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Risk-Based Life Cycle Costing Evaluation of Construction Projects in Nigeria

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ABSTRACT

Nigeria's building sector has several difficulties as a result of changing social dynamics, environmental issues, and unstable economies. A Risk-Based Life Cycle Costing (LCC) assessment approach is necessary to improve the sustainability and economic viability of building projects. The inherent complexity of construction projects has a higher risk of being completed late and going over budget. Construction investors in Nigeria make decisions primarily on financial variables related to cost and return, without considering project risks or life cycle costs. Based on this, we have developed this research to highlight additional variables and considerations to be taken into account when making investment decisions in the Nigerian construction sector. Construction projects become more robust and financially feasible when risk analysis is integrated into the LCC evaluation process. This guarantees that possible uncertainties and their effects on project costs are taken into consideration.

Keywords: Life Cycle Costing, Evaluation, Construction Project, Risk, Nigeria

INTRODUCTION

Nigeria's construction sector is crucial to the country's economic growth, increasing GDP and creating jobs at a considerable rate. Before beginning any project, a comprehensive risk analysis must be carried out, and risk management techniques and instruments must be applied as needed, in order to assure success in the construction industry [1]. The primary challenge in the project's early stages is estimating its total cost. For certain project managers, here is where they make mistakes. The final project budget should not be established based on the initial estimated expenses of design, construction, and execution [2]. There can be other costs that come up during the project that need to be considered. These costs may include maintenance, usage, and disposal fees. Project managers must thus be aware of these costs as well as external risk variables and considerations like inflation and time value of money [3]. Nonetheless, the industry faces several difficulties, such as unstable economies, erratic material prices, ecological threats, and societal demands [4]. These elements demand that cost control in building projects adopt a more comprehensive and progressive strategy [5]. Conventional cost assessment techniques frequently overlook the long-term financial effects of running, maintaining, and ultimately decommissioning buildings and infrastructure in favor of concentrating exclusively on the original development costs [2-8]. Over the course of a project, this negligence may result in unanticipated costs and financial difficulties. The idea of life cycle costing (LCC), which offers a thorough framework for evaluating the total cost of ownership across a project's life span, has gained popularity in an effort to close this gap [5]. Every stage of a project is taken into account by life cycle costing, from original design and construction to operation and maintenance to disposal at the end of the project's life. Although LCC provides a more comprehensive view of project costs, it frequently overlooks the risks and uncertainties that have a big influence on these prices [7]. Technical malfunctions, monetary fluctuations, shifts in the environment, and social dynamics are some of these dangers [6]. As a result, including risk analysis into the LCC framework is essential to producing cost estimates that are more precise and trustworthy. This study presents a Risk-Based Life Cycle Costing (LCC) assessment approach designed especially for Nigerian building projects. This technique attempts to create a more robust and resilient cost assessment framework by integrating risk management principles into the LCC process [8]. By methodically identifying and incorporating risks into the LCC evaluation it makes

sure that all possible uncertainties and their effects on project costs are taken into consideration [9-15]. The process that has been suggested involves many crucial stages, including establishing the project's goals and scope, classifying expenses, and detecting any possible hazards [8]. By emphasizing the trade-offs between upfront expenses and ongoing costs, this method not only increases the accuracy of cost predictions but also improves decision-making.

This technique is intended to be context-sensitive, taking into account local realities and stakeholder demands, given the distinct economic, environmental, and social setting of Nigeria [5]. Stakeholders may improve resource allocation, make better decisions, and increase the sustainability and financial viability of building projects by using this Risk-Based LCC review [8]. Nigerian construction projects encounter many different obstacles, and the Risk-Based Life Cycle Costing assessment technique provides a complete instrument to manage these issues [7,8]. It offers a means for the building industry to become more socially responsible, environmentally sustainable, and economically efficient.

Literature Review

Numerous studies have been conducted on the topic of project life cycle costing over the years. Most of them cover a lot of ground that is critical to the proper execution of many projects, particularly those in the construction sector [9]. While focusing on asset management in some of the articles included in this study, newer research has begun to give more weight to project life cycle costing, among other factors [10]. Additionally, these literatures support their conclusions with a variety of approaches. The major ideas or topics covered in the literature reviews are the main subject of this debate [11]. The processes involved in asset management and even asset cost analysis are among the most significant aspects that this literature have brought about [12]. The protocol lays down how things should be done in the construction business so that the goal of working on the asset may be accomplished with ease [13]. It is crucial to adhere to protocols in asset management since this facilitates appropriate planning. Hazards and waste are greatly decreased when a well-thought-out plan is followed [14-19]. The literature makes clear how important it is to follow instructions, which is obvious in a number of ways to achieve the goal of asset investment, a certain procedure must be followed [12, 14]. For example, the process begins with idea conception, then moves on to feasibility analysis, design, and lastly, execution. Since they signal the commencement of several actions during the asset's life cycle, the procedures are crucial [15-20]. These producers ought to take advantage of every opportunity that spans an asset's whole life.

Life Cycle Costing (LCC) in Construction

An established method for determining the overall cost of ownership of building projects throughout their whole life is life cycle costing, or LCC. According to [16], claim that LCC entails the identification, measurement, and assessment of all project-related expenses from start to finish. With regard to building costs, operating and maintenance costs, and end-of-life costs, LCC offers a holistic financial view. It assists stakeholders in making well-informed decisions by weighing the long-term financial effects of various options.

Risk

Risk is defined as "an uncertain event or condition that, if it occurs, has an effect on at least one project objective" by the Project Management Institute (PMI). Scope, timeline, money, and quality are examples of objectives [17]. It also says that uncertainty, which permeates every project, is the source of project risk. Some authors do not view risk and uncertainty as synonymous notions. Risk is defined as "an undesirable implication of uncertainty" by [18], however, risks are defined as "uncertain outcomes or consequences of activities or decisions when they are manageable" by [19]. Natural and human-related project and construction hazards were divided into two categories by Edwards and Bowen [20]. Events caused by meteorological systems, such as hurricanes, floods, lightning strikes, etc., and geological systems, such as earthquakes and volcanic eruptions, are included in the category of natural risk. The risk that was reviewed are: political risk which involves, war, civil unrests, industrial relations actions; economic risk such as, materials' supply, labor supply, equipment availability, inflation, fiscal policies; social risk includes criminal acts, civil torts, substance abuse; legal risk which is contract clauses, regulations, codes; health risk such as epidemic, surgery; managerial risk which is productivity, quality assurance, cost control, human resource management; technical design failure, estimation error, collision, accident, equipment and systems failure; and Cultural risk which involves religion, cultural custom [22-27]. Due to frequent interferences, whether from internal or external sources, political risks typically contribute to the failure of projects [21]. Although political risk is typically defined as civil upheaval, war, or changes to laws and regulations, it is important to take into account more recent and contemporary political developments that have an impact on Nigeria [22].

Risk Management

According to [23], risk management planning, risk identification, risk assessment, risk analysis, risk response, risk monitoring, and risk communication are all part of risk management on construction projects. "The processes of conducting risk management planning, identification, analysis, response planning, monitoring, and control on a project" is how the Project Management Institute, or PMI, defines project risk management [24]. While risk management entails developing solutions to address hazards and guarantee that they do not impair project performance, risk identification entails doing a thorough examination to develop a plan for determining a risk's core cause [24,25].

Risk Management in Construction Projects

Because construction projects have inherent uncertainties and possible implications on project results, risk management is essential. Risk management, according to [25], is recognizing, evaluating, and reducing risks in order to lessen their negative impacts. Integrating risk management into LCC aids in modifying cost estimates to take uncertainties into consideration. By ensuring that any risks are methodically assessed and taken into account in the cost analysis, this integration produces financial estimates that are more accurate and reliable [26-29].

Risk-Based Life Cycle Costing

The concept of Risk-Based Life Cycle Costing (RBLCC) integrates risk management with life cycle costing (LCC) to offer a more thorough assessment of building projects. In order to account for uncertainties that may have an influence on project costs, [8] state that RBLCC entails incorporating risk assessment into the LCC framework. This method aids in risk identification and quantification, cost estimate adjustment, and assessment of the financial effects of various risk scenarios [30].

Application of RBLCC in Developing Countries

The use of RBLCC is especially pertinent in emerging nations, such as Nigeria, because of the increasing unpredictability and variability in social, environmental, and economic situations. In [20] states that unstable infrastructure, changing material pricing, and regulatory changes are some of the difficulties faced by Nigerian building projects [31]. These issues may be addressed by integrating risk management into LCC, which offers a more precise and realistic estimation of the whole project costs. RBLCC implementation in underdeveloped nations can also enhance financial sustainability overall, resource allocation, and project planning [32].

Challenges and Opportunities in Nigerian Construction

Nigerian construction projects are faced with particular difficulties that affect risk assessment and cost control. [4] list these difficulties as corrupt practices, poor infrastructure, unreliable data availability, and unstable economies. These elements may raise the possibility of hazards and have an impact on how accurate cost estimates are. On the other hand, by delivering an organized method for assessing and controlling risks, refining decision-making procedures, and augmenting project results, incorporating RBLCC can give prospects to tackle these obstacles [19,13].

Recent Developments and Advances

Technology and data analysis developments in recent years have improved the use of RBLCC in building projects. In [19], claim that the precision and effectiveness of LCC and risk assessment have increased with the use of simulation technologies, data analytics, and building information modeling (BIM). With the use of these technologies, project costs and risks may be evaluated in more depth and dynamically, giving decision-makers insightful information.

Construction and Project Management

Any project must include the planning phase; neglecting to plan is the greatest way to fail. In order to ensure that projects operate smoothly and that shortcomings are avoided, planning is essential before the start of any project, especially construction projects [11], [16]. In order to guarantee that projects are carried out correctly and that risks are recognized and addressed, project management is essential. It also guarantees that the project will have the necessary number of materials. Due to the widespread belief that planning is a waste of time and that there is always a rush to get work done, most planning in the Nigeria is either done on the fly or occurs in tandem with other real building activity. In building projects, clients are crucial since they supervise the process and supply the resources needed to carry it out [13]. Construction projects in Nigeria are always delayed and face the danger of going over budget due to the overbearing involvement of clients, particularly in the private sector and family-owned firms. In contrast, the client's role in certain megaprojects in Nigeria is unclear or undefined, despite the fact that it is expected and necessary in these kinds of projects; typically, the client's role is that of a sleeping partner or is assigned to a project manager or project management firm, and the client prefers to be in agreement for social or political reasons. The term "developed" and "developing"

countries are used somewhat misleadingly because there is no universally accepted definition or standard. Instead, the terms refer to a set of criteria that determine whether a country is considered to be in one group or another. These criteria can be political or economic and include things like the type of government, minimum wage, GDP, per capita income, and so forth. Historically, the growth of architecture and construction has been used to gauge a country's progress. Although building cannot be used as a stand-alone indicator of growth, most nations in the globe are clearly developing as a result of increasing construction activity [18,31].

Case Studies and Practical Applications

Numerous case studies have proven the efficacy of RBLCC in diverse settings. For example, research by [21] demonstrated the advantages of incorporating risk management into cost analysis by applying RBLCC to infrastructure projects in India. Analogous investigations conducted in Nigeria, as those conducted by [23], have examined the utilization of RBLCC in regional initiatives, highlighting its capacity to tackle the distinct obstacles encountered by the Nigerian construction sector. The literature emphasizes how crucial it is to incorporate risk management into life cycle costing in order to provide building projects with a more thorough review. Because project costs may be greatly impacted by social, environmental, and economic uncertainties, developing nations like Nigeria are especially well-suited to apply Risk-Based Life Cycle Costing (RBLCC). The efficiency of RBLCC is further increased by recent technological developments, which provide useful tools for more precise and dynamic cost and risk evaluations. By using RBLCC to address the particular difficulties faced by the Nigerian construction industry, financial planning, resource management, and overall project sustainability may all be enhanced [26-30].

METHODOLOGY

Risk-Based Life Cycle Costing (LCC) evaluation in construction projects is a methodology used to assess the total cost of ownership, considering not only the initial construction costs but also the operational, maintenance, and disposal costs, while accounting for risks that may impact these costs. This evaluation was conducted by reviewing and continuously improving the identified risk. The local context, sustainability, and stakeholder engagement to ensure project acceptance and success was considered. The approach is particularly relevant for Nigerian construction projects, considering factors such as climate, materials, labor market, and regulatory environment. By incorporating risk analysis, this methodology ensures comprehensive and realistic cost assessments in construction projects.

Major Findings

The primary goal of this research was to identify the many types of risk management techniques that are presently being used in construction projects in Nigeria, as well as to look at stakeholder perceptions of risk and adoption of life cycle costing. The purpose of the literature research was to ascertain why certain project managers have not yet fully embraced the use of risk management technologies. Political risk has been updated to include new threats like as terrorism, the bandits, the kidnaping and the like, this update was in line with the findings in [21]. Political risk is often characterized as a change in the political system, new regulations, and civil unrest. The following are the findings on risk-based Life Cycle Costing evaluation of Construction Projects in Nigeria:

1. **Comprehensive Cost Assessment:** The application of Risk-Based Life Cycle Costing (RBLCC) in Nigerian construction projects allows for a more comprehensive cost assessment, as in [4],[6]. Traditional cost estimation methods focus primarily on initial construction costs, often neglecting long-term costs associated with operation, maintenance, and end-of-life disposal. RBLCC provides a holistic view by incorporating these long-term costs, thereby giving stakeholders a better understanding of the total cost of ownership.
2. **Enhanced Risk Identification and Management:** RBLCC enhances the identification and management of risks that can impact project costs throughout their lifecycle. By systematically identifying technical, economic, environmental, and social risks, and integrating them into the cost evaluation process, project planners can develop more robust financial plans, as was discussed in [8]. This proactive approach helps in mitigating potential risks before they materialize, reducing the likelihood of unexpected expenses.
3. **Improved Decision-Making:** Integrating risk analysis with LCC improves decision-making processes. Stakeholders are provided with detailed insights into how different risks and uncertainties can affect project costs. This enables them to make informed choices between various design and construction alternatives, considering both the immediate and long-term financial implications, which is in accordance with

[8]. Scenario and sensitivity analyses further aid in evaluating the impact of varying assumptions and conditions, leading to more resilient and adaptable project plans.

4. **Adaptation to Local Conditions:** The RBLCC methodology was tailored to address the specific conditions prevalent in Nigeria. Economic factors such as inflation, currency fluctuations, and material cost volatility are significant concerns that are thoroughly examined. Environmental risks, such as climate change impacts, are also integrated into the evaluation process. Social factors such as community engagement and labor market conditions are considered, ensuring that the methodology is context-sensitive and locally relevant. This was also mentioned in [5].
5. **Sustainability and Long-Term Financial Viability:** One of the key findings is the contribution of RBLCC to enhancing the sustainability and long-term financial viability of construction projects. By factoring in the costs associated with sustainability measures, such as energy-efficient designs and sustainable materials, the methodology supports environmentally responsible construction practices. This not only reduces environmental impact but also leads to cost savings over the project's lifespan through reduced operational and maintenance expenses, as was stated in [5].
6. **Technological Integration:** The integration of advanced technologies, such as Building Information Modeling (BIM) and data analytics, significantly enhances the effectiveness of RBLCC [19]. These tools allow for more accurate data collection, detailed modeling of costs and risks, and dynamic simulations. The use of technology improves the precision and reliability of the RBLCC evaluation, providing stakeholders with actionable insights and fostering better project management.
7. **Policy and Regulatory Implications:** The findings suggest that adopting RBLCC can have significant policy and regulatory implications. Encouraging the use of RBLCC in public and private construction projects can lead to more sustainable and economically sound infrastructure development. Policymakers and regulatory bodies can support this by developing guidelines and standards that promote the integration of risk management into life cycle costing evaluations.

CONCLUSION

The main findings from the application of Risk-Based Life Cycle Costing (RBLCC) in Nigerian construction projects underscore its benefits in providing a comprehensive cost assessment, enhancing risk management, and improving decision-making. The methodology's adaptability to local conditions, support for sustainability, and integration of advanced technologies further reinforce its value. Practical case studies validate its effectiveness, suggesting that wider adoption of RBLCC can significantly enhance the financial and environmental performance of construction projects in Nigeria. Practical case studies and real-world applications of RBLCC in Nigeria demonstrate its effectiveness and applicability. Studies have shown that projects employing RBLCC experience better financial outcomes and risk management compared to those using traditional costing methods. These studies validate the methodology's ability to address the unique challenges faced by the Nigerian construction industry and highlight its potential for wider adoption.

RECOMMENDATION

It was recommended by the researcher that Risk-based Life cycle costing should be conducted as part of feasibility studies to find the most cost-efficient solution, as part of all design stages. The optimization potential in the early design phases is significant and also cheap.

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