influence that climate change is expected to have on the energy performance of a residential building in Kaunas, Lithuania, essentially due to changes in heating and cooling demand. Predict temperature data of IPCC (Intergovernmental Panel on Climate Change) typically concentrates pathways (RCP) 2.6 and RCP 8.5 are used for the periods of the 2020s (near subsequent) 2050s (middle subsequent) and 2080s (far subsequent), incorporated into hourly Energy Plus Weather data files and modeled by Home Energy Efficient Design (HEED) software to assess a difference in consumption. Climate averages of over 30 year period were evaluated. The results show that the overall energy consumption in smaller. The changes were noticed in all scenarios and periods, from a drop by 8.5 %–10.3 % in total consumption in the 2020s under RCP2.6 scenario to 26.7 %–29.6 % decrease in case of the 2080s RCP8.5 scenario (the decrease by 15 %–15.6 % was observed under RCP8.5 scenario). The sensational decrease is due to a decreased number of days when space heating is required, while a slightly increase of a cooling load in a modeled house still does not make it effective over a heating load.

Fanchao, Mingcai, Jingfu, Mingming, Xiaomei and Guoyu (2017) examined the effects of climate change on heating energy consumption of office buildings. A climate plays a virtual role in heating energy consumption due to the directly parallel in between the space heating and changes in climate conditions. To compute the impact, the Transient System Simulation Program software was used to affect the heating loads of office buildings in Harbin, Tianjin, and Shanghai, characterizing three major climate zones (i.e., severe cold, cold, and hot summer and cold winter climate zones) in China during 1961–2010. Stepwise multiple linear regression was implemented to determine the key climatic parameters impact on heating energy consumption. The results showed that dry bulb temperature (DBT) is the dominant climatic parameter influencing building heating loads in all three climate zones across China during the heating period at daily, monthly, and yearly scales ($R2 \geq 0.86$). Continuous warming climate comes in with the winter over the past

50 years, heating loads decreased by 14.2, 7.2, and 7.1 W/m2 in Harbin, Tianjin, and Shanghai, respectively; announce that the decreasing rate is more possible in severe cold climate zone, when the DBT increases by 1 °C, the heating loads decrease by 253.1 W/m2 in Harbin, 177.2 W/m2 in Tianjin, and 126.4 W/m2 in Shanghai. These results suggest that the heating energy consumption can be well anticipate by the regression models at particular temporal scales in different climate conditions due to the high determination coefficients. In extension, a greater decrease in heating energy consumption in northern severe cold and cold climate zones may efficiently improve the energy saving in these areas with high energy consumption for heating. Particularly, the likely future increase in temperatures should be treated in improving building energy efficiency **Methodology**

A purposive sampling technique was used to identify the participants and the professions that were selected for this study. Each of the profession had 4 participants; 37 architects, 37 builders, 37 civil engineers and 37 urban planners from ministry of urban development. Thus, a total number of one hundred and eight (n=108) participants were conducted. Thus, each of the profession has an equal 25% representation. All participants had more than ten (10) years experience, all were registered with their professional bodies and senior staff of ministry of urban development. Participants were contacted and appointments were scheduled for administration of the questionnaire. The data collected from the questionnaire distributed was analyzed using simple percentages and descriptive analytical tool such as tables in analyzing and presenting the result. The research questionnaires were designed with variables from the exploratory studies; this was supplied by the literature survey. The design obtained representative views of the respondents on the levels of importance or relative impact of climate change on built environment, each attribute being rated. Likert scales were provided on a rating continuum (1-5) to measure the varying degrees of respondents' opinions about the relative worth of the attributes in the subsets. Likert scale is used in measuring opinions, beliefs and attitudes.

DATA PRESENTATION AND DISCUSSION

The structured questionnaire was adopted as the primary data instrument and a total of One hundred and eight (108) respondents were targeted for inclusion in the study, however, as a result of various unexpected in contingencies, only Ninety Seven (97) questionnaire copies were successfully retrieved and utilized in the study which represents 89.8 percent while 11` which represents 10.2 percent were not retrieved. This reduction and shortage is attributed to the absence and failure of some of the respondents to complete their copies of the questionnaire. The data generated was categorized into sections based on the nature of the variable of interest. The sections include: the demographic data and the data on the variables of the study. Each data is analyzed accordingly with the results presented herein **Demographic Analyses**

The demographic section of this study presents the data on the distribution of the respondents according to characteristics such as gender. The data at this level is considered as discrete and thus analysis is based on the description of distribution according to frequencies and percentages.

Table 1 Gender of the respondents of the study

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	female	3	3.1	3.1	3.1
	Male	94	96.9	96.9	100.0
	Total	97	100.0	100.0	

Source: Survey result 2024

The results of the analysis (table 1) illustrates that for the gender distribution of the study, majority of the respondents who participated in the study are male with a relative low frequency for the female category.

Univariate Analyses

The univariate section is concerned with the presentation of the data for the variables of the study. The data presented below is continuous and so is assessed using the mean and standard deviation in the assessment of its central tendencies and dispersion. Given the positive statements adopted in the measurement of each variable and

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the scaling method which ranks from 1 = for strongly disagree to 5 = strongly agree, a mean score of $x > 2.5$ with a relative standard deviation of $s < 2.0$ is adopted as substantial evidence of support or agreement to the indicator.

Table 2: Descriptive Statistics

□									STD
i.	The built environment has been reconsidered in building due to climate change	97	4	3	1	55	34	4.15	1.20746
ii.	Climate parameters are considered in architectural design	97	8	16	6	28	39	3.76	1.29169
iii.	The effect of new design can only be contain by critically considering climatic factors	97	9	7	4	21	56	4.11	1.13476
iv.	Climate parameters are put into consideration when designing	97	18	11	10	15	43	3.55	.77765
v.	Climate parameters are considered when designing windows and other openings	97	7	9	3	46	32	3.89	.76424
vi.	Building design has changed over the past five decades due climate change	97	19	13	5	27	33	3.42	.89656
vii.	Roofing has changed over the past five decades	97	2	3	3	14	75	4.62	.82887
viii.	There has been a continuous evolution of new window designs over the past five decades	97	9	3	2	16	67	4.33	.82128
ix.	The change is as a result technological innovation	97	5	11	6	28	47	4.04	1.32469
x.	The change is aimed at containing environmental condition and climate change	97	13	8	9	33	34	3.69	1.14521
xi.	Building pattern in Enugu metropolis has changed over the past five decades due climate change	97	21	3	2	19	52	3.80	1.23610
xii.	Building regulators and policy maker ought to	97	5	7	4	32	49	4.16	1.01487

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consider climate change

Source: Survey result 2024

Results in Table 2 above present respondents view climate change and the effect on building the mean of > 2.50 in the items entered and the standard deviation < 2.00 justify that the respondents strongly agree on the direct relationship between climate change and building in Rivers State. Zubairu (2012) stated that the interface between a building's outdoor environment affected by climate change with its interior environment and the comfort required by its occupants is what makes it significant. As a result, when meeting the issues of climate change in recent days, professionals among different fields now pay more attention to the management and adjustment (Xuepeishan, 2016). Studies (UKCIP, 2005; Robert and Kummert, 2012) showed that the domination of building built environment, as well as, connecting the built environment climate surrounding and its activities. Thus, understanding the study of the impact of climate change on the environment would provide a general scenario on building and vice-versa.

CONCLUSION AND RECOMMENDATIONS

The relationship between Climate change and buildings built environment in Rivers State. Based on the responses, it was clear that the respondents are quite aware of the contributions of climate change to the observed changes in building designs and the built environment in Rivers State. The respondents agreed that these changes in the designs of buildings and the built environment manifest in the obvious changes in openings in these buildings such as in the designs of windows, roof designs, doors. Similarly, for the consideration of climatic parameters in building designs, all the respondents agreed that climate change affect building design and the built environment in Rivers State. This follows from the fact that in one way or the other, the persons involved in construction would make decisions regarding the positions of the building, positioning of openings such as windows and doors to ensure maximum illumination of the indoors of such buildings by sunshine during the day while trying to maintain maximum ventilation putting the effects of climate change into consideration. Finally, they believed that the climate parameters have caused deteriorations in buildings and reduction of the life span of these buildings.

Recommendations

i. Professional bodies should provide avenues for more information and knowledge on the areas of climate change, buildings and sustainability. Collaborations should be encouraged amongst built environment with specific agenda for the promotion of sustainable practices within the building industry in Rivers State and Nigeria at large.·

ii. Specific climatic checklist should be developed in order to address areas of regional peculiarities. The built environment professionals should serve as a pressure group to ensure government formulates policies which promotes sustainability and monitoring in face of climate change.

iii. Government should reward sustainable practice to climate change in the construction industry · Further research is necessary on how each of the professions within the built environment in Nigeria can promote sustainable practices with response to climate change.

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