DOI: 10.36108/ujees/3202.50.0250
UNIOSUN Journal of Engineering and Environmental Sciences. Vol. 5 No. 2. Sep. 2023

ANALYZING COST RISK INDICATORS FOR ENHANCING CONSTRUCTION PROJECT DELIVERY PERFORMANCE

Ahmad, A., Ahmed, A., Siyaka, S. O., Yaro, N.S.A, Musa, M. M. and Aliyu, B. U.

Abstract: Risk factors are an inherent component of construction projects, and sometimes, it is difficult to completely eliminate these risks without proper management. This research focused on investigating cost-related risk indicators influencing the performance of construction projects in insurgency-affected areas such as Maiduguri. The assessment employed the Relative Importance Index (RII) and Exploratory Factor Analysis (EFA) to gauge the likelihood of these risks. Data was collected via a questionnaire from construction professionals, including clients, consultants, contractors, and subcontractors. The results analyzed through statistical software revealed that key drivers of cost-related risks were safety and environmental factors, physical threats, disasters, force majeure events, and economic risk factors. The top five most probable risks included costs related to insurgency damages, financial limitations due to insurgency, oversights caused by the insurgency, price increases due to attacks, and labour shortages. Conversely, risks related to cash flow issues and project cost estimation errors were less common. The findings suggest that professionals who consider these specific risk factors when devising risk management strategies can enhance the accuracy of their risk assessments and cost projections.

Keywords: Cost Risks, Relative Importance Index, Exploratory Factor Analysis, Construction Performance, Construction Projects

I. Introduction

The progression of a construction project comprises multiple stages, each marked by challenges, unpredictability, and potential risks. Challenges include conditions that jeopardize health, property, the environment, and personal safety. In the project execution, threat encompasses anything impeding the project's progress. While unpredictability and potential risk are often used interchangeably, they have distinct meanings. Unpredictability emerges when multiple possible scenarios exist, while risk results from making decisions that could lead to unfavourable outcomes among various possibilities [1]; while still containing some uncertainties [2], the risk stems from events that can typically be predicted based on probabilities. Risk, as defined by [3], encompasses various factors, occurrences, or impacts that threaten the completion of a project within the planned timeframe, quality, and cost parameters.

The construction sector is recognized for its intense competition, intricate nature, and complexity, mainly because of the distinctive characteristics of projects and the participation of a multitude of professionals [4]. It is widely recognized that every phase of the construction

Ahmad, A., Yaro, N.S.A., Musa, M.M.
(Department of Civil Engineering, Ahmadu Bello University, Zaria 810107, Nigeria)
Ahmed, A
(Department of Mechanical Engineering, Aliko Dangote University of Science and Technology, Wudil, Nigeria)
Siyaka, S. O
(Department of Mechanical Engineering Technology, Federal Polytechnic Nasarawa, Nigeria)
Ahmad, A., Aliyu, B. U.
(School of Civil Engineering, Central South University, Changsha 410075, China)
Aliyu, B. U.
(Department of Water Resources and Environmental Engineering, Ahmadu Bello University, Zaria 810107, Nigeria)
Corresponding Author: azizdanbab02@gmail.com
Phone Number: +234-806-211-9100

journey, from the initial investment assessment to the actual construction phase and facility utilization, is susceptible to diverse risk factors that influence project execution. The construction sector has experienced rapid growth, with cost recognized as a crucial determinant of project success [5, 6]. However, the industry faces numerous challenges, such as project delays, exceeding budget limits, structural flaws, and labour coordination issues [7], resulting in projects failing to meet scheduled deadlines and budgets. The intricate nature of the construction sector further complicates efforts to mitigate the risks related to time and cost overruns [6].

Construction projects, in general, often struggle to achieve satisfactory profitability and performance due to various risk factors related to cost, time, and scope [8]. This issue is especially prevalent in developing nations, where various limitations impede the achievement of project goals. Nigerian construction companies, compared to other sectors, have a distinctively unfavorable track record in this aspect, encountering a frequent occurrence of risks related to construction on an annual basis [9]. These risks include profit margin reduction, loss of public trust, and project failures, especially in government- funded projects [10]. The nature, occurrence, and impact of risks in construction have garnered significant attention because they influenced construction project costs [11, 12]. To address and effectively manage cost-related risk indicators that arise during construction projects, the practice of risk management has been established. Its origins date back to the 1930s in the United States, and by the 1970s, it had become an integral component of project management [13]. Akcakanat [14] defines risk management as a systematic process that involves taking precautionary measures to anticipate potential risks, ensuring that an organization is not adversely affected by its negative consequences while striving to achieve its goals. It is a systematic management approach wherein risks are identified, categorized, and analysed using various methods to understand their potential impacts if they occur. Subsequently, appropriate responses are determined [3]. This procedure intends to diminish the probability of risk events and mitigate their adverse consequences when they do occur. Moreover, risk management has become a fundamental component of project management, as it is believed that the distinctive conditions within the construction sector require the incorporation of risk management and analysis methodologies [15].

The influence of risks on a construction endeavour can vary significantly depending on factors such as the project's size, the operating environment, and the characteristics and quantity of resources employed. To systematically assess how these risks affect a specific project, it's essential to evaluate the unique risk factors associated with that project. This process helps in proactively addressing potential disputes among involved parties by establishing suitable contract terms [16]. Numerous research studies have explored risk indicators within the construction sector. For instance, [17] proposed five macro factors influencing the progress of construction projects: environmental, project management, contractual, organizational, and technical. Soewin and Chinda [18] identified ten critical items impacting the performance of construction: safety, quality, time, health, cost stakeholders (internal and external), financial performance, environmental considerations, client satisfaction, and information technology and innovation. Dixit, et al. [19] surveyed significant stakeholders in the Indian construction sector. They found that resource availability, contractual disputes, project scope clarity, design proficiency, and frequent design changes significantly affect construction productivity. In the Gaza Strip, Bassam, et al. [20] determined that political risks were the predominant challenges construction projects face based on input from engineering offices and consulting engineering companies. Genc [3] identified and examined the main risk threats in the Turkish construction industry, emphasizing technical management challenges, disaster and force majeure events, project management issues, external factors, and design and estimation problems as the main risk factors affecting construction projects. Meanwhile, using systems thinking and system dynamics modelling, Jahan, et al. [4] assessed the causal relationships between profitability- influencing risk factors (PIRF) in construction projects. They highlighted factors such as rising material costs, payment issues, financial difficulties, planning and scheduling problems, supply chain processes, and effective control of workforce and equipment resources as the most critical PIRFs.

Considering the significant impact that construction projects can have on a nation's economic development and the growing global trend of cost-related challenges, it is crucial to thoroughly investigate cost-related risks in construction projects executed in insurgency-affected areas like Maiduguri. A comprehensive examination of this concept could alleviate the concerns and uncertainties experienced by all parties involved in construction projects, ensuring that projects are completed within the specified budget and timeframe. Additionally, gaining insights into the primary critical cost risk factors affecting construction projects can help identify gaps and deficiencies in project implementation and open avenues for enhancing project performance. While earlier research has provided insight into evaluating the performance of construction projects concerning influential factors, most of these studies have predominantly concentrated on pinpointing causative factors impacting projects. Nevertheless, there is a restricted body of research that explores the likelihood of these risk factors occurring and how they influence the performance of construction projects.

Therefore, this research seeks to explore the critical cost risk threats affecting the construction project performance delivery in Maiduguri, specifically assessing their likelihood of occurrence. This assessment will be conducted using the RII and EFA. This research is particularly relevant because Borno State has grappled with insurgency issues for over a decade, and these challenges have significantly impeded the state's development, specifically in structural development. The execution of construction projects has been notably vulnerable to risks linked with insurgency, frequently resulting in the abandonment of such projects [6].

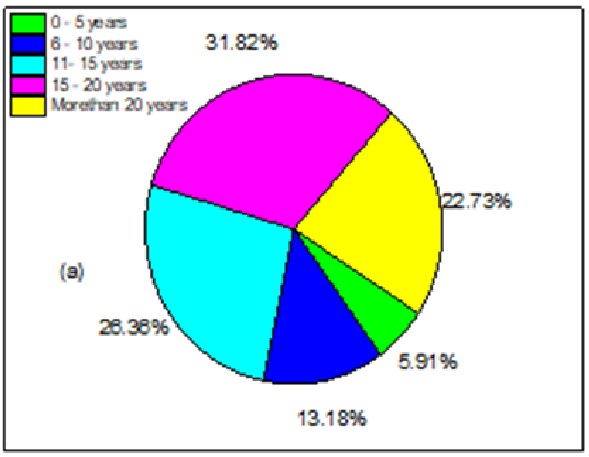
II. Materials and Methods

This section outlines the approach utilized in this research. It begins by discussing the data collection process, following the variables' identification, the questions' formulation, and the chosen data analysis approach.

A. Data collection

The survey targeted professionals within the construction project sector, specifically individuals such as clients, consultants, contractors, and sub-contractors located in

Maiduguri. This diverse group of participants was deliberately selected to enrich the study with a wide range of insights and perspectives on construction projects. To ensure broad participation, 248 questionnaires were distributed through an online platform, with follow-up reminders sent to enhance the response rate. For 8 weeks, the survey garnered 220 valid responses, representing an impressive 88.7% response rate. This response rate exceeds the 30% threshold typically considered satisfactory for reliable statistical analysis, as noted by [21]. The survey's participant breakdown included 44 clients (20%), 72 contractors (32.7%), 46 consultants (21%), and 58 sub-contractors (26.4%). Figure 1 displays the distribution of these valid questionnaires, highlighting that approximately 31.82% of respondents had over 15-20 years of experience executing construction projects.



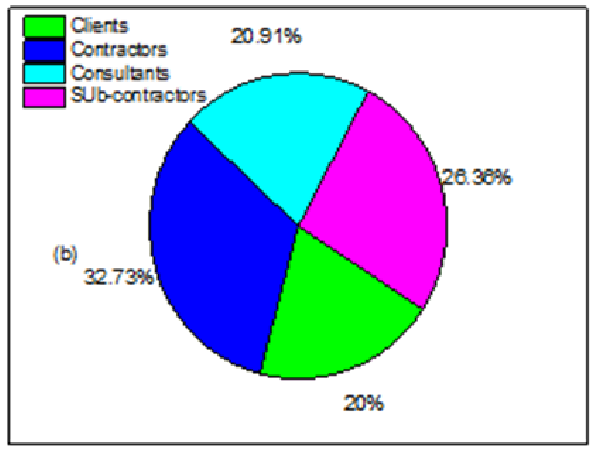


Figure 1: Summary of Distributed Questionnaires (a) Participant's Years of Experience, and (b) Participants' Status

B. Questionnaire design

The research collected data via a questionnaire distributed to construction project professionals. This questionnaire had two sections, each with questions rated on a 5-point Likert scale, ranging from 1 (very low) to 5 (very high). The first section evaluated the influence and probability of cost-related risks occurring during construction project execution. The second section consisted of demographic questions. However, for this study, the analysis exclusively utilized the responses from the first part of the questionnaire, which focused on assessing the likelihood and impact of various cost-related variables affecting construction project performance.

C. Data analysis

The reliability of the questionnaire data was evaluated by computing Cronbach's alpha coefficient, which yielded a higher value of 0.805, indicating robust internal consistency [22]. This study delves into the impact of cost-related risk factors on construction projects, particularly their likelihood of occurrence. It utilizes two analytical techniques, the RII and EFA, applied to data acquired from existing literature and processed using SPSS version 26. The subsequent subsections detail the methodologies employed to assess the influence of cost risk factors on the performance of construction projects. Section (i) elucidates the RII method, while Section (ii) outlines the EFA method employed in this research.

i. Relative importance index (RII)

To obtain an accurate and comprehensive result for analysis, the data were analyzed using SPSS v26.0. Table 1 presents the results for the significance index. Adopted from [3], RII is expressed by;

Where W represents the weight assigned to each factor by the respondent, which falls within the range of 1 to 5, A representing the maximum weight, which is set at 5, and N is the total number of respondents. The RII values fall within the range of 0 to 1[23].

ii. Exploratory factor analysis (EFA)

EFA is a statistical technique employed to condense a set of interconnected variables into more fundamental, overarching constructs referred to as "components" [24, 25]. The primary objective of the approach is to condense the number of measured items into more manageable parameters, enhancing interpretability, and revealing underlying data structures [17, 26]. Before extracting these factors, two critical principles of factor analysis (FA) must be assessed: multivariate normality and sampling adequacy [27]. The assessment of multivariate normality involves employing Bartlett's test of sphericity, while the Kaiser-Meyer-Olkin (KMO) test is used to determine if the data's value distribution is suitable for conducting FA [26].

The results of the Bartlett sphericity test indicate statistical significance ($p < 0.05$), and the KMO value (0.898) confirms the data's suitability for FA [28]. To perform EFA, the extraction method employs principal component analysis, while Promax with Kaiser normalization is chosen as the rotation method because it is the most likely to give a straightforward and interpretable solution [29]. To discern the importance of each factor, primary variables associated with each factor are identified and utilized as explanatory indicators as shown in Table 3. These key variables are selected based on five criteria: (1) eigenvalue greater than 1, (2) the scree plot test, (3) minimum loading values of variables of above 0.5, (4) ensuring that a single variable is only loaded onto one factor, and (5) each factor should consist of at least two variables [30].

III. Results and Discussion

A. Results

This part provides the findings of the data analysis. Initially, the outcomes of the RII are showcased, followed by the results of the EFA.

i. RII results

The RII values of all the indicators are displayed in Table 1. According to [3], an RII score exceeding 0.60 signifies a high level of significance, while scores below 0.40 indicate low importance. Interestingly, most of the risk variables analyzed exhibit RII values surpassing 0.519, suggesting a consensus among respondents regarding the likelihood of these risk variables occurring in construction projects [3]. However, there are differences in the degree of agreement, ranging from minimal to moderate levels. Among the 23 variables assessed, 9 are notably considered highly significant. These variables are; "cost of liquidated insurgency-related damages", "state‟ s financial limitations as a result of insurgency", "unexpected oversight brought on by insurgency", "price inflation brought on by ongoing persistent attacks", "lack of labour in the building industry", "curfew is enforced because of the ongoing attack", "improper cost control system", "wastes due to insurgency", "attack on the construction workers on a regular basis". While 11 indicators are moderately important, "payment delays", "project stakeholders making change-order request late", "exceeding the expected budget for project completion", "executing the design phase without involving stakeholders", "non-compliance with contract and specific requirements", "worker conflicts on the project, acts of terrorism", "explosions or construction accidents", "incidents and inadequate safety procedures leading to accidents", "receipt of substandard materials", "environmental catastrophes". The variables, "divergent of project budget to security purposes", "improper

Table 1: RII Scores of Cost Risk Variables

Code	Indicators	Overall, Weight (RII)	Rank
CR1	Cost of liquidated insurgency-related damages	0.74	1st
CR2	State‟ s financial limitations as a result of insurgency	0.70	2nd
CR3	Unexpected oversight brought on by insurgency	0.71	3rd
CR4	Price inflation brought on by ongoing persistent attacks	0.69	4th
CR5	Lack of labour in the building industry	0.67	5th
CR6	Curfew is enforced because of the ongoing attack	0.66	6th
CR7	Improper cost control system	0.65	7th
CR8	Wastes due to insurgency	0.64	8th
CR9	Attack on the construction workers on a regular basis	0.62	9th
CR10	Payment delays	0.60	10th
CR11	Project stakeholders making change-order request late	0.59	11th
CR12	Exceeding the expected budget for project completion	0.58	12th
CR13	Executing the design phase without involving stakeholders	0.56	13th
CR14	Non-compliance with contract and specific requirements	0.53	14th
CR15	Worker conflicts on the project	0.52	15th
CR16	Acts of terrorism	0.51	16th
CR17	Explosions or construction accidents	0.48	17th
CR18	Incidents and inadequate safety processes leading to accidents	0.47	18th
CR19	Receipt of substandard materials	0.45	19th
CR20	Environmental catastrophes	0.42	20th
CR21	Divergent of the project budget for security purposes	0.38	21st
CR22	Improper cash flow	0.36	22nd
CR23	Errors in project cost estimation	0.32	23rd

cash flow", and "errors in project cost estimation" are perceived to have a low level of importance.

ii. EFA results

Following EFA, we have identified four components that collectively account for 75.213% of the variance. Table 2 provides a detailed breakdown of these components and their corresponding variances. In Table 3, the structure and loadings resulting from the principal factor extraction are presented. Notably, the loadings for most variables associated with each factor exceed 0.5, signifying their substantial contributions to these factors. Variables with cross-loadings and loading scores, below 0.4, such as CR7, CR8, CR9 and CR14 have been excluded from the analysis. Each of these extracted factors has been assigned a descriptive name that reflects the commonality among the variables it encompasses. Table 4 provides a summary of these extracted components and their respective variables. The scree plot (see Fig. 2) that the line exhibits a nearly horizontal trend from the fifth component onwards. This suggests that it is appropriate to retain only four components [31] (see Fig. 2). Furthermore, when comparing the actual eigenvalues for the first two components derived from real data with those obtained from random data, it becomes evident that the number of components to be retained should indeed be two [32] (see Table 4).

Table 2. Total Variance Explained

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	7.668	33.340	33.340	7.688	33.340	33.340	5.931
2	4.455	19.371	52.710	4.455	19.371	52.710	5.586
3	3.075	13.371	66.082	3.075	13.371	66.082	5.741
4	1.390	6.041	72.123	1.390	6.041	72.123	2.194

Note: Extraction Method; Principal Component Analysis

B. Discussion

The "safety and environment" component encompasses the highest number of risk indicators. The results from the RII demonstrate that most of these variables have moderate RII scores. Likewise, the physical risk category variables also show average RII scores. Despite the RII scores signifying a moderate influence on the performance of construction projects, there remains a substantial likelihood of their occurrence. This is primarily because the EFA results reveal that some of the variables, such as incidents and insufficient safety protocols leading to construction accidents, explosions, exceeding the expected budget for project completion, payment delays, and project stakeholders making change-order requests late have the most significant influence

Table 3: Structure and Loadings of the Extracted Factors

Code	Component 1	2	3	4
CR18	**0.910**	-0.870	0.312	0.169
CR17	**0.901**	-0.130	0.328	0.136
CR16	**0.882**	-0.134	0.372	0.197
CR19	**0.873**	-0.101	0.265	0.145
CR15	**0.858**	-0.052	0.256	0.109
CR20	**0.809**	-0.152	0.234	0.119
CR21	**0.800**	-0.185	0.255	0.187
CR12	-0.189	**0.908**	-0.245	-0.086
CR10	-0.031	**0.906**	-0.164	-0.116
CR11	-0.130	**0.904**	-0.314	-0.103
CR13	-0.112	**0.863**	-0.316	-0.163
CR2	0.305	-0.189	**0.877**	0.181
CR1	0.278	-0.275	**0.872**	0.185
CR5	0.252	-0.260	**0.855**	0.196
CR3	0.272	-0.158	**0.804**	0.221
CR4	0.293	-0.251	**0.797**	0.260
CR6	0.217	-0.203	**0.715**	0.240
CR23	0.189	-0.207	0.277	**0.870**
CR22	0.170	-0.79	0.241	**0.865**

Note: Rotation Method; Promax with Kaiser Normalization

Table 4: Extracted Common Factors

Factor No.	**Factor**	**Code**	**Variables**
1	Safety and environment	CR18	Incidents and inadequate safety processes leading to accidents
		CR17	Explosions or construction accidents
		CR16	Acts of terrorism
		CR19	Receipt of substandard materials
		CR15	Worker conflicts on the project
		CR20	Environmental catastrophes
		CR21	Divergent of the project budget for security purposes
2	Physical risk factors	CR12	Exceeding the expected budget for project completion
		CR10	Payment delays
		CR11	Project stakeholders making change-order requests late
		CR13	Executing the design phase without involving stakeholders
3	Disaster and force majeure	CR2	State's financial limitations as a result of insurgency
		CR1	Cost of liquidated insurgency-related damages
		CR5	Lack of labour in the building industry
		CR3	Unexpected oversight brought on by insurgency
		CR4	Price inflation brought on by ongoing persistent attacks
		CR6	Curfew is enforced because of the ongoing attack
4	Economic risk factors	CR23	Errors in project cost estimation
		CR22	Improper cash flow

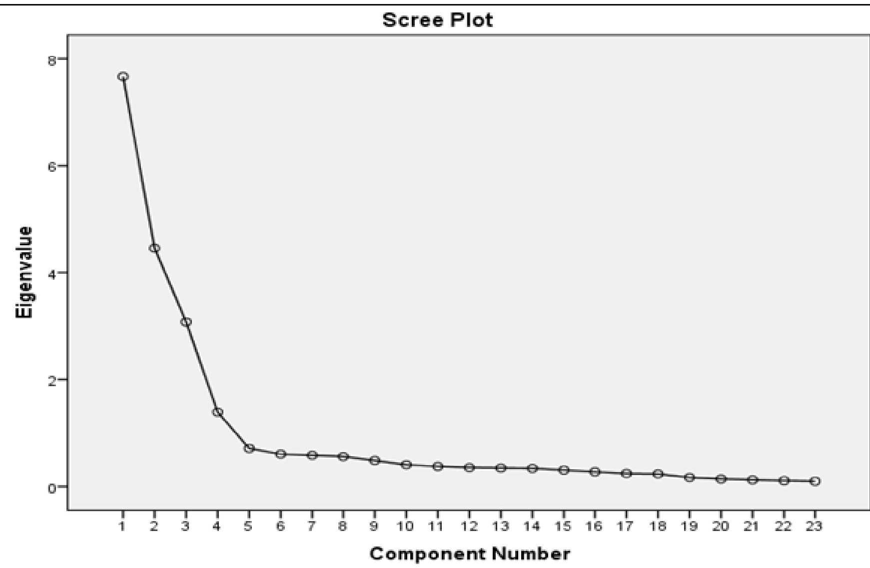


Fig. 2: Scree Plot

on the performance of construction projects delivery in Maiduguri. This discovery aligns with [20] and [3], who also identified these factors as the primary drivers affecting the performance of construction projects in the Gaza Strip and the Turkish construction sector, respectively.

However, our study differs as it is conducted explicitly within the context of construction project performance in Maiduguri. Therefore, our research provides new contextualized evidence that contributes to the existing literature on project performance.

One of the primary risks that significantly impacts the performance of construction projects involves the uncertainties stemming from disasters and force majeure events, typically triggered by external factors [6]. All the variables related to disasters and force majeure exhibit notably high RII scores and likewise with the EFA results, with two of them ranking as the most influential factors, namely, the cost of damage caused by insurgency-related incidents and the financial constraints faced by the state due to insurgency. This finding corroborates [6], which also identified these factors as critical constraints on project performance. Therefore, this research has yielded fresh empirical evidence that sheds new light on the influence of disasters and force majeure events on project performance. It underscores the significance of diligently managing external risk factors like disasters and force majeure to achieve optimal project performance.

The "economic risk" element includes a smaller set of variables, regarded as having low significance due to the RII outcomes indicating low scores, signifying a minimal likelihood of affecting construction project performance. This could be attributed to a robust contingency plan designed to manage unforeseen cost increases or estimation errors, potentially mitigating negative project impacts [3, 33]. This denotes that these variables are infrequent and extraordinary occurrences in the context of Maiduguri.

IV. Conclusion

This study evaluated cost risk factors impacting the performance of construction projects in regions affected by insurgency. Through a survey involving 220 professionals, cost risk indicators influencing project performance were pinpointed using RII and EFA. Integrating findings from RII and EFA offered novel insights, allowing a comprehensive analysis of the main cost risks' likelihood. RII significantly enhanced understanding of variable significance. The top five high-probability cost risk factors in construction included "cost of insurgency-related damages," "state financial constraints due to insurgency," "oversight due to insurgency," "price inflation from persistent attacks," and "labour shortage." EFA, meanwhile, illuminated four key components:
(1) safety and environment, (2) physical risk factors, (3) disaster and force majeure, and (4) economic risk factors.

The study" s theoretical contribution lies in its questionnaire-based approach, enriching risk management knowledge and aiding risk response method selection. Integrating RII and EFA methodologically yields unique insights, assisting decision-making in risk management for optimal project outcomes. To enhance applicability, cross-cultural validation is recommended, and further research should address causal relationships between risk variables and utilize Confirmatory Factor Analysis (CFA) for measuring tool adequacy. Future studies could replicate this approach in different insurgency-affected regions to compare and explore cost risk factors affecting construction project performance.

References

[1] O. Perminova, M. Gustafsson, and K. Wikstrom, "Defining uncertainty in projects – a new perspective," *Int J Proj Manag.*, vol. 26, no. 1, pp. 73–79, 2008.

[2] W. Duncan, "A guide to the project management body of knowledge (PMBOK guide)," *Sylva, NC: PMI Communications,* 2005.

[3] O. Genc, "Identifying principal risk factors in Turkish construction sector according to their probability of occurrences: a relative importance index (RII) and exploratory factor analysis (EFA) approach," *International Journal of Construction Management,* vol. 23, no. 6, pp. 979-987, 2021, doi: 10.1080/15623599.2021.1946901.

[4] S. Jahan, K. I. A. Khan, M. J. Thaheem, F. Ullah, M. Alqurashi, and B. T. Alsulami, "Modeling Profitability-Influencing Risk Factors for Construction Projects: A System Dynamics Approach," *Buildings,* vol. 12, no. 6, 2022, doi: 10.3390/buildings12060701.

[5] A. Shreenaath, S. Arunmozhi, and R. Sivagamasundari, "Analysis of factors influencing construction cost overruns in large construction projects of Tamilnadu," *International Journal of Engineering and Technical Research (IJETR),* vol. 2, no. 11, 2014.

[6] A. Ahmad, D. Alhassan, M. Ahmad, and, and Y. M. Hashim, "Performance Evaluation of Construction Projects Delivery in Insurgency Affected

Locations in Maiduguri, North East, Nigeria," *UNIOSUN Journal of Engineering and Environmental Sciences*, vol. 4, no. 1, 2022, doi: 10.36108/ujees/2202.40.0101.

[7] M. Zayyanu and B. Umar, "Causes of Delay in Construction Projects: A Systematic Review," *International Journal of Engineering Research & Technology (IJERT)*, vol. 11 no. 03, 2022.

[8] A. B. Seddeeq, S. Assaf, A. Abdallah, and M. A. Hassanain, "Time and Cost Overrun in the Saudi Arabian Oil and Gas Construction Industry," *Buildings*, vol. 9, no. 41. [CrossRef], 2019.

[9] U. O. Ajator, "Financial Engineering and Project Risk Management: Imperatives for Professional Quantity Surveyors," *Journal of Environment and Earth Science*, vol. 4 no. 23, pp. 60-71, 2014. [Online]. Available: www.iiste.org.

[10] S. Zailani, H. A. M. Ariffin, M. Iranmanesh, S. Moeinzadeh, and M. Iranmanesh, "The moderating effect of project risk mitigation strategies on the relationship between delay factors and construction project performance," *Journal of Science and Technology Policy Management*, 2016.

[11] U. O. Ajator and G. Ogika, "Analysis of Risk Factors Affecting Cost Performance of Jalingo Hospital Projects," Masters MSc. Thesis Presentation, Department of Quantity Surveying, ESUT Enugu, Nigeria., 2016.

[12] A. A. Aibunu and G. O. Jagboro, "The Effects of Construction Delays on Project Delivery in Nigerian Construction Industry " *International Journal of Project Management*, vol. 20, pp. 593-599, 2002

[13] M. A. Ali and H. A.-S. Mohammaed, "Risk Factors in Construction Projects during Unrest Period in Yemen," *Journal of Construction in Developing Countries*, vol. 23, no. 2, pp. 43-62, 2018.

[14] O. Akcakanat, "Kurumsal Risk Y € €onetimi Ve Kurumsal Risk Yonetim € Sureci," *S € uleyman Demirel € Universitesi Vizyoner Derg.*, vol. 4, no. 30, pp. € –46, 2016.

[15] P. Baloi and A. Price, "Modelling Global Risk Factors Affecting Construction Cost Performance," *International Journal of Project Management*, vol. 21, no. 4, pp. 261–269, 2003.

[16] K. Mhetre, B. A. Konnur, and A. B. Landage, "Risk management in the construction industry.," *Int J Eng Res.*, vol. 1, pp. 153–155, 2016.

[17] S. Jadidoleslami, E. Saghatforoush, and A. Zare Ravasan, "Constructability obstacles: an exploratory factor analysis approach," *Int J Constr Manag.*, pp. 1–14, 2018, doi: DOI: 10.1080/15623599.2018.1534044.

[18] E. Soewin and T. Chinda, "Factors affecting construction performance: exploratory factor analysis," in *IOP Conf Ser: Earth Environ Sci.*, 2018, vol. 140.

[19] S. Dixit, S. N. Mandal, J. V. Thanikal, and K. Saurabh, "Study of significant factors affecting construction productivity using relative importance index in Indian construction industry," presented at the E3S Web Conf., 2019, 09010.

[20] A. T. Bassam, J. S. Tareq, I. Yazan, Abu Aisheh., and W. S. Alaloul., "Risk Factors Affecting the Performance of Construction Projects in Gaza Strip," *The Open Civil Engineering Journal*, vol. 14, pp. 94-104, 2020, doi: DOI: 10.2174/1874149502014010094.

[21] S. M. Elseufy, A. Hussein, and M. Badawy, "A hybrid SEM-ANN model for predicting overall rework impact on the performance of bridge construction projects," *Structures*, vol. 46, pp. 713-724, 2022, doi: 10.1016/j.istruc.2022.10.100.

[22] Z. M. Mazlina and B. H. W. Hadikusumo, " Structural equation model of integrated safety intervention practices affecting the safety behaviour of workers in the construction industry " *Saf Sci.*, vol. 98, pp. 124–135, 2017.

[23] C. M. Tam, S. X. Zeng, and Z. M. Deng, "Identifying elements of poor construction safety management in China," *Safety Science* vol. 42 no. (2004) pp. 569–586, 2004, doi: 10.1016/j.ssci.2003.09.001.

[24] M. Gunduz and E. A. Abdi, "Motivational factors and challenges of cooperative partnerships between contractors in the construction industry," *J Manage Eng.*, vol. 36, no. 4, 2020.

[25] W. Liu, T. Zhao, W. Zhou, and J. Tang, "Safety risk factors of metro tunnel construction in China: An integrated study with EFA and SEM," *Safety Science*, vol. 105, pp. 98-113, 2018, doi: 10.1016/j.ssci.2018.01.009.

[26] Hair, W. C. Black, B. J. Babin, and R. E. Anderson, "Multivariate Data Analysis, Pearson, Upper Saddle River, NJ.," 2010.

[27] C. T. W. Chan, "The principal factors affecting construction project overhead expenses: an exploratory factor analysis approach.," *Constr Manag Econ.*, vol. 30, no. 10, pp. 903–914, 2012.

[28] M. J. Norušis, "SPSS 16.0 Advanced Statistical Procedures Companion, Prentice Hall Higher Education.," 2008.

[29] J. M. Conway and A. I. Huffcutt, ""A review and evaluation of exploratory factor analysis practices in organizational research."," *Organizational research methods*, vol. 6, no. 2, pp. 147-168, 2003.

[30] R. L. Gorsuch, ""Exploratory factor analysis: Its role in item analysis."," *Journal of personality assessment*, vol. 68, no. 3, pp. 532-560, 1997.

[31] X. Zhang, "Critical success factors for public–private partnerships in infrastructure development," *Journal of Construction Engineering and Management*, vol. 131, no. 1, pp. 3-14, 2005b.

[32] B. P. O Connor, ""SPSS and SAS programs for determining the number of components using parallel analysis and Veliger’s MAP test."," *Behaviour research methods, instruments, & computers*, vol. 32, no. 3, pp. 396-402, 2000.

[33] M. Skitmore and D. H. Picken, "The accuracy of pre-tender building price forecasts: an analysis of USA data," *Information and Communication in Construction Procurement CIB W92 Procurement System Symposium*, 2000