Engineering and Technology Journal e-ISSN: 2456-3358

Volume 10 Issue 07 July-2025, Page No.- 5654-5660

DOI: 10.47191/etj/v10i07.12, I.F. – 8.482

Analysis of Risk Factors Influencing Time and Quality Performance in Multi-Storey Building Projects

Susi Suryanta Nainggolan[1], Budi Susetyo[2]

[1,2]Master of Civil Engineering, Faculty of Engineering, Mercu Buana University. Jl. Meruya Selatan No 1 Joglo Kembangan Jakarta Barat, 11650 Indonesia

ABSTRACT: In today's global era, the construction industry is experiencing rapid growth, though its implementation often encounters challenges related to time, cost, and quality. Project implementation in construction is frequently delayed, often due to a shortage of labor or the absence of necessary equipment on site. This study aims to identify the risk factors that influence project implementation time and the quality of project performance. This study combines quantitative and qualitative descriptive research approaches that utilize numerical data and are subject to statistical analysis. The methodology applied in this high-rise construction research includes journal-based literature reviews, expert opinions, and data gathered through interviews and questionnaires. For analyzing the data, the research makes use of Structural Equation Modeling through the SmartPLS application. The results and discussion of the study will explain the process and results of the research conducted by the researcher. The results of the study show risk factors that affect contractor performance on high-rise building construction projects, namely: terms of reference, inappropriate field planners, inappropriate mobilization of tools and labor, inappropriate working drawings and inadequate licensing identification. The results of the study also show that contractor performance has a positive and significant effect on time and quality performance in building construction projects. The risk factors of contractor performance that have an effect on quality and time on the performance of high-rise building construction projects are: inadequate workforce skills, availability of equipment on site, late payments to subcontractors, experience of field managers/supervisors and shortage of workers.

KEYWORDS: Risk Management, Time Performance, Quality Performance, High-rise Buildings, Influential Factors, SEM-PLS

INTRODUCTION

In today's global era, the development of the construction world is increasingly rapid. During its execution, it occasionally encounters challenges such as time, expenses, and quality limitations. These three challenges represent the objectives of the project: time, expenses, and quality. (Lin & Chen, 2021). Building assignments frequently face setbacks because of a labour shortage or a lack of construction machinery on location. The existence of uncertainty factors and other unexpected things often causes failure to achieve project goals/targets in general. (Situmorang et al., 2018).

Risk management aims to improve project performance from start to finish by identifying, evaluating, and controlling project risks. Conducting a project risk analysis is crucial to ensure that the project remains aligned with its established goals and plans. The impact of inadequate risk management on a building project can lead to various adverse consequences, including project failure, financial loss, loss of life, environmental damage, disruption of community activities, and damage to the company's reputation.

To address the problem of inadequate risk management in building projects, efforts can be made to improve the understanding of risk management, increase commitment from project management, allocate sufficient resources, manage time and costs effectively, improve coordination between stakeholders, and foster an organisational culture that emphasises risk management practices. Applying effective risk management strategies in construction projects is vital for promoting project sustainability and reducing negative impacts.

This study focuses on a high-rise building construction project in Jakarta. The construction of this project is a reasonably large-scale project. However, this project is not free from risks that may occur, such as delays in work and quality of work that does not meet the specified standards.

LITERATURE REVIEW

Key risk factors contributing significantly to delays in building construction projects include the contractor's financial difficulties, late progress payments from the project owner for completed work, awarding contracts solely based on the lowest bid, changes to the original design during construction, poor planning and scheduling by the contractor, labor shortages, and weak site management and supervision by the contractor. Successful risk management involves analysing and managing risk responses and risk plans to shift or mitigate the effects of these factors to other parties, such as insurance companies, subcontractors, or the client itself, resulting in increased costs and contingency requirements.

A. MULTI-STOREY BUILDING

High-rise buildings are strongly connected to urban environments, as they naturally emerge in response to population density, limited land availability, and elevated land costs. The increasing difficulty of land acquisition significantly impacts the selection of building structures due to economic considerations and land efficiency. (Hawari, 2009).

With the advancement of science and technology, many advancements have been experienced by the general public, and along with this, there has been an increase in the growth of the construction industry. The constraints posed by limited space have not hindered progress, especially in educational institutions for academic and hands-on sessions, and corporate settings, especially in metropolitan areas. High-rise structures and buildings are considered a viable option to meet the demand for commercial space in densely populated cities with limited land availability.

B. RISK MANAGEMENT

Risk refers to the possibility of miscommunication and issues related to completing tasks and meeting project goals, as well as uncertain future events that cause project delays, cost overruns, and poor quality. (Kamal et al., 2022) . It is important to note that risk is inherently related to uncertainty. This idea aligns with the perspective put forward by Kountur (2008), suggesting that uncertainty stems from a lack of information or the unavailability of critical data regarding future events.

Risk management can be applied at many organisational levels, such as the strategic and operational levels. Risk management can also be done on a specific project to manage specific risk areas.

Figure 1 Risk Management Process

C. RISK MANAGEMENT PLAN

The risk management plan plays a vital role in informing stakeholders and securing their agreement and support, ensuring that the risk management process is effectively implemented throughout the entire project lifecycle. (An American National Standard, 2008) . This phase involves identifying the steps needed to address the risks that arise in a project. Therefore, defining the risk factors through a responsive plan or procedure is essential.

Risk management considerations describe the proper structure and implementation of risk management in construction projects. The success of a project is measured by four important project objectives: Cost, Time, Scope, and Quality. The impact of risk on a project can be classified as low, medium, or high, depending on how much the risk impacts the project.

D. RISK IDENTIFICATION

As described in A Guide to the Project Management Body of Knowledge (PMBOK), the steps involved in risk identification include document review, utilisation of information gathering techniques, evaluation of checklists, analysis of assumptions, and use of diagramming techniques for a comprehensive understanding of potential risks.

E. QUALITATIVE RISK ANALYSIS

A risk assessment matrix serves as an instrument that aids in identifying the risks necessary for formulating a risk response. The initial phase of creating a RAM involves establishing the scale for likelihood and impact ratings. This rating scale is closely tied to particular aspects of the project; for instance, when the chance of a project being executed suggests that an incident's risk is unlikely to occur during the subsequent execution. To effectively prioritize project risks, it is essential to utilize the Risk Assessment Matrix (RAM) and a rating scale to evaluate the probability of each event and its potential impact based on the determined Risk Level.

F. QUANTITATIVE RISK ANALYSIS

Quantitative risk analysis attempts to allocate numerical values to all elements of risk analysis. It is suggested for large budget projects that require precise calculations. This is usually done to study the practicality of project costs or schedule objectives.

G. RISK RESPONSE PLANNING

Risk response refers to the method of addressing a risk as it arises. This response is outlined in a plan dedicated to risk management. A risk response plan consists of a comprehensive approach for handling the risk. It comprises particular tactics and measures to reduce or evade adverse risks while taking advantage of beneficial risks. In creating a risk response plan, prioritise risks that are either high-impact or have a high likelihood of occurring.

H. RISK MONITORING & CONTROL

According to the PMBOK Guide Seventh Edition, Risk Monitoring and Control is a core process that continuously involves identifying, analyzing, planning for, and managing project risks. Because it directly influences project outcomes, risk monitoring and control is considered a critical factor in achieving success or avoiding failure. With sustained risk monitoring and control, project leaders can mitigate the impact of unforeseen events that may jeopardize the project.

RESEARCH METHODS

This study combines quantitative and qualitative descriptive research approaches that utilise numerical data and are subjected to statistical analysis. According to Darmawan (2013), quantitative research is a methodology that aims to systematically, factually, and precisely describe the characteristics and aspects of a particular population or seek to provide a detailed explanation of a phenomenon. Descriptive methods, as explained by Sugiyono (2012), involve formulating questions related to the existence of independent variables, whether they relate to a single variable or multiple variables (where the independent variable is a stand-alone variable, different from the dependent variable and the intervening variable, which affects both). In line with the research methodology mentioned above, this study aims to explain the findings derived from the processed data, evaluated in line with the theory explored, which ultimately leads to reasonable conclusions.

This descriptive exploratory study focuses on a specific target population to examine the manifestation of a concept or phenomenon by detailing many variables related to the problem. Furthermore, additional data regarding the study variables will be derived from various sources that are considered relevant or significant. The research variables are divided into three, namely independent variables, dependent variables, and intervening variables.

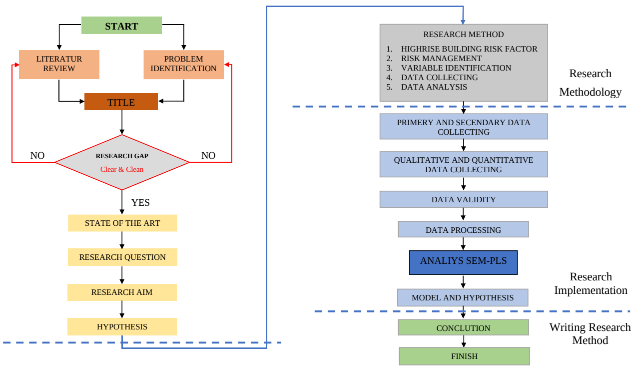

Figure 2 Risk Management Process

RESULT AND DISCUSSION

The findings and analysis of the study will outline the methodology and outcomes of the investigation carried out by the researchers. The discussion and presentation start from the data collection process, data validation, data processing, statistical analysis, hypothesis testing, and the basis for decision making, are presented in this chapter. In making the questionnaire, we look for indicators that influence journal references and books that previous researchers have presented. The survey will be shared with participants directly engaged in this skyscraper development initiative. Alternatively, those who are not directly involved in it are included in the provisions that have been previously determined. The individuals involved should embody the building infrastructure initiative and include scholars, advisors, builders, project creators, and representatives from governmental organisations (Berawi et al., 2019).

The data analysis will use a simulation tool, SEM-PLS (Structural Equation Modelling - Partial Least Squares). Through this software, the primary factors and sub-factors that affect the effectiveness of quality and time, which are the focus of this study, are identified. SMART PLS stands as a tool for simulation, which is currently popularly used in several scientific studies to analyse data. The data collection that has been carried out is data from the distribution of research questionnaires, where the data will later be analysed to answer the problem formulation questions. In each dependent variable (variable Y), independent variable (variable X), and intervening variable (Variable X3), parameters are needed to be used as benchmarks in the assessment of each variable. In this study, the dependent variable (variable Y) is project performance. In contrast, the independent variable (Variable X) is Planning and Implementation (X1), Implementation of Risk Management (X2), and Contractor Performance (X3) as intervening variables.

A. DATA ANALYSIS

SEM-PLS involves importing data from questionnaire processing in CSV file format, followed by establishing structural paths connecting latent variables according to the theoretical framework in the internal model. An outside framework is established to illustrate the connection between latent variables and their measurable indicators. The orientation of the arrows demonstrates the mutual impact among the relevant variables.

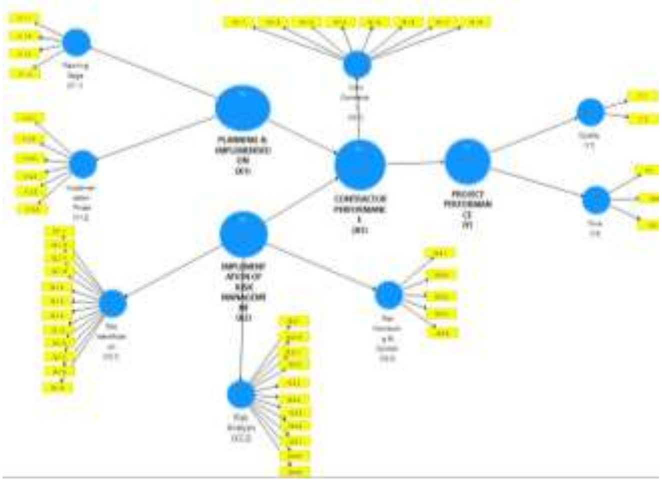

Figure 3 Main SEM Modelling

Table 1 SEM Modelling Relationships

Variable / Indicator	Latent Variables	Main Variables
X1.1.1 – X1.1.4	Planning Stage (X1.1)	Planning & Implementation (X1)
X1.2.1 – X1.2.6	Implementation Phase (X1.2)	

X2.1.1 – X2.1.12	Risk Identification (X2.2)	Implementation Of Risk Management (X2)
X2.2.1 – X2.2.12	Risk Analysis (X2.3)	
X2.3.1 – X2.3.5	Risk Monitoring & Control (X2.6)	
X3.1.1 – X3.1.8	Main Contractor (X3.1)	Contractor Perforamance (X3)
Y1.1 – Y1.2	Quality (Y1)	Project Performance (Y)
Y2.1 – Y1.2.3	Time (Y2)	

B. OUTER LOADING ANALYSIS

Outer Model denotes a framework for measurement that links indicators to latent variables, evaluating the model's validity and reliability. The configuration of the measurement model, or outer model, dictates the traits of the indicators associated with each latent variable, whether reflective or formative, relying on the operational definition of that variable. Outer SEM evaluation involves assessing the reflective indicator model, which includes: Individual Item Reliability, Construct Reliability or internal consistency, Average Variance Extract, and Discriminant Validity.

The standardised loading factor indicates a significant relationship between each measurement item and its construct. An ideal loading factor is ≥ 0.7, signifying that the indicator effectively measures the construct it represents. A loading factor of ≥ 0.5 is generally deemed acceptable, even though some experts might accept a value of 0.5.

The modeling results show that all indicators with outer loading values > 0.5 are declared valid based on the outer loading validity value which states that all indicators have validity.

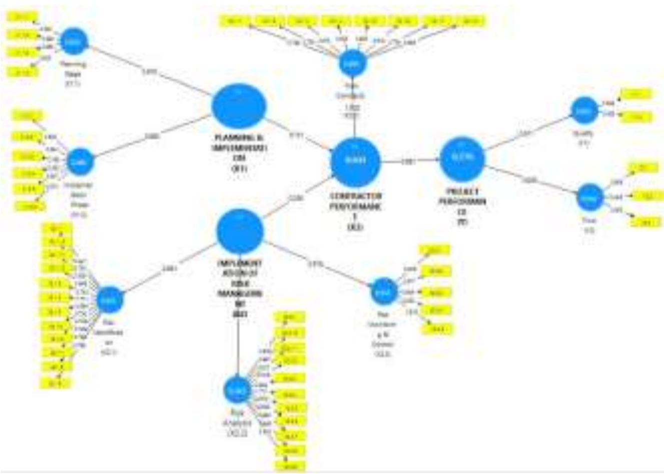

Figure 4 Path Coefficient

Internal consistency reliability evaluates how well the indicators represent the associated latent variables. This assessment utilizes two tools: composite reliability and Cronbach's alpha. Composite reliability assesses the degree to which indicators demonstrate strong reliability, with values ranging from 0.6 to 0.7 generally regarded as acceptable (Sarstedt et al., 2020).

Table 2 Findings from the Construct Reliability Analysis Based on Convergent Validity

	Cronbach's Alpha	**rho_A**	**Composite Reliability**	**Average Variance Extracted (AVE)**
Risk Analysis (X2.2)	0,954	0,960	0,961	0,697
Risk Identification (X2.1)	0,925	0,929	0,936	0,552
Contractor Performance (X3)	0,928	0,932	0,941	0,667
Project Performance (Y)	0,846	0,870	0,891	0,623
Main Contractor (X3.1)	0,928	0,930	0,941	0,667
Risk Monitoring & Control (X2.3)	0,827	0,847	0,881	0,600
Quality (Y1)	0,907	0,908	0,955	0,915
Implementation of Risk Management (X2)	0,972	0,975	0,974	0,576
Planning Stage (X1)	0,967	0,969	0,971	0,772
Implementation Phase (X1.2)	0,945	0,951	0,957	0,788
Planning Stage (X1.1)	0,919	0,921	0,943	0,806
Time (Y2)	0,745	0,753	0,854	0,660

From the attached table, it can be seen that the Composite Reliability (CR) value for each variable exceeds 0.70. Planning and Implementation Variables reaches a CR value of 0.974, Implementation of Risk Management reaches a CR value of 0.988, Contractor Performance has a CR value of 0.949, and Project Performance has a CR value of 0.891. The Composite Reliability test results indicate that all variables exhibit strong reliability and have surpassed the established minimum threshold.

Table 3 R Square Test (R^2)

	R Square	**R Square Adjusted**
Risk Analysis (X2.2)	0,945	0,944
Risk Identification (X2.1)	0,923	0,922
Contractor Performance (X3)	0,943	0,942

Project Performance (Y)	0,776	0,773
Main Contractor (X3.1)	0,999	0,999
Risk Monitoring&Control (X2.3)	0,956	0,955
Quality (Y1)	0,829	0,827
Implementation Phase (X1.2)	0,980	0,980
Planning Stage (X1.1)	0,958	0,957
Time (Y2)	0,818	0,816

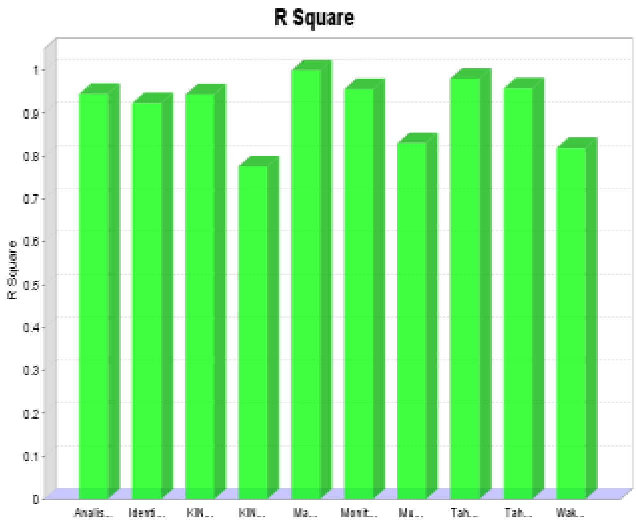

Figure 5 R-Square Value Diagram

It can be articulated that the findings of the R2 value analysis, which serves as a goodness-of-fit measurement derived from the data collected at the outer loading stage of the model, reflect the extent to which the independent (exogenous) variable impacts the intervening variable (moderator). The analysis revealed that the R2 value affecting the Contractor Performance (X3) was 0.943, accompanied by an adjusted R2 value of 0.942. Consequently, it can be inferred that all independent and intervening variables collectively influence Project Performance (Y) at 0.776 or 77.60%. Therefore, with the Adjusted R2 value being 77.3%, which is greater than 50%, the effect of the independent variables on Performance Project (Y) is considered quite substantial.

C. INNER LOADING ANALYSIS

This assessment employs a bootstrapping technique to forecast the connection among hidden variables in analysing the structural model. It does this by examining the proportion of variance accounted for, specifically by evaluating the R2 value for dependent latent constructs. It also uses Stone-Geisser’s Q2 to assess predictive significance and average variance extracted (AVE) to measure predictability through a resampling method. This method encompasses the complete initial sample for further resampling, stipulating that the quantity has to exceed that of the original sample.

The Path Coefficient Interpretation, according to the Path Coefficient table, is the result of the bootstrapping process. To determine the significant influence on the path, it can be determined by the p value where the results of the analysis show that the path analysis on the indirect effect between Planning and Implementation and Implementaion of Risk Management to the Contractor Performance and then to Project Performance has a p value of 0.000 <0.05 and T statistic 8,269 > 1.666 indicating that the path analysis positively and significantly influences each other. From the results of the path analysis/ path coefficient in this study, the following mathematical equation was obtained: Y = 0.990 (PI) + 0.978 (IRM) + 1.000 (CP) + 0.911 (PP) .... (2)

Table 3 Specific Values of Indirect Effect

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
(X2) -> (X3) -> (Y)	0,228	0,232	0,079	2.894	0.004
(X1) -> (X3) -> (Y)	0,635	0,631	0,076	8.369	0.000
(X2) -> (X3) -> (X3.1)	0,259	0,263	0,088	2.929	0.004
(X1) -> (X3) -> (X3.1)	0,721	0,717	0,087	8.270	0.000
(X2) -> (X3) -> (Y) -> (Y1)	0,208	0,212	0,071	2.904	0.004
(X3) -> (Y) -> (Y1)	0,802	0,804	0,024	32.909	0.000
(X1) -> (X3) -> (Y) -> (Y1)	0,579	0,576	0,071	8.104	0.000
(X2) -> (X3) -> (Y) -> (Y2)	0,206	0,209	0,070	2.952	0.003
(X3) -> (Y) -> (Y2)	0,797	0,797	0,027	29.541	0.000
(X1) -> (X3) -> (Y) -> (Y2)	0,575	0,572	0,074	7.775	0.000

From the specific indirect effect table above, it can be concluded that there is a significant relationship between Planning & Implementation (X1) and Contractor Performance (X3) and Project Performance Variable (Y). A significant relationship also exists between the Implementation of Risk Management (X2) and Contractor Performance (X3) with Project Performance (Y).

From the table, it can also be seen that contractor performance (X3) has a simultaneous effect on the quality and time performance (Y) of implementation on a multi-storey building construction project. As obtained, the significance value is 0.000 <0.05 or F count = 29.541> F table = 1.666.

From the results of the discussion presented to provide answers to the formulation of the problem and research objectives, the following conclusions can be drawn:

Table 4 Risk Factors Affecting Contractor Performance

			T Statistics	
		Original Sample	>1.96	**Against R Square**
No	Sub Factors		(p< 0.05)	
1	Terms of reference	0.949	80,130	**0.776**
2	Field plan	0.934	67,440	
3	Mobilisation of tools and workforce	0.933	62,753	
4	Shop drawing	0.927	61,411	
5	Identification of Licensing	0.932	55,006	

Table 5 Risk factors of contractor performance that affect high-rise building construction projects.

			T Statistics	
		Original Sample	>1.96	**Against R Square**
No	Sub Factors		(p< 0.05)	
1	Inadequate labour skills	0,873	33,705	**0.776**
2	Availability of equipment on site	0,825	31,073	
3	Late payments to subcontractors	0,869	30,915	
4	Experience of field managers/supervisors	0,829	23,887	
5	Shortage of workforce	0,768	22,755	

CONCLUSIONS

Risk factors in high-rise buildings that influence contractor performance in high-rise building construction projects are:

1. Terms Of Reference
2. Inappropriate field planning can affect contractor performance.
3. Mobilising equipment and workforce not according to the plan can affect the contractor's performance.
4. Inappropriate working drawings can affect the contractor's performance.
5. Inadequate licensing identification can affect contractor performance

Time and quality performance in construction projects are positively and significantly affected by how well contractors perform. The success of a project in completing work on schedule is highly dependent on the synergy and optimal performance of the three parties. Effective supervision, good management, and strong coordination are the keys to achieving good time and quality performance in construction projects.

Factors of the contractor's role that influence the quality and time of controlling a high-rise building construction project are:

1. Inadequate workforce skills can affect contractor performance on high-rise building construction projects
2. The availability of equipment on site can affect contractor performance on high-rise building construction projects.
3. Late payment to subcontractors can affect contractor performance on high-rise building construction projects.
4. The experience of the field manager/supervisor can affect contractor performance on high-rise building construction projects.
5. Labor shortages can affect contractor performance on high-rise building construction projects.

REFERENCES

1. Abd El-Karim, MSBA, Mosa El Nawawy, OA, & Abdel-Alim, AM (2017). Identification and assessment of risk factors affecting construction projects. HBRC Journal, 13(2), 202–216. https://doi.org/10.1016/j.hbrcj.2015.05.001
2. An American National Standard. (2008). A Guide To The Project Management Body of Knowledge (PMBOK Guide) (Fourth Edi). Project Management Institute, Inc.
3. Haryono, S. (2016). SEM Method for Management Research with AMOS, LISREL, Smart PLS. Journal of Physics A: Mathematical and Theoretical, 450.
4. Hawari, K. (2009). Project Risk Identification in the Construction Phase of 4-20 Storey Buildings in Jabotabek from a Contractor's Perspective. 1, 1–129.
5. Kamal, A., Abas, M., Khan, D., & Azfar, R.W. (2022). Risk factors influencing the building projects in Pakistan: from the perspective of contractors, clients, and consultants. International Journal of Construction Management, 22(6), 1141–1157. https://doi.org/10.1080/15623599.2019.1683693
6. Lin, C.L., & Chen, B.K. (2021). Research for risk management of construction projects in Taiwan. Sustainability (Switzerland), 13(4), 1–15. https://doi.org/10.3390/su13042034
7. Mas'ud, F., Mursidi, B., Darmawan, LOR, & Rustan, FR (2023). Analysis of Time and Cost Risk Management in the Construction Project of the Type D Regional Public Hospital in Kendari City. STABILITA || Scientific Journal of Civil Engineering, 11(3), 122. https://doi.org/10.55679/jts.v11i3.43080
8. Sarstedt, M., Ringle, C. M., & Hair, J. F. (2020). Handbook of Market Research. In Handbook of Market Research (September Issue).

https://doi.org/10.1007/978-3-319-05542-8

9. Sinaga, L. (2024). Analysis of the green retrofit concept according to the guidelines of the Minister of Public Works and Public Housing Regulation No. 21 of 2021 on chemical industry buildings based on blockchain-BIM for cost efficiency. Lastarida Sinaga's thesis NIM:... 21. https://doi.org/10.13140/RG.2.2.17159.82085
10. Situmorang, BE, Arsjad, TT, Tjakra, J., Sipil, T., Sam, U., Manado, R., Manado, JKB, & Ratulangi, S. (2018). Risk Analysis of Building Construction Project Implementation. Tekno, 16(69), 31–36.
11. Sutikno, S., Husin, AE, & Yuliati, MME (2022). PLS-SEM will analyse the criteria for the optimum cost of green MICE projects in Indonesia based on value engineering and lifecycle cost analysis. Archives of Civil Engineering, 68(4), 555–570. https://doi.org/10.24425/ace.2022.143054
12. Tri Wizaksono, B., & Waty, M. (2023). Risk Analysis of the Bumi Slipi Mandiri IT Development Project. JMTS: Jurnal Mitra Teknik Sipil, 6(4), 885–898. https://doi.org/10.24912/jmts.v6i4.24917