eksis
jurnal riset ekonomi & bisnis
E-ISSN : 2549-6018
P-ISSN : 1907-7513

RISK ANALYSIS FOR THE DEVELOPMENT OF XYZ RESIDENCE

Dewie Saktia Ardiantono*, Satrio Hestu Pidekso
Institut Teknologi Sepulih Nopember
*Correspondence *: dewie@mb.its.ac.id*

Submitted: 5 February 2024, Revised: 15 March 2024, Published: 30 April 2024

Abstract

Population growth in Indonesia creates new challenges for the housing sector. Scarcity in Jakarta and high land prices make residents actively look for alternative housing options in neighboring areas such as Bogor. This causes increased competition between housing development companies, including the XYZ residence project. This research uses the severity index to analyze, evaluate, prioritize and suggest strategies for managing construction-related hazards in the xyz housing area project. From the research results it appears that in the temporal dimension of the XYZ residence construction project, 28 hazards have a very low probability of affecting the project schedule, 14 hazards have a low probability, 2 (two) hazards have a medium probability, 3 (three) hazards have a high probability, and 4 (four) danger has a very high probability. Likewise, the evaluation of the level of risk in the cost aspect of the xyz residence development project shows that 36 risks have a very low probability of influencing project costs, compared to 5 (five) low risks, five medium risks, 1 (one) high risk, and 4 (four) very high risks. For this reason, it is necessary to implement measures that impact the financial dimension.
Keywords: Impact Matrix, Probability, Risk Analysis, Severity Index

A. INTRODUCTION

The population of Indonesia is experiencing a steady increase daily. Based on the statistics provided by the Central Statistics Agency (2018), it is projected that the population of Indonesia will see a substantial annual growth of approximately 3,000 individuals. The escalation in population will inevitably lead to the emergence of novel challenges, specifically in housing. Residential dwellings are a fundamental societal necessity and play a significant economic role (Antony et al., 2018). The scarcity of land, high costs of land and houses, and the high population density in Jakarta have prompted residents to seek alternate housing options in the surrounding districts. As a result, housing development businesses compete to construct housing in various places surrounding Jakarta, particularly in the Bogor region. This has led to the rise of multiple housing development projects, including the XYZ Residence.

A project is a transient endeavor to generate a distinctive product, service, or outcome (Project Management Institute, 2013). Nevertheless, the unique attributes of a project give rise to ambiguity over the outcome or provision of the project's product or service. Project uncertainty can arise from diverse sources and conditions, particularly in building projects. The objective of a construction project is to accomplish it within the designated timeframe and budget while upholding a standard of quality that aligns with the intended concept and specifications of the housing project. However, achieving these goals can be compromised if there is a failure to acknowledge the presence of uncertain conditions that may lead to potential risks. Implementing building projects frequently encounters challenges, such as the need for time extensions and the imposition of supplementary expenses.

Risk can cause a disturbance that adversely affects the company's operations (Jedynak & Bąk, 2021). The initial step in project development is conducting a feasibility study (Barraza de la Paz et al., 2023). it is imperative to incorporate risk analysis and mitigation strategies to perform a comprehensive and accurate feasibility assessment. The risk analysis for the construction of XYZ Residence will be conducted during the land processing phase. The Severity Index and Probability and Impact Matrix methodologies were utilized to conduct risk assessments at XYZ Residence. The objective of employing the Severity Index methodology is to derive a mean value that encapsulates participants' responses regarding the likelihood and consequences of risk, expressed in the form of risk categories. Utilizing a severity index offers the benefit of facilitating the categorization process.

B. LITERATURE REVIEW

1. Project Risk Management

Project risk management is a methodical procedure for formulating and advancing strategies, recognizing, examining, and addressing current project hazards. Risk management involves identifying, calculating, analyzing, and reviewing potential hazards and effectively developing methods to manage these risks(Ferreira de Araújo Lima et al., 2021). According to Gachie (2017), project risk management is a multifaceted approach that involves identifying, analyzing, and responding to risks that may arise throughout a project while simultaneously ensuring the attainment of project objectives. The primary purpose of project risk management is to enhance favorable prospects and mitigate potential unfavorable occurrences. When implementing a project, the aspect of risk management is frequently overlooked. However, it is crucial to recognize that risk management is vital in enhancing the likelihood of project success. It aids projects in various stages, including initiation, project scope, and the development of realistic estimates.

According to the Project Management Institute (2017), the risk management process consists of six stages of activities, which are: 1) Risk management planning; 2) Risk identification; 3) The process of qualitative risk analysis; 4) Quantitative risk analysis; 5) A risk management plan; and 6) The activities of risk monitoring and control.

2. Construction Project

A construction project refers to a deliberate undertaking to construct a building, with constraints imposed by cost, quality, time, and resources (Bucay et al., 2022). The completion must meet three specific outputs: adherence to defined standards, the designated time schedule, and intended costs (Silva, 2016). The primary objectives of a building project encompass quality, money, and time. The efficacy of a construction project is typically contingent upon the caliber of planning and preparations undertaken to facilitate its execution, given the intricate nature of construction projects (Adaurhere et al., 2021).

3. Project Risk

Risk can be defined as the amalgamation of the likelihood of an adverse occurrence and the magnitude of its consequences while acknowledging the potential existence of several outcomes resulting from a single event (Woodruff, 2005). Risks can be attributed to one or multiple sources, and upon their occurrence, they can result in one or various repercussions. Two uncertainties accompany the realization of construction projects. The initial uncertainty refers to uncertainty that has a detrimental effect, also known as risk. The second type of uncertainty is called opportunity, which has a positive influence (Kuchta et al., 2023).

4. Severity Index

The severity index is one approach to risk assessment. The objective is to acquire outcomes from a synthesis of impact and risk probability evaluations. The severity index is computed using the respondents' responses (Gu et al., 2011). Following this, the results of the calculations will be classified according to the magnitude of the impact and probability calculations. A severity index yields more precise and consistent results with the participants' responses, specifically in percentages, which is an advantage. As the percentage value of risk increases, so does the magnitude of its influence. The formula for the severity index is given below:

$$SI= \frac{\sum_{i=0}^{4} a_i x_i}{4\sum_{i=0}^{4} x_i}(100\%)$$

5. Probability Impact Matrix

Risk probability and impact matrices are used to enter the risk values. The matrix provides a risk level based on recognized and analyzed risks (A. Kassem et al., 2020). The likelihood and impact of each risk are evaluated using a probability and impact matrix, which determines the combination of probabilities and effects that result in shallow, low, medium, high, and very high-risk categories. To input probability values and risk implications characterized by SI percentages, they will first be transformed into a Likert scale.

6. Risk Priority Number

The Risk Priority Number (RPN) is a crucial indicator for reducing remedial activities or identifying opportunities to explore system faults based on their condition (Satria, 2017). RPN is a Failure Mode and Effects Analysis (FMEA) technique component derived from multiplication results (Zuniawan, 2020). The multiplication result used to calculate the RPN value reflects the severity of the risk factor. The greater the RPN risk score, the more problematic or critical the risk factor is; conversely, the lower the RPN risk score, the lower the risk factor's level. RPN analysis is expected to reduce or eliminate the number of risk variables through risk management.

C. RESEARCH METHOD

The present study can be classified as applied research. Applied research aims to identify resolutions to societal or organizational challenges (Harto et al., 2019). This study employs a combination of quantitative and qualitative research approaches. Quantitative methodologies are used to quantify data acquired through questionnaires. Furthermore, qualitative methods were employed to analyze and elucidate the data acquired from the interviews. This study uses a checklist analysis approach to detect risks by integrating a historical inventory of organizational hazards with literature reviews on risks in development projects. Subsequently, the risk inventory will be analyzed through a questionnaire comprising statements that employ a Likert scale methodology to evaluate the extent of the influence exerted by risk factors and the likelihood of such impact on the time performance and construction expenses of XYZ Residence. The procedure of processing the questionnaire questions will involve the utilization of the Severity Index. The subsequent step consists of a risk priority rating utilizing the Probability and Impact Matrix. Ultimately, risk mitigation measures will be implemented for significant or prevailing hazards based on the assigned risk assessment.

The research relies on primary data obtained through the distribution of questionnaires to critical informants involved in the XYZ Residence project, specifically focusing on the urgency of risk factors. The critical informants chosen for this study are individuals in project risk management positions. The informants in this research were 1) the Project Manager, 2) the Head of Quality Control, 3) the Head of Supervision, 4) the Head of Contractor, and 5) the Contractor. The five informants were chosen based on their responsibility for implementing the XYZ Residence land processing stage within their work division.

The preliminary questionnaire is assessed by assigning checklist marks to pertinent or irrelevant columns. The relevant column indicates that the risk indicator occurred or may occur during the XYZ Residence development project. In contrast, the irrelevant column suggests that the risk indicator did not happen and is unlikely to occur during construction.

A follow-up questionnaire was used to choose frequency and impact scale values, followed by the Severity Index approach. The Severity Index method was selected for risk assessment because it simplifies the process of processing and classifying risks, making calculations easier. The Severity Index data processing results will also be in percentages, which are more accessible for the project and external parties to understand. The goal of the risk analysis stage is to create a composite value based on an evaluation of the frequency of events and their influence on performance, quality, and project costs.

After determining the impact and probability using the Probability and Impact Matrix, the impact and probability scale will be multiplied using the RPN Formula. After deciding the risks at high and very high levels, a risk response will be developed, which includes a process, technique, and strategy for dealing with the probability of risk occurring.

D. RESULTS AND DISCUSSION

1. Risk Factor Identification

The initial phase of this study is the identification of risk variables associated with the development of XYZ Residence at the land processing stage. This will be accomplished through expert consultations and the validation of risk identification mechanisms. Risk identification is conducted at the land processing step at XYZ Residence, utilizing the business process as a basis. All stages in the business process of the land processing phase in this home complex are considered risk variables. In this last task, the validation of risk variables was conducted by two individuals who had responsibility for the land processing stage and possessed a comprehensive awareness of both technical and managerial issues. The relevance of each risk factor indication is determined by the responses provided by the respondents to each indicator.

A total of 11 risk variables will be identified, each accompanied by its respective indicator. The risk variables encompass various aspects, commencing from the initial phase, which involves the provision of tools and materials, labor, blow plank, foundation excavation, foundation stonework, steel, wall, roof, finishing work, supervision, and coordination of implementation, supervision risk, and financial coordination. The ranking of each risk indicator for each variable is determined by the respondent's response, indicating whether it is crucial or unimportant.

Risk identification involves the active participation of the Project Manager and Head of Contractor to authenticate and confirm the presence of any existing risks. The two managers were chosen based on their demonstrated ability and comprehensive expertise encompassing all project parts, from technical to management. Out of the 62 indicators listed in the questionnaire, 11 were found to be irrelevant, and 51 were found to be relevant. These indicators were then examined to determine the probability and consequences of risk using the Severity Index (SI).

2. Severity Index

The probability and impact of risks can be evaluated using the severity index formula based on the data acquired to assess the likelihood and impact of risks using the severity index (SI). The calculated outcomes will be modified according to the evaluation scale outlined in Table 1, encompassing both probability and impact.

Table 1 The Severity Index Scale for Evaluating Impact

Description	Severity Index Scale
Very Rare/Very Low	$0 \leq SI \leq 12{,}5$
Rare/Low	$12{,}5 \leq SI \leq 37{,}5$
Fairly Frequent/Moderate	$37{,}5 \leq SI \leq 62{,}5$
Frequent/High	$62{,}5 \leq SI \leq 87{,}5$
Very Often/Very High	$87{,}5 \leq SI \leq 100$

An example calculation will be performed on the risk variable for the material utilized that did not meet the agreement and standards. In this risk variable, three persons stated it was highly unusual, while two said it was rare. Using the severity index formula, we can compute the risk probability as follows:

Known:

a_0	= 0,	x_0	= 3
a_1	= 1,	x_1	= 2
a_2	= 2,	x_2	= 0
a_3	= 3,	x_3	= 0
a4	= 4,	x_4	= 0

Thus,

$$SI=\frac{\sum_{i=0}^{4} a_i x_i}{4\sum_{i=0}^{4} x_i}(100\%)$$

$$SI=\frac{\left((0\times3)+(1\times2)+(2\times0)+(3\times0)+(4\times0)\right)}{4\times5}\times100\%$$

$$SI=10\%$$

Based on the risk probability assessment outcomes, it has been determined that the material utilized does not adhere to the agreed-upon requirements, resulting in an SI value of 10%. The SI value is between 0% and 12.5%, indicating a risk category characterized by a possibility of being classified as "very rare or very low." These formulas apply to the computation of probabilities and impacts. Probability calculations serve the objective of quantifying uncertainty by producing predictions on the likelihood of the occurrence of this risk in the XYZ Residence development project. The process of impact computation is conducted to determine the categorization of risks based on their impact, which is classified as very low, low, fair, high, and very high.

Subsequently, a risk analysis computation is performed by multiplying the probability by the impact (PxI) utilizing a matrix that combines probability and effect. The risk level determination is presented in Table 2. The risk level can be categorized into three distinct levels, which are as follows:

1. Very Low and Low Risk is a risk that can be accepted or ignored if it occurs.
2. Medium risk is a low impact but has a high probability level or a high impact with a low probability of occurrence.
3. High and Very High Risks are risks with a high probability of occurrence and a significant impact on the project.

Table 2 Risk Level Matrix Description

Score	Risk Level
1 - 5	*Very Low*
6 - 8	*Low*
9 - 12	*Moderate*
15 - 16	*High*
20 - 25	*Very High*

Table 3 Risk Level Matrix based on Impact Over Time

Indicator Code	**Indicator**	**Severity Index**	**Risk Level**
X10.5	An internal debate arose within the realm of project management.	1	Very Low
X10.6	Regular supervision is not consistently conducted.	1	Very Low
X3.2	The stake changed.	2	Very Low
X3.3	Damaged planks accompany the wooden posts.	2	Very Low
X3.4	Installing foundation boundary threads is causing an error.	2	Very Low
X9.5	The porcelain fractured during the process of placing it on the floor.	2	Very Low
X9.8	The sink, spot, and water closet were damaged during installation—failure to consider unforeseen expenses (contingencies).	2	Very Low
X11.2	The materials utilized fail to adhere to the terms and criteria outlined in the agreement.	2	Very Low
X1.1	Delayed delivery of materials	3	Very Low
X1.4	Delayed delivery of equipment	3	Very Low
X1.9	The delivery of equipment was delayed.	3	Very Low
X1.10	An internal debate arose within the realm of project management.	3	Very Low
X2.3	Labor Strike	3	Very Low
X4.1	The pattern of the excavated earth does not match. Wooden stakes, twine	3	Very Low
X4.2	The elevation of the soil excavation is inappropriate.	3	Very Low
X5.1	Mix adhesive to install damaged foundation stones.	3	Very Low
X6.6	The formwork was removed, destroying the column's cast concrete.	3	Very Low
X7.5	Bricks were damaged during installation.	3	Very Low
X9.6	Ceramics are not trimmed to size.	3	Very Low
X9.7	The sink/pisspot/water closet does not fulfill the standards.	3	Very Low
X9.9	Error in the installation of the electrical system	3	Very Low
X8.3	The horses made of lightweight steel transformed.	4	Very Low
X8.4	During the process of installation or assembly, the ring	4	Very Low

Indicator Code	Indicator	Severity Index	Risk Level
	balk incurred damage.		
X8.6	The cast ring obtained will undergo destruction with the removal of the formwork.	4	Very Low
X8.8	The aluminum truss fractured during the process of assembly.	4	Very Low
X10.2	Inadequate communication among employees	4	Very Low
X10.3	The daily reports lack completeness.	4	Very Low
X10.4	*Change Order*	4	Very Low
X1.3	The necessary materials are deficient.	6	Low
X1.6	The utilized equipment fails to adhere to the terms of the agreement and does not meet the prescribed quality standards.	6	Low
X3.1	Incorrect positioning of wooden stakes	6	Low
X5.2	The organization of crushed stone	6	Low
X6.5	The cast concrete sloof undergoes destruction upon the removal of the formwork.	6	Low
X7.1	The arranged bricks exhibit signs of deterioration.	6	Low
X7.4	Unclean and unsanitary state	6	Low
X8.1	The assembling process resulted in damage to the light steel trusses.	6	Low
X8.2	During the installation process, the light steel truss was damaged.	6	Low
X9.2	The frame sustained damage during the process of installation.	6	Low
X9.3	The door sustained damage during the installation.	6	Low
X1.2	Escalating costs of materials	8	Low
X2.1	There is an increase in labor wages.	8	Low
X7.3	The difference in height of the bricks when they are installed	8	Low
X1.7	Equipment damaged	9	Moderate
X4.3	Groundwater is overflowing	12	Moderate
X1.8	Equipment lost	15	High
X2.2	Accidents experienced by workers	15	High
X2.4	The workforce lacks experience	16	High
X1.5	Materials delivered late	20	Very High
X7.2	The brick installation point is not correct	20	Very High
X9.1	Wall painting is uneven	20	Very High
X10.1	Implementation does not match the planning schedule	20	Very High

According to the risk level matrix table, 44 risks are classified as extremely low-medium based on their influence on time. These risks have been computed and are included in the risk matrix. Out of the total number of dangers, 28 are categorized as having a shallow risk, 14 as having a low risk, and two as having a high risk. A significant level of risk characterizes three dangers. A substantial likelihood of occurrence and consequences characterizes a high-risk level. Risks that possess a considerable level of risk should be classified as risky due to their frequent occurrence and significant impact on the execution of the present project. A risk response is necessary for high-risk situations. Four dangers exhibit a significantly elevated level of risk. This is because the value falls within the range of 20 to 25 when graphed in the Probability Impact Matrix. The risk level has a significantly elevated likelihood of occurrence and carries a substantial consequence. Therefore, a risk response is needed to overcome this problem.

Table 4 Risk Level Matrix based on Impact Over Cost

Indicator Code	Indicator	Severity Index	Risk Level
X1.9	Delayed delivery of equipment	1	*Very Low*
X3.2	The stake changed.	1	*Very Low*
X3.4	Installing foundation boundary threads is causing an error.	1	*Very Low*
X10.5	An internal debate arose within the realm of project management.	1	*Very Low*
X10.6	Regular supervision is not consistently conducted.	1	*Very Low*
X1.1	The materials utilized fail to adhere to the terms and criteria outlined in the agreement.	2	*Very Low*
X1.10	The delivery of equipment was delayed.	2	*Very Low*
X2.3	Workers' strike	2	*Very Low*
X3.1	Incorrect positioning of wooden stakes	2	*Very Low*
X3.3	Damaged planks accompany the wooden posts.	2	*Very Low*
X4.1	The observed soil pattern does not exhibit congruence. Staples made of wood and thread	2	*Very Low*
X4.2	The soil excavation elevation is inadequate.	2	*Very Low*
X5.1	Prepare adhesive to mount impaired foundation stones.	2	*Very Low*
X7.5	The bricks incurred damage during the installation.	2	*Very Low*
X9.9	Error in the installation of the electrical system	2	*Very Low*
X10.2	Inadequate communication among employees	2	*Very Low*
X10.3	The daily reports lack completeness.	2	*Very Low*
X1.4	Delayed delivery of materials	3	*Very Low*
X6.6	The structural integrity of the column's cast concrete was compromised with the removal of the formwork.	3	*Very Low*
X7.4	Unclean and unsanitary state	3	*Very Low*
X8.8	The aluminum truss fractured during the process of assembly.	3	*Very Low*
X9.5	The ceramic fractured during the floor installation process. The ceramics were not correctly trimmed.	3	*Very Low*
X9.6	The utilized equipment fails to adhere to the terms of the agreement and does not meet the prescribed quality standards.	3	*Very Low*
X1.6	The organization of crushed stone	4	*Very Low*
X5.2	The observed soil pattern does not exhibit congruence. Staples made of wood and thread	4	*Very Low*
X6.5	Cast concrete spoof is destroyed when the formwork is removed	4	*Very Low*
X7.3	The difference in height of the bricks when they are installed	4	*Very Low*
X8.3	The light steel horses shifted	4	*Very Low*
X8.4	The ring balk was damaged during installation or assembly	4	*Very Low*
X8.6	The resulting cast ring will be destroyed when the formwork is removed	4	*Very Low*
X9.2	The frame was damaged during the installation	4	*Very Low*
X9.3	The door was damaged during the installation	4	*Very Low*
X9.8	The sink/pisspot/water closet was damaged during installation	4	*Very Low*
X11.2	Not paying attention to unexpected costs (contingencies)	4	*Very Low*
X9.7	The sink/pisspot/water closet does not meet the specifications	5	*Very Low*
X10.4	Change Orders	5	*Very Low*
X7.1	The bricks that have been arranged are damaged	6	*Low*

Indicator Code	Indicator	Severity Index	Risk Level
X8.1	The light steel trusses were damaged during assembly	6	*Low*
X8.2	The light steel truss was damaged during installation	6	*Low*
X1.3	The materials required are lacking	8	*Low*
X10.1	The execution does not align with the predetermined timetable.	8	*Low*
X1.7	The equipment has incurred damage.	9	*Moderate*
X1.5	The delivery of materials was delayed, resulting in uneven wall painting.	10	*Moderate*
X9.1	The labor force is deficient in expertise.	10	*Moderate*
X2.4	The location of the brick installation is incorrect.	12	*Moderate*
X7.2	Escalating costs of materials	12	*Moderate*
X1.2	Lost equipment	16	*High*
X1.8	There is an increase in labor wages.	20	*Very High*
X2.1	The groundwater is beyond its capacity.	20	*Very High*
X4.3	Worker accidents	20	*Very High*
X2.2	The execution does not align with the predetermined timetable.	25	*Very High*

According to the risk level matrix table, 46 risks are classified as extremely low-medium based on their influence on costs. These risks have been evaluated and are included in the risk matrix. 36 dangers are categorized as having a very low-risk level. These risks are typically encountered during project execution. Dangers with a very low-risk level are disregarded since they are deemed to have no impact on project expenses. An instance of an indicator categorized as having a very low-risk level is the absence of regular monitoring. This implies that in the event of this risk materializing inside the project, its potential consequences on project expenses would be minimal, and the likelihood of this risk materializing is exceedingly minimal.

Similarly, the level of risks is relatively low, encompassing five dangers often disregarded due to their limited impact. For instance, one such risk pertains to the insufficiency of essential materials and the potential destruction of arranged bricks. Risks classified as medium typically exhibit a moderate to high likelihood of occurrence; however, their impact on costs is relatively low. Alternatively, risks with a low probability may nonetheless have a relatively high or moderate influence on costs. In some cases, these risks may even have both a probability and an impact on costs within the same category. Among the five concerns categorized as moderate risk, one pertains to the delayed delivery of materials.

A single risk exists characterized by a high level of risk. A significant level of risk is determined by dangers that are highly likely to happen and the impact of risk on expenses. Risks that possess a high level of risk should be regarded as inherently dangerous. High-risk risks are characterized by their frequent occurrence and substantial influence on the ongoing implementation of a project. According to the results of the analysis, the likelihood of "material price increases" being a high probability is 80%, and the long-term impact of this risk is 85%, which is also highly rated. An increase in the cost of materials utilized in the project results in a corresponding increase in the budget allocated for executing project tasks. A risk response is necessary for high-risk situations.

As can be seen, there are four dangers with a very high risk rating. This is because when plotted in the Probability Impact Matrix, the value ranges from 20 to 25. A very high-risk level means the risk has a high possibility of occurring and having a significant impact. As with expenses, danger requires a reaction. For example, the analysis results suggest that the threat of "worker accidents" is relatively high because SI has a 90% occurrence probability ratio, which is regarded as very high, and the risk impact of SI over time in the classroom is very high. The results indicate that the probability and risk effect values are high or extremely high. As a result, risk management is required; additionally, it will impact project implementation in terms of cost and time.

3. Risk Priority Number

The Risk Priority Number defines risk priority for risk management or response. The Risk Priority Number is a component of the FMEA technique derived from multiplication findings. The Risk Priority Number is calculated as the product of impact, probability, and detection. After determining the effect and probability from the Probability and Impact Matrix, the scale of impact and probability will be entered into the RPN Formula using the following formula:

RPN = SEV x OCC x DET

Notion:

RPN : Risk Priority Number
SEV : The impact of risk factors
OCC : The probability that a risk factor can occur.
DET : Detection that can be done of risk factors

The Risk Priority Number Formula results are presented in Tables 5 (five) and 6 (six). To calculate the Risk Priority Number, one must multiply the impact, probability, and detection values. The Severity Index computations are used to determine the impact and probability, which are further analyzed using the Probability and Impact Matrix. In the interim, the detection process was acquired by administering a questionnaire to the XYZ Residence Project Manager, who completed many indications. Table 5 (five) presents a comprehensive overview of seven risk factors influencing the time aspect.

Similarly, Table 6 presents an analysis of five risk factors that impact the cost aspect of the Probability and Impact Matrix calculation. These risk factors are categorized into high and very high categories, with their priorities determined based on the Risk Priority Number calculation results. Implementing the Risk Priority Number enables the project team to prioritize providing risk control measures within the high and very high categories.

Table 5 Impact of Risk Prioritization on Time Aspects Using RPN

Risk Factor	Probability	Impact	Detection	RPN	Priority
Inexperienced workforce.	4	4	7	112	1
Materials sent late	5	4	4	80	2
Implementation does not align with the planning schedule.	4	5	4	80	3
The brick installation point is incorrect.	4	5	3	60	4
Workers had accidents.	5	3	3	45	5
Wall painting is uneven	5	4	2	40	6
Lost Equipment	5	3	2	30	7

Table 6 Impact of Risk Prioritization on Cost Aspects Using RPN

Risk Factor	Probability	Impact	Detection	RPN	Priority
There is an increase in labor wages.	4	5	5	100	1
Workers had accidents	5	5	3	75	2
There has been an increase in material prices.	4	4	4	64	3
Superfluous groundwater	4	5	3	60	4
Lost Equipment	5	4	2	40	5

4. Risk Response

There exist seven prevailing risks that manifest and exert influence across time. Every risk indicator is accompanied by a cause, preventative measures, repressive measures, and comprehensive documentation to aid the relevant party in addressing the risk. The causes and responses to hazards that have been prioritized on a scale that impacts the temporal dimension encompass, among various factors:

a. The danger of an inexperienced workforce is encompassed within the broader risk of workforce supply. As mentioned above, the risk arises from the caliber of the personnel engaged in the XYZ Residence project. Consequently, the proposed reaction will pertain to the training and assessment of the project's workforce's performance. This risk will undoubtedly affect the project's completion time due to the presence of less skilled workers, resulting in decreased productivity and a longer project timeline. Additionally, the need for workforce training will further prolong the project's duration.

b. Delayed delivery of materials: This risk encompasses potential delays in the dispatch of tools and materials. This risk may arise due to supplier delivery delays, procurement challenges, and material shortages. The acquisition of tools and supplies following specific requirements and predetermined schedules has a negative impact on worker productivity due to the significant quantity of idle time, which impedes the overall pace of work.

c. The execution of the project deviates from the predetermined timeline. One of the risks associated with this situation is monitoring and coordinating implementation. This risk may arise due to various factors, including incongruity between the number of workers and their competence with the current activities or tasks, unavailability of construction equipment at the project site, monitoring factors about the appropriateness of the project timeline, and negligence in project work reports. Due to this rationale, the risk response will pertain to monitoring, evaluating, and reporting project implementation to ensure alignment with the established timeline. Additionally, it will involve the selection of a suitable and proficient workforce as a proactive measure to mitigate potential errors that may arise during the implementation of project development. The misalignment between the project completion time and the planning timeline has a significant impact, resulting in an extended project activity duration.

d. The risk of incorrect brick installation point is encompassed within the broader risk associated with wall work. The occurrence of this risk can be attributed to various variables, including inadequate layout (zigzag/straight), inaccuracies in measuring the placement of bricks, variations in the composition of cement and sand used as a binding agent, and the competence of the labor force involved in the construction process. Hence, the risk response implemented will be associated with the brick-laying methodology and the personnel responsible for executing the brick-laying process. The wrong installation of bricks directly impacts the project's completion schedule since it necessitates repairs that will extend the project's overall duration.

e. Worker accidents: This risk encompasses the potential for supplying labor. The risk is attributed to various causes, including environmental, human, and equipment issues. Therefore, the response will focus on K3 equipment, equipment, and workforce training. The presence of this risk will undoubtedly affect the project's completion time. In a labor accident, the project's workforce will be diminished, resulting in decreased productivity. Additionally, replacing workers affected by accidents may arise, which consumes time.
f. The potential for uneven wall coverings is encompassed under the dangers of finishing work. Errors in the application of wall plaster can lead to this risk. Hence, the risk response implemented will pertain to the methodology and oversight of plaster application on wall plastering. The uneven plastering of the walls in the construction project significantly impacts the project completion time. This is due to the resulting wavy and textured appearance of the walls, necessitating adjustments to the project. Consequently, the duration of the project completion will be extended.
g. The risk associated with lost equipment encompasses the potential loss of tools and supplies. The potential risk at the project construction storage location can be attributed to security concerns, thus necessitating a response specifically focused on project security. This risk will undoubtedly affect the project's completion time since the loss of necessary equipment would halt project progress and necessitate acquiring new or replacement equipment to sustain project activities.

Five primary risks manifest and exert influence on costs. Every risk indicator is accompanied by a cause, preventative measures, repressive measures, and comprehensive documentation to aid the relevant party in addressing the risk. The temporal dimension is influenced by a priority scale that ranks the causes and risk responses:

a. The potential for increased labor wages includes the risk associated with foundation excavation activity. As mentioned above, the risk arises from many causes, including governmental regulations, the imperative for a satisfactory standard of life, the influence exerted by trade unions within the vicinity, prevailing pricing levels, work productivity, economic structure, and average salary within the community. The proposed risk response pertains to the Draft Cost Budget concerning labor expenses to mitigate potential losses during project implementation. This directly impacts the expenses associated with project work, as raising labor wages will result in a more significant labor burden on the project budget.
b. Worker accidents: This risk encompasses the potential hazards associated with job recruitment. The danger arises from multiple causes, specifically environmental, human, and equipment variables. Hence, the responses pertain to personal protective equipment (PPE), equipment, and worker training. Industrial accidents will impact the cost of project implementation due to the resulting financial losses. These losses encompass damage to equipment, materials, and structures, as well as expenses related to care and maintenance, accident compensation, and additional costs for wounded workers.
c. The risk associated with rising material prices encompasses the potential for increased costs in shipping tools and materials. The risk arises from multiple factors, including a rise in Value Added Tax (VAT) from 10 percent to 11 percent

commencing in April 2022 and an escalation in production expenses. Consequently, the risk response to this risk is situated within the framework of a proposed budget decrease. It is conceivable for implementation projects to incur losses. The cost of project work will be impacted by this since a rise in material prices necessitates the contractor reassessing the Project Budget Presentation to mitigate potential project losses.

d. Groundwater overflow: This risk includes the risk of providing labor. This risk is caused by various factors, such as the water level not being comparable to the ground level in housing projects. This can cause the water to almost approach the ground-level floor tiles in housing projects. Conditions like this can make it easier for water in the ground to seep in and enter through the pores so that the water can penetrate the floor in housing projects. This, of course, affects the costs of project work because, with overflowing groundwater, repairs are needed to excavate the foundation of the housing project, so the risk response given will be related to inspection of the excavated soil, such as dewatering.

e. The risk associated with lost equipment encompasses the potential loss of tools and supplies. The potential risk at the project construction storage location can be attributed to security concerns, thus necessitating a response specifically focused on project security. This risk will undoubtedly affect the project's completion time since the loss of necessary equipment would halt project progress and necessitate acquiring new or replacement equipment to sustain project activities.

E. CONCLUSION

The findings of the risk identification process indicate that there are 6 (six) risk factors associated with foundation stonework, 2 (two) risk factors associated with steelwork, 5 (five) risk factors associated with wall work, 6 (six) risk factors associated with roof work, 8 (eight) risk factors associated with finishing work, 6 (six) risk factors associated with supervision and coordination of implementation, and 1 (one) risk factor associated with supervision and financial coordination. Based on the findings of the risk level assessment conducted on the temporal dimension of the XYZ Residence construction project, it has been determined that there exist 28 risk factors exhibiting a significantly low risk level, 14 risk factors displaying a low-risk level, 2 (two) risk factors exhibiting a medium risk level, 3 (three) risk factors exhibiting a high-risk level, and 4 (four) risk factors exhibiting a very high-risk level. Additionally, the findings from evaluating the risk level of the cost aspect of the XYZ Residence construction project indicate that a significantly low-risk level characterizes 36 risk factors. Furthermore, 5 (five) risk factors exhibit a low risk level, 5 (five) risk factors demonstrate a medium risk level, 1 (one) risk factor exhibits a high-risk level, and 4 (four) risk factors exhibit a very high risk level. A total of twelve risk variables necessitate the implementation of risk control measures. Risk control is implemented on seven risk variables that impact the temporal dimension and five risk factors that impact the financial dimension.

REFERENCES

A. Kassem, M., Khoiry, M. A., & Hamzah, N. (2020). Using probability impact matrix (PIM) in analyzing risk factors affecting the success of oil and gas construction projects in Yemen. *International Journal of Energy Sector Management*, *14*(3), 527–546. https://doi.org/10.1108/IJESM-03-2019-0011

Adaurhere, R. E., Musonda, I., & Okoro, C. S. (2021). Construction Contingency Determination: A Review of Processes and Techniques. In *Advances in Science, Technology, and Innovation* (pp. 271–277). Springer Nature. https://doi.org/10.1007/978-3-030-48465-1_45

Antony, J., Palsuk, P., Gupta, S., Mishra, D., & Barach, P. (2018). Six Sigma in healthcare: a systematic review of the literature. In *International Journal of Quality and Reliability Management* (Vol. 35, Issue 5, pp. 1075–1092). Emerald Group Publishing Ltd. https://doi.org/10.1108/IJQRM-02-2017-0027

Barraza de la Paz, J. V., Rodríguez-Picón, L. A., Morales-Rocha, V., & Torres-Argüelles, S. V. (2023). A Systematic Review of Risk Management Methodologies for Complex Organizations in Industry 4.0 and 5.0. In *Systems* (Vol. 11, Issue 5). MDPI. https://doi.org/10.3390/systems11050218

Bucay, M. A., Abrina, T. A., Gan, J., & Cosico, M. F. (2022). A Technical Analysis on the Manila Bay Dolomite Beach Reclamation Project. *Philippine Journal of Public Policy: Interdisciplinary Development Perspectives*, *2021*. https://doi.org/10.54096/yogv6309

Ferreira de Araújo Lima, P., Marcelino-Sadaba, S., & Verbano, C. (2021). Successful implementation of project risk management in small and medium enterprises: a cross-case analysis. *International Journal of Managing Projects in Business*, *14*(4), 1023–1045. https://doi.org/10.1108/IJMPB-06-2020-0203

Gachie, W. (2017). Project risk management: A review of an institutional project life cycle. *Risk Governance and Control: Financial Markets and Institutions*, *7*(4–1), 163–173. https://doi.org/10.22495/rgc7i4c1art8

Gu, N. Y., Botteman, M. F., Ji, X., Bell, C. F., Carter, J. A., & van Hout, B. (2011). Mapping of the Insomnia Severity Index and other sleep measures to EuroQol EQ-5D health state utilities. *Health and Quality of Life Outcomes*, *9*. https://doi.org/10.1186/1477-7525-9-119

Jedynak, P., & Bąk, S. (2021). Risk Management in Crisis: Winners and Losers during the COVID-19 Pandemic. In *Risk Management in Crisis: Winners and Losers during the COVID-19 Pandemic*. Taylor and Francis. https://doi.org/10.4324/9781003131366

Kuchta, D., Canonico, P., Capone, V., & Capaldo, G. (2023). Uncertainty in the Planning Phase of Public Projects—Its Scope, Consequences, and Possible Remedies. *Administrative Sciences*, *13*(6). https://doi.org/10.3390/admsci13060145

Project Management Institute. (n.d.). *A guide to the project management body of knowledge* (6th ed.).

Project Management Institute. (2013). *A guide to the project management body of knowledge (PMBOK® guide).*

Satria, A. (2017). A FAILURE MODE AND EFFECT ANALYSIS ON WATER RECIPROCATING PUMP FOR DRILLING INDUSTRY. In *Jurnal Ilmiah Informatika dan Komputer* (Vol. 22, Issue 2).

Silva, G. A. S. K. (2016). *Criteria for Construction Project Success: A Literature Review*. https://ssrn.com/abstract=2910305Electroniccopyavailableat:https://ssrn.com/abstract=2910305Electroniccopyavailableat:https://ssrn.com/abstract=2910305

Woodruff, J. M. (2005). Consequence and likelihood in risk estimation: A matter of balance in UK health and safety risk assessment practice. *Safety Science*, *43*(5–6), 345–353. https://doi.org/10.1016/j.ssci.2005.07.003

Zuniawan, A. (2020). A Systematic Literature Review of Failure Mode and Effect Analysis (FMEA) Implementation in Industries. In *IJIEM (Indonesian Journal of Industrial Engineering & Management)* (Vol. 1, Issue 2).