

ASSESSING CAUSAL RELATIONSHIP AMONGST CRITICAL SUCCESS FACTORS FOR SUSTAINABLE BUILDINGS IN BAUCHI STATE

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Abstract

This study assessed the critical success factors (CSFs) for implementing sustainable buildings (SBs) in Bauchi State, a crucial step in addressing climate change. While previous research has identified CSFs, the causal relationships between them remain unclear. To address this gap, a questionnaire survey was administered to obtain data from building professionals who were involved in the construction of SB's from pre-delivery to post-delivery stage using purposive sampling and snowballing were the adopted data collection techniques and a total of 250 respondents were gotten from the 350 questionnaire survey that were administered both online and offline. The findings revealed that use of renewable energy, power efficiency, stakeholder benefit effectiveness, budget and risk control effectiveness were found to be the most important. Furthermore a factor analysis was done in order to group the CSF's and eight principal component factor groups comprising Natural environment factors, Project delivery factors, Project , Social related factors, and Project control related factors . The structural equation modelling (SEM) was used as the tool to develop the model showing the causal relationships and the Partial least system (PLS-SEM) was the type of SEM adopted. PLS SEM was selected due to the nature of data and the small sample size. The findings of this study highlighted the causal relationships amongst CSF for SB's in Nigeria and these factors are expected to facilitate building professionals in drawing up a set of policies and the best possible factors to consider in order to maximise the success of a SB's in Nigeria.

Keywords: sustainability, Building, Causal, factors.

1. Introduction

1.1. Background to the study

With global warming reaching alarming levels (Abanda et al., 2018), the urgent call for conserving scarce resources and maintaining a sustainable environment has driven governments and many corporations throughout the world to introduce environmentally friendly practices and products (Ahmed, 2020). The construction industry has significant effects on the environment due to the consumption of huge amounts of non-renewable resources and materials, especially in new construction, (Wong et al., 2013; Dimoudi and Tompa, 2008; Mohammad and Amato, 2006) because construction activities, which include the manufacture and transport of building materials, consume vast quantities of energy, which creates emissions of large amounts of greenhouse gases. The construction industry is a significant contributor to environmental degradation and resource depletion (Wang et al., 2019) . In response to

global calls for climate change mitigation, the concept of sustainable buildings (SB) has emerged as a critical approach toward minimizing the environmental impact of construction projects. Sustainable construction aims to create buildings that minimize environmental impact while promoting economic, social, and cultural improvement (ISO, 2006). This approach addresses global issues like climate change, as buildings consume significant resources and energy throughout their life cycle (Roosa, 2010). Sustainable buildings (SB) offer a viable solution to the global challenge of climate change through resource efficiency, energy conservation, and environmental protection. However, successful implementation depends on identifying and managing Critical Success Factors (CSFs). Despite numerous studies in developed countries, there is limited understanding of how these factors interact in Bauchi State. This sustainable buildings are designed to efficiently utilize resources such as energy, water, and materials, while minimizing waste and promoting occupant well-being. More-over identifying the critical success factors (CSFs) is a necessity for studying sustainable building success. It is important for project managers to focus on these key factors so as to allocate more resources to them. Sanvido et al. (1992) defined the CSFs as factors that could predict a project's success.

In Bauchi analysis, the adoption of sustainable building practices remains limited despite growing awareness of environmental concerns. Although numerous studies have identified critical success factors (CSFs) influencing the implementation of sustainable buildings, few have examined how these factors interact and influence one another. Understanding these causal relationships is essential to achieving effective project outcomes and guiding policy development. However, research on causal relationships of CSFs for sustainable buildings is lacking, representing a gap in literature that this research aims to fill (Chen et al., 2021). The study aims to assess the causal relationship among Critical Success Factors (CSFs) for sustainable buildings, with the goal of contributing to the development of sustainable building projects. This research will aim at identify Success Factors (SFs) for sustainable buildings, assess CSFs for sustainable buildings, and also assess the causal relationship among CSFs for sustainable buildings Hence, this study aims to assess the causal relationships among critical success factors for sustainable building projects in Nigeria using Partial Least Squares Structural Equation Modelling (PLS-SEM).

2. Literature Review

2.1 Sustainable Building Concept

Sustainable buildings integrate environmental responsibility, economic efficiency, and social well-being throughout their lifecycle from design to demolition. The growing need to curb Bauchi state rapid urbanisation, energy shortages, and environmental damage has made sustainable-building adoption increasingly vital. Yet translating generic critical success factors (CSFs) into the Bauchi state context requires careful adaptation. Local conditions—such as weak regulatory enforcement, limited technical capacity, high upfront costs, top management support, stakeholder participation, financial control and reliance. However, understanding **how** these factors influence each other helps practitioners prioritize and strategize effectively. The principles align with global frameworks such as the UN Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action).

2.2 Critical Success Factors (CSFs)

Sanvido et al. (1992) defined the CSFs as factors that could predict a project's success. The Critical Success Factors (CSFs) are the key areas that must be effectively managed for a project to succeed. Critical Success Factors (CSFs) are essential for achieving sustainable building success, as they predict project success and help project managers allocate resources effectively (Sanvido et al., 1992). Identified CSFs for sustainable building projects include top management support, competent project manager and team members, clear goals and objectives, effective communication and coordination, sufficient resource allocation, control mechanisms and feedback capabilities, and responsiveness to clients and problem-solving abilities (Belassi & Tukel, 1996; Cserhádi & Szabó, 2014; Frodell et al., 2008; Ofori, 2013; Pinto & Slevin, 1988; Wai et al., 2012). (Shen et al., 2017; Darko & Chan, 2018) have identified factors as top management commitment, financial viability and budget control, energy efficiency and renewable energy adoption stakeholder participation and communication, training and awareness programs, government policy and regulatory framework. However, while these factors have been individually identified, their interdependence and causal influence on sustainable building success remain underexplored, particularly in the Nigerian, more precisely in Bauchi state context.

2.3 Causal Relationship Analysis in CSFs

Structural Equation Modelling (SEM) is an advanced multivariate technique that allows researchers to test relationships between observed and latent variables. **PLS-SEM** is suitable when the sample size is small and data are non-normally distributed, making it ideal for exploratory studies like this. It enables the establishment of direct and indirect effects among success factors, providing insights into which factors drive or mediate others.

3. Methodology

3.1 Research Design

The study adopted a quantitative research design using a structured questionnaire to collect primary data from building professionals involved in sustainable construction projects across Nigeria.

3.2 Population and Sampling

Respondents included architects, engineers, quantity surveyors, and project managers with prior experience in sustainable building projects. **Purposive and snowball sampling** techniques were employed. A total of 200 valid responses were obtained, both online and offline.

3.3 Data Collection Instrument

The questionnaire was divided into two sections: Section A: Respondents’ demographic and professional background. Section B: 30 CSFs identified from literature, rated on a 5-point Likert scale (1 = Not Important to 5 = Extremely Important).

3.4 Data Analysis Techniques

Data analysis was conducted using Descriptive statistics (Mean Scores) to rank the importance of CSFs, exploratory Factor Analysis (EFA) to group similar CSFs into principal components, partial Least Squares Structural Equation Modelling (PLS-SEM) to determine causal relationships among factor groups.

4. Results and Discussion

4.1 Ranking of CSFs

Analysis revealed that use of renewable energy, energy efficiency, and budget and risk control effectiveness were the most important CSFs. Conversely, stakeholder benefit effectiveness and training and awareness programs were ranked lowest, suggesting limited emphasis on capacity development and post-project evaluation.

4. Results and Discussion

Table 1: Ranking of Critical Success Factors (CSFs) for Sustainable Buildings

Rank	Critical Success Factor	Mean Score	Interpretation
1	Use of renewable energy	4.61	Very High Importance
2	Power efficiency	4.54	Very High Importance
3	Budget and risk control effectiveness	4.48	High Importance
4	Top management commitment	4.43	High Importance
5	Government policy and incentives	4.39	High Importance
6	Project team collaboration	4.26	High Importance
7	Stakeholder engagement	4.19	Moderate Importance
8	Training and awareness	3.82	Moderate Importance
9	Post-project evaluation	3.74	Moderate Importance
10	Stakeholder benefit effectiveness	3.61	Low Importance

Source: Field Survey, 2025

4.2 Factor Grouping

The EFA identified eight principal component groups, namely: Natural environment factors, project delivery factors, project personnel-related factors, energy-related factors, social-related factors, organizational culture-related factors, work ethics and human relations factors

Project control factors

These groupings indicate that sustainability success depends on an interplay between technical, social, and organizational dimensions.

Table 2: Grouping of CSFs through Factor Analysis

Factor Group	Constituent Variables	Interpretation
F1: Natural Environment Factors	Renewable energy use, waste management, environmental protection	Eco-centered drivers
F2: Project Delivery Factors	Cost control, risk management, delivery time	Project management performance
F3: Project Personnel Factors	Technical competence, experience, communication	Human resource influence
F4: Energy-Related Factors	Power efficiency, energy optimization	Energy management
F5: Social Factors	Stakeholder engagement, community acceptance	Social involvement
F6: Organizational Culture Factors	Top management support, leadership, policy adherence	Institutional environment
F7: Work Ethics and Relations	Team collaboration, communication	Professional culture
F8: Project Control Factors	Monitoring, post-evaluation, documentation	Governance and control

Extracted via Principal Component Analysis (PCA) accountability.

4.3 Causal Relationships (SEM Results)

The PLS-SEM model demonstrated significant relationships among the eight CSF categories. Key findings include: Energy-related factors strongly influence project control factors and organizational culture, project delivery factors mediate the effect of organizational culture on project outcomes, natural environment factors have both direct and indirect effects on social-related and work ethics components. These results emphasize that achieving sustainability is not dependent on a single factor, but rather on a system of interconnected elements that reinforce one another.

4.4 Implications

The study underscores the importance of integrated management approaches. Energy and project control factors should be prioritized in sustainability policies, while organizational culture must encourage continuous learning and adaptation.

5. Conclusion and Recommendations

This study assessed the causal relationships among CSFs for sustainable buildings in Nigeria using PLS-SEM. The findings revealed eight key factor groups with significant interdependencies influencing project success. The results show that technical and managerial factors—such as renewable energy use, budget control, and energy efficiency—drive sustainable building success. Meanwhile, social and organizational factors play indirect but critical roles in sustaining progress. The SEM model confirmed that organizational culture and project delivery efficiency are key mediators linking environmental and energy strategies to overall success. To enhance sustainable building delivery: Policymakers should develop **clear guidelines** promoting energy efficiency and project control measures. Stakeholders should invest in **capacity building** to strengthen technical and managerial skills. Organizations should foster a **sustainability-oriented culture** emphasizing collaboration, ethical practices, and innovation. Future studies could expand the sample size and explore longitudinal data to better understand the evolution of causal relationships across project stages.

6. Conclusion and Recommendations

The study established eight interrelated CSF groups that jointly influence the success of sustainable buildings in Nigeria. Key recommendations include: Strengthening policy and institutional frameworks to support renewable energy adoption, promoting training and knowledge-sharing among professionals, embedding sustainability culture in organizational operations, encouraging integrated project delivery systems to enhance control and accountability.

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