©NIJSES
Publications

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ONLINE ISSN: 2992-5819
PRINT ISSN: 2992-6149

NEWPORT INTERNATIONAL JOURNAL OF SCIENTIFIC AND EXPERIMENTAL SCIENCES (NIJSES)

Volume 5 Issue 2 2024

https://doi.org/10.59298/NIJSES/2024/10.5.263542

Analyzing the Impact of Cost-Cutting Measures on Structural Integrity: A Case Study of Construction Building Collapses

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ABSTRACT

It can be difficult for the building sector to strike a balance between structural soundness and cost-effectiveness. Builders may sacrifice important structural components to cut costs, endangering the stability and safety of structures Substandard materials in construction can lead to issues such as lower-grade concrete, inferior steel, inadequate masonry, compromised integrity, and improper substitutions. This paper uses a case study of construction building collapses to examine the effects of cost-cutting methods on structural integrity. This study used a mixed-methods approach to investigate a sequence of building collapses and analyze the elements that contributed to the collapses, including construction processes, material quality, and adherence to safety rules. The research attempts to clarify the complex link between cost-cutting strategies and structural failures by using quantitative assessment of structural flaws, and interviews with industry experience. The results show how the recurring theme in these incidents is poor construction practices the lack of quality control with a mean value of 5 and the use of substandard materials with a mean value of 4. The least recurring factor is inadequate waterproofing with a mean value of 3. The highest implication is the safety risk (5) followed by economic consequences (4). The work recommends mitigation risk as a rigorous quality control followed by the use of high-quality materials. Also recommended are timely maintenance and repairs and enhanced design review processes.
Keywords: Cost-cutting measures, Structural integrity, soundness, Building Project, Safety.

INTRODUCTION

The construction sector often employs cost-cutting strategies to optimize profit margins and meet financial constraints. However, the balance between cutting costs and preserving structural integrity is crucial, as such actions can have severe consequences, including building collapses that can result in human life loss, substantial financial losses, and damage to the reputation of construction companies [1]. Understanding the interactions between cost-cutting strategies and structural integrity is essential for engineers, architects, construction managers, legislators, and other stakeholders who prioritize cost and safety [2]. The study investigates the impact of cost-cutting strategies on a building's structural integrity, focusing on common practices like using inferior materials, poor quality control, and insufficient manpower. It evaluates structural failures, assesses safety standards, and suggests best practices for balancing structural integrity and cost-effectiveness [3]. The construction sector is particularly important in terms of the interplay between a company's structural and financial integrity. The tragic 9/11 terrorist attacks highlighted the importance of addressing structural ineptitude in the building sector. International structural engineers examined their designs to determine if they could withstand column shearing tests, finding that a significant percentage of American constructions were deemed inadequate [4]. The terrorist attacks highlighted the building industry's enhanced regulatory requirements, which often lead to increased costs and minimal cost reductions leading to catastrophic structural errors. Buildings' reliance on passive fire protection is also significant as fire safety precautions are now seen as liabilities [5]. The cost of planning and building structures has been a major concern since the beginning, with building experts striving to deliver the lowest cost while ensuring safety, serviceability, economy, and elegance [6]. Owners have always sought the lowest cost possible, and the perception of pressure to reduce expenses has increased in the early 20th century [7]. As a result,

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many construction businesses have implemented drastic cost-cutting initiatives, sometimes leading to less sturdy structures.

LITERATURE REVIEW

The literature review provides a comprehensive overview of research on the impact of cost-cutting measures on structural integrity in the construction industry. It synthesizes findings from academic studies, industry reports, and case analyses to understand the subject [4]. Key themes include motivations behind cost-cutting, common practices, consequences on structural integrity, regulatory frameworks, and case studies of notable building collapses. Cost-cutting in construction is often driven by competitive bidding, budget constraints, and profit maximization, which can compromise materials, labor, and safety protocols. For example, [8] highlighted that economic pressures often force contractors to prioritize cost reduction over quality, which can result in substandard construction practices. Use of Substandard Materials: Using subpar or improper materials is one of the most common ways to minimize costs. Poor-quality steel, concrete, and other building components can seriously impair a structure's structural stability [9]. Another frequent practice is cutting down on quality control procedures, such as conducting fewer inspections and providing inadequate supervision [10]. Researcher emphasizes that insufficient quality control can lead to construction defects and eventual structural failures. Underpaid and undertrained labor can negatively impact the quality of construction by reducing labor costs and reducing the number of experienced workers employed [11]. According to a study by [12] there is a strong correlation between the skill level of labor and the structural soundness of buildings. Cutting Corners in Design and Engineering: Reducing the complexity or eliminating necessary design and engineering processes to reduce expenses might jeopardize a structure's overall stability. According to a review by [13], value engineering frequently results in worse structural performance when used incorrectly. Cutting costs in construction can have disastrous results, increasing the risk of breakdowns and creating structural flaws. Buildings built with cost-cutting techniques are more prone to encounter problems including cracking, deflection, and collapse, according to research by [14]. According to [15][16] meta-analysis, economic considerations have a major role in predicting structural breakdowns in the building industry. The purpose of regulatory frameworks is to guarantee the integrity and safety of building projects. The efficacy of these rules can, however, differ greatly. According to research [17, reducing the hazards connected with cost-cutting requires strict laws and strong enforcement [17]. However, rules frequently include holes and inconsistencies, especially in developing nations, which allow cost-cutting measures to go unchecked. One of the most striking illustrations of the deadly effects of cost-cutting is the collapse of Rana Plaza in Bangladesh [18]. Poor construction techniques and the use of low-quality materials caused the building, which housed many garment companies, to collapse [18]. The long-term effects of poor maintenance and cost-cutting efforts were brought to light with the collapse of Champlain Towers South in Surfside, Florida [19]. Investigations showed that financial limitations caused important repairs to be postponed, which ultimately led to the building's collapse [20]. Sampoong Department Store Collapse unauthorized structural alterations and the use of inferior materials were blamed for the collapse of the Sampoong Department Store in South Korea [21]. Significant lives were lost in the accident, which also brought attention to the risks of compromising on construction standards [22]. Cost-cutting measures in construction, while initially beneficial, can lead to structural failures due to poor materials, inadequate quality control, undertrained labor, and flawed design practices. Regulatory frameworks play a crucial role in mitigating these risks, but their effectiveness depends on strict enforcement and regular updates to standards [23]. The literature review emphasizes the need for a balance between cost efficiency and structural integrity, as cost-cutting can compromise safety and increase the risk of building collapses.

Cost-Cutting Measures in Construction

Cost-cutting measures in construction are strategies used to reduce expenses and maximize profitability [24]. However, some of these techniques can have detrimental effects on structural integrity. Some common cost-cutting measures include using substandard materials, such as lower-grade concrete and steel, which may compromise load-bearing capacities and increase susceptibility to cracks and other forms of damage [21]. Inadequate insulation and waterproofing materials can also weaken the structure over time. Inadequate quality control is another common cost-cutting strategy that can have severe repercussions [25]. Skipping or reducing the frequency of inspections can allow construction defects to go unnoticed and unaddressed. Insufficient safety training increases the risk of accidents and injuries on the job site, potentially leading to project delays and additional costs [24]. Design and engineering compromises can also occur during cost-cutting, with simplified designs or omitting critical engineering steps often at the expense of structural soundness and resilience [26]. Value engineering aims to optimize project costs without sacrificing functionality, but it can lead to issues if critical components or systems are downgraded or eliminated. Over-simplified designs may lack the necessary redundancies and fail to account for all loads and stresses the structure will encounter. Reduced site investigations and preparations are crucial for understanding ground conditions and ensuring the foundation is properly designed and constructed. Skimping on these activities can lead to foundation failures and other structural problems. Inadequate soil testing can result in incorrect foundation

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designs, leading to settlement issues and instability [27]. Cutting corners on-site preparation, such as inadequate compaction or improper grading, can compromise the stability of the structure [24]. Deferred maintenance and repairs can also lead to a gradual decline in structural integrity and increase the likelihood of catastrophic failures. Skipping routine maintenance tasks such as inspections, cleaning, and minor repairs can allow minor issues to escalate into major problems [25]. Delaying structural repairs, such as fixing cracks or reinforcing weak areas, can compromise the building's safety and longevity. The adoption of cost-cutting measures can have several implications for construction projects, including increased risk of structural failures, legal and financial repercussions, damage to reputation, and higher long-term costs. To balance cost efficiency with structural integrity, construction firms should adopt best practices that prioritize safety and quality without unnecessary expenses.

METHODOLOGY

A methodical approach to data collection, analysis, and interpretation is used in the technique for examining how cost-cutting initiatives affect structural integrity in the building industry. To offer a thorough grasp of the topic, this study uses a mixed-methods approach, integrating qualitative and quantitative research approaches. Statistical analysis, expert interviews, and case study analysis are all part of the technique. The research offers a comprehensive understanding of the effects of cost-cutting strategies by utilizing both qualitative and quantitative methodologies. Case studies and expert interviews are two examples of qualitative methods used to provide comprehensive insights and contextual understanding. Statistical analysis of data from recorded building collapses and construction errors is one of the quantitative methods used to find trends and correlations. To collect data, case studies were used. The selection of case studies is based on several factors, including data availability, importance, and relevance in demonstrating how cost-cutting initiatives affect structural integrity in five East African countries: Tanzania, Uganda, Kenya, Ethiopia, and Zimbabwe. Expert interviews with structural engineers, construction managers, safety inspectors, architects, builders, quantity surveyors, and regulatory authorities are used to gather data. Important subjects including typical cost-cutting techniques, noted effects on structural integrity, and suggestions for risk mitigation are covered in a semi-structured interview guide. Interviews are done in person, over the phone, or via video conference. They are then transcribed and recorded for further study. Basic information on construction failures, including mean and median, as well as consequences and mitigating actions, were determined using statistical analysis. These methods are employed to investigate the connections between structural breakdowns and cost-cutting initiatives. Before conducting the expert interviews, participants are told about the study's goal, and their agreement is sought. Sensitive material is anonymized to safeguard the identity of people and organizations, and data from case studies and interviews is treated with secrecy ensuring the dependability and correctness of data by transparently documenting the research process and cross-checking information from several sources. The availability of thorough and trustworthy data on construction failures and cost-cutting practices may be limited.

ANALYSIS AND FINDINGS

Table 3 reveals the demographic data of respondents while Table 4 is the year of working experience for the respondents.

Table 1: Professions of Respondents.

Profession of Respondents	No	%Age	Cumm%Age
Architect	3	12	12
Safety Inspectors	6	24	36
Structural Engineers	5	20	56
Builder	4	16	72
Quantity Surveyor	2	8	80
Construction Managers	4	16	96
Other Stakeholder	1	4	100

Table 2: Years of Working Experiences

Years of Working Experience	**No**	**%age**	**Cumm %age**
3 -7	3	12	12
8 – 15	10	40	52
15 and above	12	48	100

The evidence from Tables 1 and 2 shows that a greater percentage of the respondents are safety inspectors, followed by structural Engineers. Research indicates that those with over fifteen years of experience had a higher percentage.

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The recurring theme in these incidents is Poor construction practices, including the use of substandard materials, and lack of quality control. The least recurring factor is inadequate waterproofing as can be seen in Table 3 and Figure 1. This means that there is inadequate planning and design such as inadequate site preparation, non-adherence to codes and standards, poor workmanship, and lack of quality control are rated highest with both having a mean value of 5. Substandard materials, inadequate maintenance, and poor supervision among others are rated second with a mean value of 4.

Table 3: Impact of Cost-Cutting Measures on Structural Integrity

Cost-Cutting Measures on Structural Integrity	Rated Value	Mean
Poor construction practices, (the use of substandard materials)	5	
Lack of professional supervision.	4	
Structural weaknesses exacerbated by the fire.	3	
Unauthorized Structural Modifications	4	
Removal of supporting columns to install escalators	3	
Use of Substandard Materials.	3	
Inadequate Design Adjustments.	3	
Structural defects and inadequate professional oversight.	4	
It also lacked adequate maintenance.	4	
Failure to adhere to safety regulations.	4	
Deferred Maintenance.	3	
Inadequate Waterproofing.	2	
Ignored Engineering Recommendations.	3	
Lack of Quality Control	5	

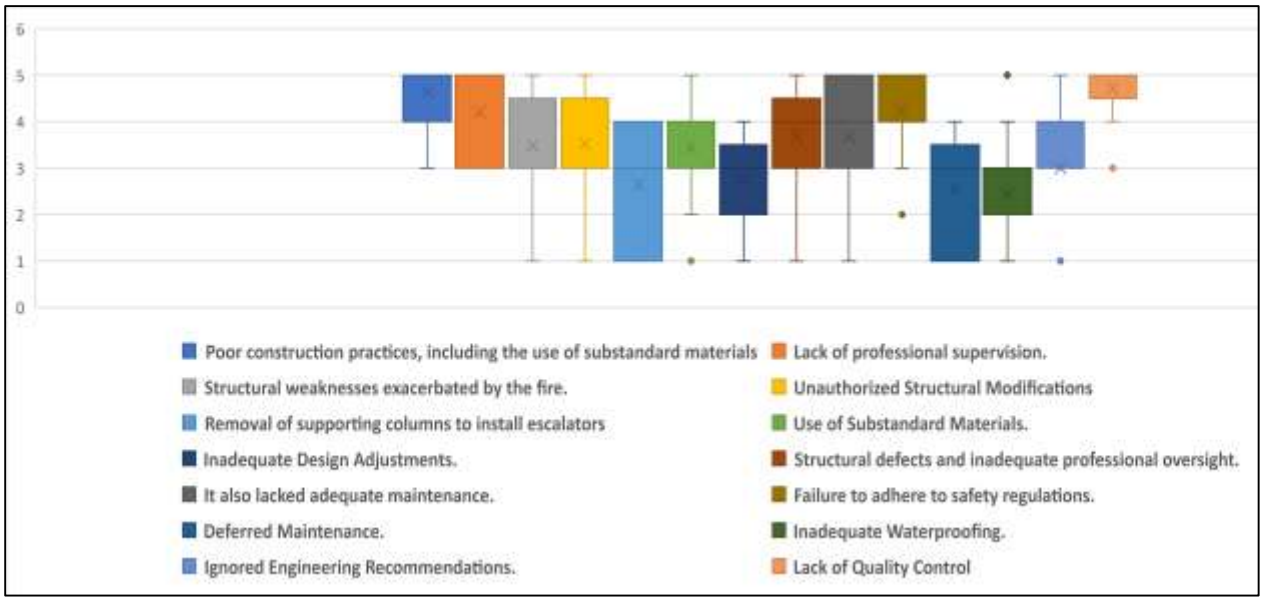

Figure 1: Impact of Cost-Cutting Measures on Structural Integrity

The highest implication is the safety risk followed by economic consequences. The last one is an increased risk of structural failures and legal and financial repercussions as shown in Table 4 and Figure 2. This indicates that poor construction practices and substandard materials can lead to serious safety risks, economic consequences, and increased risk of structural failures. These risks include injuries, fire hazards, health issues, and inadequate emergency exits. Economic consequences include increased maintenance and repair costs, decreased property value, higher insurance premiums, and business disruptions. Structural failures can result from foundation problems, load-bearing failures, envelope failures, and component failures. Legal and financial repercussions include litigation costs, regulatory fines, compensation claims, project delays and cost overruns, and reputation damage.

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Table 4: The Implication of cost-cutting measures in structural integrity

Implication	Mean Value
Safety Risk	5
Economic Consequence	4
Regulatory Impact	4
Reputation and Trust	4
Increased Risk of Structural Failures	3
Legal and Financial Repercussions	3

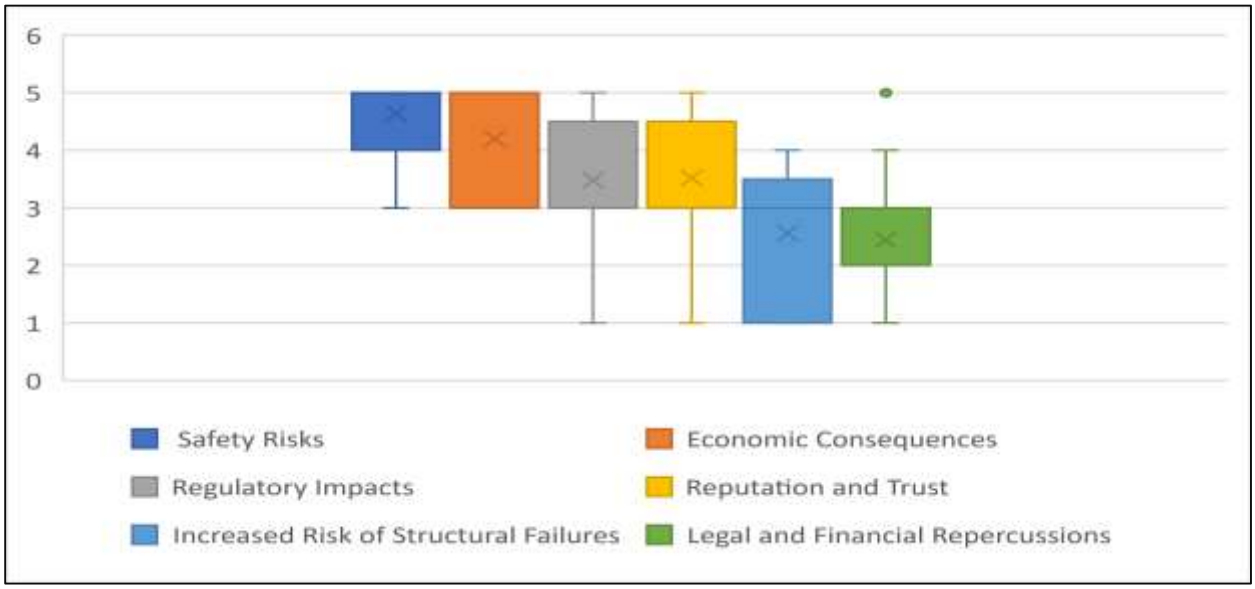

Figure 2: The Implication of cost-cutting measures in structural integrity

The highly recommended mitigation risk is rigorous quality control followed by the use of high-quality materials. The least recommended factor is timely maintenance and repairs and enhanced design review processes as indicated in table 5 and in figure 3. This indicates that rigorous quality control, the use of high-quality materials, timely maintenance and repairs, and enhanced design review processes are essential for the safety, durability, and economic viability of construction projects. These measures include inspection and testing, quality assurance plans, skilled workforce, documentation and reporting, independent audits, and the use of high-quality materials. High-quality materials are essential for the longevity and performance of a structure, and they must meet or exceed industry standards. Reliable suppliers, material certification, regular testing, and proper storage and handling are crucial. Timely maintenance and repairs are essential for preserving a building's integrity and functionality. Scheduled maintenance, prompt repairs, lifecycle management, maintenance documentation, and the use of durable materials are essential.

Table 5: Mitigation factors of cost-cutting in structural integrity

Mitigation Factors	Mean Value
Rigorous Quality Control	5
Use High-Quality Materials	4
Proper Structural Modifications	3
Timely Maintenance and Repairs	3
Enhanced Design Review	3
Implement Regular Maintenance and Repairs	3
Enhance Design Review Processes	3

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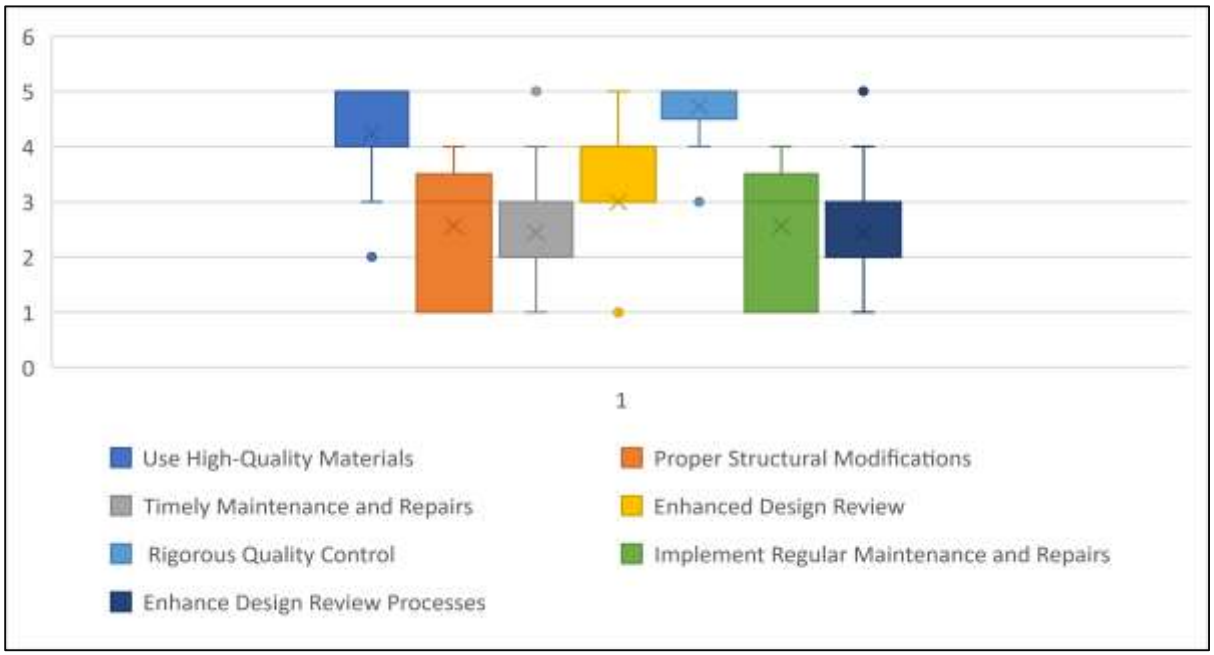

Figure 3: Mitigation factors of cost-cutting in structural integrity

DISCUSSION

Substandard materials in construction can lead to issues such as lower-grade concrete, inferior steel, inadequate masonry, compromised integrity, and improper substitutions this was rated highest in Table 3 and it is the same with the work of [9][21]. Recycled or second-hand materials can also introduce weaknesses and inconsistent quality. Poor construction practices, such as inadequate foundation preparation, shoddy formwork, and lack of skilled labor, can also contribute to these issues [18]. Inadequate training and supervision can also lead to mistakes and neglect of best practices, resulting in vulnerabilities in the final product. The structural defects resulting from cost-cutting measures pose a major danger to public safety since they have the potential to result in fatalities and serious injuries. Workers are frequently put in danger during building by low-quality materials and inadequate construction methods. Building collapses cause significant financial losses, including costs for repairs and rebuilding, legal fees, and compensation claims. Incidents involving structural breakdowns could lead to increased insurance costs for developers and building projects. Severe accidents usually result in stricter building codes and enforcement protocols to try and prevent future occurrences of the same kind. Findings were in agreement with [28] which found that the top-ranked factors causing building collapses in Nigeria include unapproved materials, defective design, and quack construction operators. These factors significantly impact people's lives, the economy, and the country's image, with the highest rankings being loss of materials, capital investments, psychological trauma, and loss of lives. Building enterprises may find it more costly to comply with stricter regulations, but honesty and safety must always come first. Companies that slash costs run the danger of seriously damaging their reputations, which could impair their capacity to acquire future business opportunities. Recurrent incidents may erode public trust in the building industry and regulatory bodies, leading to increased scrutiny and demands for accountability.

RECOMMENDATIONS

To address cost-cutting in construction, a balanced approach is needed that prioritizes cost efficiency and structural integrity. In East Africa, stronger laws, better materials, and trained supervision are recommended to increase building safety. Industry requirements should be met, and routine testing and verification procedures are necessary. Engineering evaluations should be carried out before structural changes, and licensed structural engineers should be included in approval procedures. Proactive maintenance plans and adequate funds for upkeep and repairs should be established. Independent third-party reviewers and comprehensive design review procedures should be implemented. Real-time monitoring systems, continuous quality control, and oversight should be maintained throughout the construction process. Thorough risk assessments and a comprehensive cost management plan are essential. Investing in quality materials and skilled labor, implementing robust quality control and inspection procedures, and fostering open communication among stakeholders is also crucial.

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Contribution to knowledge

The study contributed to knowledge by examining cost-cutting measures' impact on building collapses, using case studies to identify risk factors; thus, informing construction practices, regulations, and preventative measures, enhancing public safety and infrastructure resilience.

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CITE AS: Ikwueze Stella Nneka and Nnadi Ezekiel Ejiofor (2024). Analyzing the Impact of Cost-Cutting Measures on Structural Integrity: A Case Study of Construction Building Collapses. NEWPORT INTERNATIONAL JOURNAL OF SCIENTIFIC AND EXPERIMENTAL SCIENCES, 5(2):35-42
https://doi.org/10.59298/NIJSES/2024/10.5.263542