



Innovative Model for Assessing the Level of Failure Risk in Construction and Buildings

Sayfuddin^{1*}, Henny Pratiwi Adi², and Tom Joy Pentenga³

¹ *Civil Engineering Doctoral Program, Sultan Agung Islamic University, Jl. Raya Kaligawe Km. 4 Semarang*

² *Civil Engineering Department, Sultan Agung Islamic University, Jl. Raya Kaligawe Km. 4 Semarang*

³ *Civil Engineering Rotterdam University of Applied Science*

*Corresponding author: sayfud_01@yahoo.co.id

(Received: April 24th, 2024 ; Revised: June 16th, 2024 ; Accepted: June 19th, 2024)

Abstract: This research explores risk management in construction projects to prevent potential failures due to natural factors or human errors. The objective is to develop a risk assessment model for failures in construction and building projects, focusing on identification, categorization, risk level determination, and model development. The research benefits encompass theoretical contributions to construction risk management, governmental policy guidelines, operational assistance in project risk management, and enhancements in the safety and quality of construction projects. This research innovates by expanding research variables, incorporating failure risk level assessments, and utilizing technological approaches. The research methodology combines quantitative and descriptive approaches, focusing on failure risk factors from service/contractor providers, consultants, and project owners. Data is obtained through literature studies, secondary data, and primary data via questionnaires. The analysis involves factor analysis, importance index, impact probability matrix, and the Partial Least Square (PLS) method for structural analysis. The research conclusion identifies failure risk factors including financial aspects, management, equipment availability, and natural impacts such as floods and earthquakes. The risk assessment model categorizes risks into high, medium, and low, enabling appropriate anticipatory measures. This model provides guidance for stakeholders to mitigate risks, improve quality, and maintain the integrity of construction projects and buildings, supporting safety and success throughout project stages. This research makes a significant contribution to construction project risk management and construction quality improvement.

Keywords: *risk management; construction projects; risk assessment model; failure risk factors; safety and quality improvement*

1. Introduction

The importance of risk management in construction and building projects to prevent potential failures is paramount. Construction failures can result from natural factors or human errors, impacting both economically and socially. This research aims to develop a risk assessment model for failures in construction projects and building failures, focusing on risk factor identification, risk categorization, risk level determination, and model development. The benefits of this research include theoretical contributions to construction risk management, policy guidelines for the government, assistance in project risk management, and improvement in the safety and quality of construction projects. This research limits its focus to building development in the Lombok-NTB

region and offers innovation by adding research variables, assessing the risk level of construction and building failures, and developing an innovative assessment model.

2. Research Method

This research utilizes a combined quantitative and descriptive approach. The quantitative approach is used to collect and analyze data regarding failure risks in construction projects and building failures that have utilized risk-level management models. The descriptive approach provides a detailed overview of the characteristics of these projects involving the use of assessment models in managing risks. The research is conducted in the Lombok Nusa Tenggara Barat region. The research stages include preparation, determining the sample size, preparation of data collection instruments, data collection, data processing and analysis, results and discussion, implementation conclusions, and recommendations. The research variables encompass failure risk factors from the perspective of service/contractor providers, consultants, and project owners. Data collection methods involve literature studies, secondary data, and primary data collected through questionnaires. Data analysis includes factor analysis, importance index, impact probability matrix, and the Partial Least Square (PLS) method for structural analysis.

3. Discussion & Research Results

3.1. Correlation among Variables

The analysis results indicate that the risk variables for construction and building failures are correlated among several pairs of variables with significant correlations as follows:

The analysis results show that the Risk Variable has a significant correlation with several other variables. Below are the results of the correlation analysis among variables, as can be seen in Fig. 1.

- i. Correlation with Risk Variable (X01): The Risk Variable has a strong and significant positive correlation with the low Project Manager Performance Factor (X02), Delay in payment progress to subcontractors (X03), Inadequate equipment availability (X05), Poor design capacity and frequent design changes (X06), Poor Material Quality (X07), and Inadequate financial support and payment from clients for completed work (X12). The positive correlation values indicate that an increase in the Risk variable is associated with an increase in the values of the other variables. This correlation is quite strong, especially with X05, X06, X07, and X12.
- ii. Correlation with Low Project Manager Performance Factor (X02): The Low Project Manager Performance Factor (X02) has a very significant positive correlation with several other variables such as Delay in payment progress to subcontractors (X03), Inadequate equipment availability (X05), Poor design capacity and frequent design changes (X06), Lack of Coordination among Teams (X08), Absence of Quality Control (X09), Project Management and Ineffective Supervision Issues (X10), and Conflicts between Parties in the project (X11). The high correlation indicates that an increase in the Low Project Manager Performance Factor (X02) is closely related to an increase in the values of other variables. A very strong correlation occurs with X10 and X11.
- iii. Correlation with Delay in payment progress to subcontractors (X03): The Delay in payment progress to subcontractors (X03) has a significant positive correlation with several other variables such as Inadequate equipment availability (X05), Poor design capacity and frequent design changes (X06), Lack of Coordination among Teams (X08), and Absence of Quality Control (X09). This indicates that an increase in the Delay in payment progress to subcontractors (X03) is related to a potential increase in the values of other variables. A fairly strong correlation occurs with X09.
- iv. Correlation with Lack of Raw Materials (X04): The Lack of Raw Materials (X04) has a significant positive correlation with Poor Material Quality (X07). This suggests that an increase in the Lack of raw materials (X04) is likely to result in an increase in Poor Material

- Quality (X07).
- v. Correlation with Inadequate equipment availability (X05): Inadequate equipment availability (X05) has a significant positive correlation with several other variables such as Poor design capacity and frequent design changes (X06), Poor Material Quality (X07), Lack of Coordination among Teams (X08), Absence of Quality Control (X09), Project Management and Ineffective Supervision Issues (X10), and Inadequate financial support and payment from clients for completed work (X12). The high correlation indicates a close relationship with an increase in the values of other variables. A very strong correlation occurs with X12.
 - vi. Correlation with Poor design capacity and frequent design changes (X06): Poor design capacity and frequent design changes (X06) have a significant positive correlation with several other variables such as Poor Material Quality (X07), Lack of Coordination among Teams (X08), and Absence of Quality Control (X09). The high correlation indicates a close relationship with an increase in the values of other variables. A very strong correlation occurs with X09.
 - vii. Correlation with Poor Material Quality (X07): Poor Material Quality (X07) has a significant positive correlation with Inadequate financial support and payment from clients for completed work (X12). The fairly strong correlation indicates a close relationship with an increase in the values of other variables.
 - viii. Correlation with Lack of Coordination among Teams (X08): Lack of Coordination among Teams (X08) has a significant positive correlation with the Absence of Quality Control (X09) and Project management and Ineffective Supervision Issues (X10). The fairly strong correlation indicates a close relationship with an increase in the values of other variables.
 - ix. Correlation with Absence of Quality Control (X09): Absence of Quality Control (X09) has a significant positive correlation with Project Management and Ineffective Supervision Issues (X10), Conflicts between Parties in the project (X11), and Inadequate financial support and payment from clients for completed work (X12). The high correlation indicates a close relationship with an increase in the values of other variables. A very strong correlation occurs with X10 and X11.
 - x. Correlation with Project Management and Ineffective Supervision Issues (X10): Project Management and Ineffective Supervision Issues (X10) have a significant positive correlation with Conflicts between Parties in the project (X11) and Inadequate financial support and payment from clients for completed work (X12). The fairly strong correlation indicates a close relationship with an increase in the values of other variables.
 - xi. Correlation with Conflicts between Parties in the project (X11): Conflicts between Parties in the project (X11) have a significant positive correlation with Inadequate financial support and payment from clients for completed work (X12). The fairly strong correlation indicates a close relationship with an increase in the values of other variables.
 - xii. Correlation with Inadequate financial support and payment from clients for completed work (X12): Inadequate financial support and payment from clients for completed work (X12) have a significant positive correlation with Deviations from the Initial Building Function (X13). The fairly strong correlation indicates a close relationship with an increase in the values of other variables.
 - xiii. Correlation with Deviations from the Initial Building Function (X13): Deviations from the Initial Building Function (X13) have a significant positive correlation with Conflicts between Parties outside the project (X14). The fairly strong correlation indicates a close relationship with an increase in the values of other variables.
 - xiv. Correlation with Conflicts between Parties outside the project (X14): Conflicts between Parties outside the project (X14) have a significant positive correlation with Lack of maintenance and operational budget (X15). The fairly strong correlation indicates a close relationship with an increase in the values of other variables.
 - xv. Correlation with Lack of maintenance and operational budget (X15): Lack of maintenance and operational budget (X15) has a significant positive correlation with Negative and

- irresponsible Stakeholder Behavior (X16). The fairly strong correlation indicates a close relationship with an increase in the values of other variables.
- xvi. Correlation with Negative and Irresponsible Stakeholder Behavior (X16): Negative and irresponsible Stakeholder Behavior (X16) has a significant positive correlation with Structural Damage (X17). The fairly strong correlation indicates a close relationship with an increase in the values of other variables.
- xvii. Correlation with Structural Damage (X17): Structural Damage (X17) has a significant positive correlation with the Impact of Earthquakes above 6 Richter Scale (X19). The fairly strong correlation indicates a close relationship with an increase in the values of other variables.
- xviii. Correlation with Effects of Floods/Landslides (X18): Effects of Floods/Landslides (X18) have a significant positive correlation with Structural Damage (X17). The fairly strong correlation indicates a close relationship with an increase in the values of other variables.
- xix. Correlation with Impact of Earthquakes above 6 Richter Scale (X19): Impact of Earthquakes above 6 Richter Scale (X19) has a significant positive correlation with Effects of Floods/Landslides (X18). The fairly strong correlation indicates a close relationship with an increase in the values of other variables.

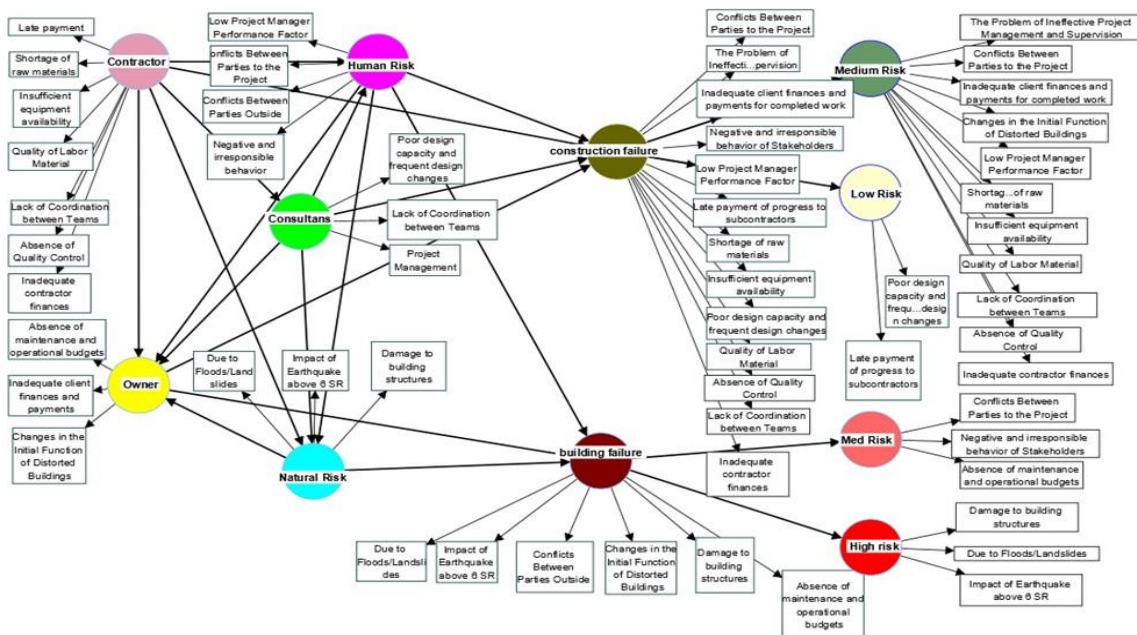


Fig. 1. Correlation Analysis Model among Variables (Source: analysis, 2023).

3.2. Construct Reliability and Validity

The discussion on Construct Reliability and Validity will cover four concepts that appear in the table you provide: Cronbach's Alpha, Composite Reliability (rho_a), Composite Reliability (rho_c), and Average Variance Extracted (AVE). These are the metrics used in the analysis of construct reliability and validity in research or measurement as can be seen in Fig. 2 and Table 1.

Table 1. Construct reliability and validity – Overview.

Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
High Risk	0.892	0.904	0.825
Human Risk	0.854	0.858	0.700
Building Failure	0.926	0.945	0.752
Construction Failure	0.951	0.953	0.638
Contractor	0.942	0.942	0.749
Low Risk	0.835	0.836	0.859
With risk	0.761	0.833	0.673
Medium Risk	0.939	0.945	0.624
Natural Risk	0.892	0.901	0.825
Owner	0.806	0.829	0.737
Consultant	0.733	0.745	0.857

Source: 2023 Research Data Processing Results

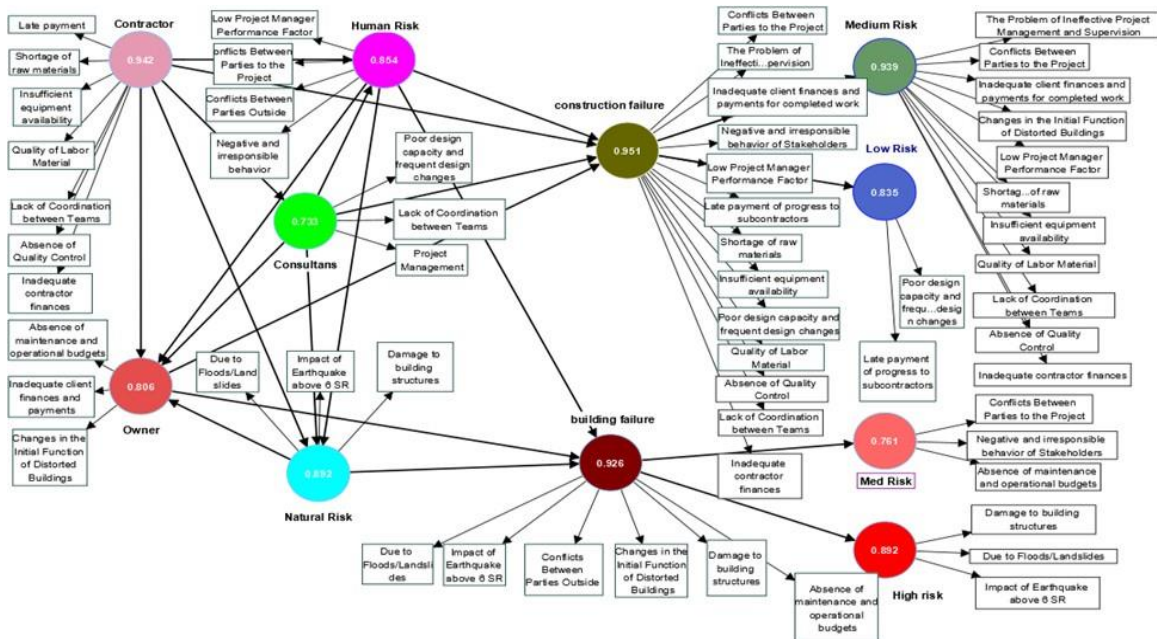


Fig. 2. Model of Construct Reliability and Validity Analysis results (Source: analysis, 2023).

Here's a detailed breakdown of each metric:

Cronbach's Alpha:

- i. High Risk: Cronbach's Alpha is 0.892. It measures the extent to which items in the "High Risk" construct correlate with each other. Higher values indicate better reliability in measuring such constructs. Values above 0.7 are often considered quite good.
- ii. Human Risk: Cronbach's Alpha is 0.854. The construct "Human Risk" has a fairly good level of reliability, although not as strong as "High Risk".
- iii. Building Failure: Cronbach's Alpha is 0.926. The construct "Building Failure" has an excellent level of reliability.
- iv. Construction Failure: Cronbach's Alpha is 0.951. The construct "Construction Failure" has a very high degree of reliability.
- v. Contractor: Cronbach's Alpha is 0.942. The construct "Contractor" also has a very high level of reliability.

- vi. Low Risk: Cronbach's Alpha is 0.835. The " Risk" construct has a good degree of reliability, but it is not as strong as some other constructs.
- vii. Med Risk: Cronbach's Alpha is 0.761. The construct "Med Risk" has a lower level of reliability compared to other constructs.
- viii. Medium Risk: Cronbach's Alpha is 0.939. The construct "Medium Risk" has a very high level of reliability.
- ix. Natural Risk: Cronbach's Alpha is 0.892. The construct "Natural Risk" has a fairly good level of reliability, the same as "High Risk".
- x. Owner: Cronbach's Alpha is 0.806. The construct "Owner" has a fairly good level of reliability.
- xi. Consultant: Cronbach's Alpha is 0.733. The construct "Consultant" has a lower level of reliability compared to other constructs.
- xii. Composite Reliability (rho_a) dan Composite Reliability (rho_c):
- xiii. Both Composite Reliability (rho_a) and Composite Reliability (rho_c) are metrics that measure construct reliability, similar to Cronbach's Alpha. Typically, a high Composite Reliability value (more than 0.7) indicates a good level of reliability in construct measurements.

3.3. Average Variance Extracted (AVE):

Average Variance Extracted (AVE) is a metric used to measure construct validity in the context of factor analysis or psychometric research. AVE reflects the extent to which the variance of the items associated with the construct being measured is compared to the variance caused by other factors or measurement errors. A high AVE value indicates that the items consistently represent the measured construct.

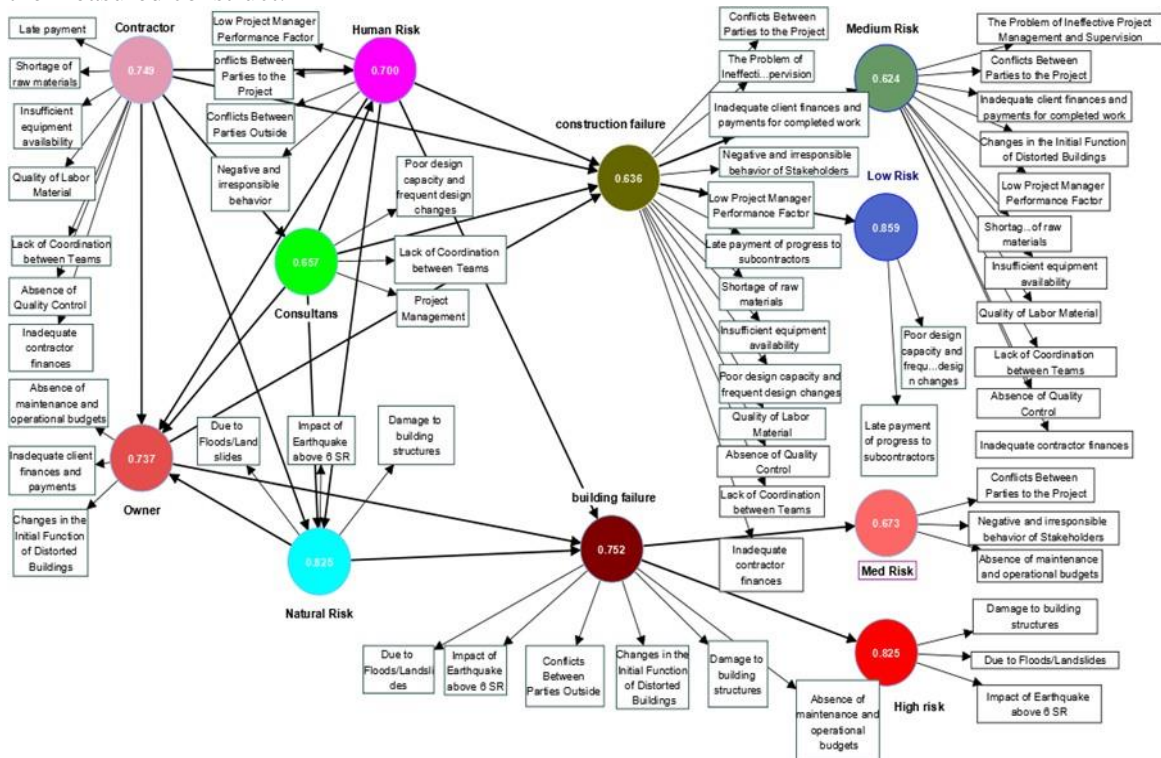


Fig. 3. Model Results of Average Variance Extracted (AVE) analysis (Source: analysis, 2023).

Here we describe the AVE for each of the constructs listed in the Fig. 3.

- i. High Risk: The AVE value for "High Risk" is 0.825. This value indicates that 82.5% of the variance in items measuring "High Risk" is incarnated in that construct, while the other 17.5% can be considered a measurement error or influenced by other factors.
- ii. Human Risk: "Human Risk" has an AVE value of 0.700, indicating that 70% of the variance in items that measure "Human Risk" is variance derived from that construct, while the remaining 30% can be attributed to other factors or measurement errors.
- iii. Building Failure: The AVE for "Building Failure" is 0.752, meaning that about 75.2% of the variance in items measuring the "Building Failure" construct is the variance relevant to that construct.
- iv. Construction Failure: The AVE value for "Construction Failure" is 0.638, indicating that 63.8% of the variance in those items measuring "Construction Failure" is the variance relevant to that construct.
- v. Contractor: The AVE for "Contractor" is 0.749, which means that approximately 74.9% of the variance in the items measuring "Contractor" is the variance described by that construct.
- vi. Low Risk: The "Low Risk" construct has an AVE value of 0.859, indicating that 85.9% of the variance in items measuring "Low Risk" is the variance relevant to that construct.
- vii. Med Risk: The AVE for "Med Risk" is 0.673, indicating that 67.3% of the variance in items measuring "Med Risk" is the variance described by that construct.
- viii. Medium Risk: "Medium Risk" has an AVE value of 0.624, indicating that 62.4% of the variance in items measuring the "Medium Risk" construct is the variance relevant to that construct.
- ix. Natural Risk: The AVE for "Natural Risk" is 0.825, indicating that 82.5% of the variance in items measuring "Natural Risk" is the variance described by that construct.
- x. Owner: The "Owner" construct has an AVE value of 0.737, which means that about 73.7% of the variance in items measuring "Owner" is the variance relevant to that construct.
- xi. Consultant: The AVE for "Consultant" is 0.857, indicating that 85.7% of the variance in those items measuring "Consultant" is the variance described by that construct.
- xii. In general, high AVE values in each construct indicate a good degree of validity, with most of the variance in items measuring those constructs incarnated within the corresponding construct. This indicates that the items have good relevance and consistency in measuring the constructs represented by each.

3.4. Latent Variable Correlations

A correlation matrix is a table or matrix that reflects the relationship between pairs of variables in the form of numbers, which shows how strong and directional the linear relationship between the variables is. The correlation can range from -1 to 1, where -1 indicates a perfect negative linear relationship, 1 indicates a perfect positive linear relationship, and 0 indicates no linear relationship.

Table 2. Latent Variable Correlations.

	High risk	Hum Risk	Building Failure	Const. Failure	Contract- or	Low Risk	With risk	Med Risk	Natur Risk	Owner	Consult ant
High Risk	0.608	0.842	0.982	0.715	0.608	0.476	0.885	0.753	1.000	0.902	0.912
Human Risk	0.788	1.000	0.865	0.905	0.788	0.732	0.954	0.898	0.842	0.865	0.905
Building Failure	0.708	0.865	1.000	0.790	0.708	0.558	0.935	0.830	0.981	0.966	0.940
Const. Failure	0.971	0.905	0.790	1.000	0.971	0.909	0.906	0.993	0.716	0.862	0.887
Contractor	1.000	0.788	0.708	0.971	1.000	0.915	0.825	0.970	0.609	0.815	0.799
Low Risk	0.915	0.732	0.558	0.909	0.915	1.000	0.698	0.868	0.477	0.652	0.705

	High risk	Hum Risk	Building Failure	Const. Failure	Contractor	Low Risk	With risk	Med Risk	Natur Risk	Owner	Consultant
With risk	0.825	0.954	0.935	0.906	0.825	0.698	1.000	0.920	0.886	0.951	0.939
Medium Risk	0.970	0.898	0.830	0.993	0.970	0.868	0.920	1.000	0.753	0.903	0.905
Natural Risk	0.609	0.842	0.981	0.716	0.609	0.477	0.886	0.753	1.000	0.901	0.913
Owner	0.815	0.865	0.966	0.862	0.815	0.652	0.951	0.903	0.901	1.000	0.929
Consultant	0.799	0.905	0.940	0.887	0.799	0.705	0.939	0.905	0.913	0.929	1.000

Here is the analysis of the correlation matrix on Table 2 as follows:

- i. High Risk: The highest correlation with "Building Failure" (0.982), shows a very strong positive relationship.
- ii. Human Risk: The highest correlation with "Consultant" (0.905), indicates a very strong positive relationship between human risk and consultant.
- iii. Building Failure: The highest correlation with "High Risk" (0.982) and "Natural Risk" (0.981), shows a very strong positive relationship between building failure with high risk and natural risk.
- iv. Construction Failure: The highest correlation with "Medium Risk" (0.993), indicates a very strong positive relationship between construction failure and medium risk. The correlation is quite high with "Consultant" (0.887), indicating a fairly strong positive relationship.
- v. Contractors: The highest correlation with "Construction Failure" (0.971), shows a very strong positive relationship between contractors and construction failures. The correlation is quite high with "Building Failure" (0.708), indicating a fairly strong positive relationship.
- vi. Low Risk: The highest correlation with "Med Risk" (0.868), shows a strong positive relationship between low risk and medium risk.
- vii. Med Risk: The highest correlation with "Consultant" (0.939), indicates a very strong positive relationship between moderate risk and consultant. The correlation is quite high with "Human Risk" (0.954), indicating a very strong positive relationship.
- viii. Medium Risk: The highest correlation with "Construction Failure" (0.993), indicates a very strong positive relationship between moderate risk and construction failure. The correlation is quite high with "Consultant" (0.905), indicating a fairly strong positive relationship.
- ix. Natural Risk: The highest correlation with "Building Failure" (0.981) and "High Risk" (1.000), shows a very strong positive relationship between natural risk and high risk.
- x. Owner: The highest correlation with "Medium Risk" (0.903) and "Building Failure" (0.966), shows a strong positive relationship between ownership and moderate risk and building failure.
- xi. Consultants: The highest correlation with "Construction Failure" (0.887) and "Med Risk" (0.939), shows a fairly strong positive relationship between consultants with construction failure and moderate risk.

A high correlation indicates a strong relationship between these variables in the context of your analysis. In addition, it is also important to pay attention to the presence of negative correlations, even if they are not visible in the matrix you provide. Negative correlations can also provide insight into the complex relationships between those variables.

3.5. Path Coefficient – Matrix

The path coefficient matrix that you have provided represents the results of the analysis of paths between variables in the structural equation model (SEM). Each path coefficient describes how strong and directional the relationship between variables is.

Table 3. Path Coefficient – Matrix

	High risk	Hum Risk	Building Failure	Const. Failure	Contract or	Low Risk	High risk	Med Risk	Natural Risk	Owner	Consultant
High risk											
Human Risk			-0.031	0.336					0.220	-0.075	
Building Failure 0.982							0.935				
Const. Failure						0.909		0.993			
Contractor		0.180		0.695					-0.372	0.428	0.899
Low Risk											
High risk											
Med Risk											
Natural Risk			0.600							0.636	
Owner			0.452	-0.152							
Consultant		0.762		0.169					1.001	0.074	

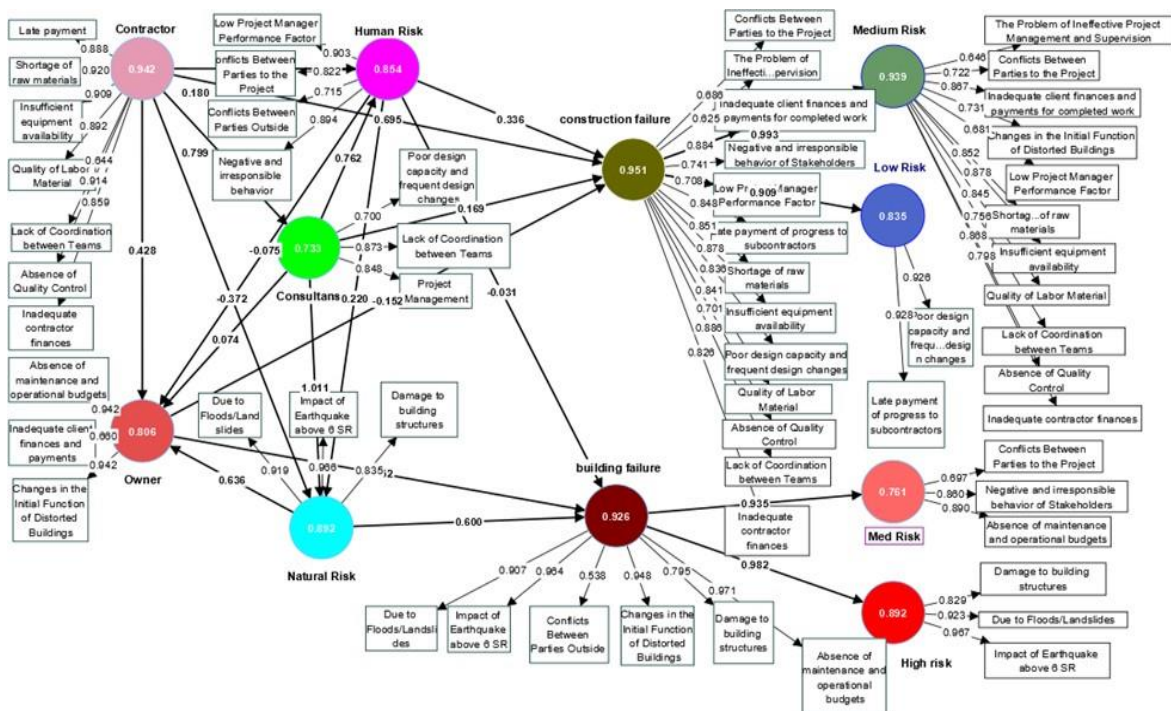


Fig.4. Model Results of Path Coefficient Analysis – Matrix (Source: analysis, 2023).

Here is an analysis of the path coefficient matrix as seen in Table 3 and Fig. 4.

- i. Man Risk: Positively affected by "Construction Failure" (path coefficient: 0.336). This indicates that human risk increases positively with an increase in construction failure rates.
- ii. Building Failure: Positively affected by "High Risk" (path coefficient: 0.982). That is, high risk is positively related to the failure rate of buildings.
- iii. Construction Failure: Positively affected by "Building Failure" (path coefficient: 0.935) and "Contractors" (path coefficient: 0.909). This shows that the construction failure rate is strongly influenced by the failure rate of the building and the role of the contractor.
- iv. Contractor: Positively affected by "Human Risk" (path coefficient: 0.180) and "Low Risk" (path coefficient: 0.799), and negatively affected by "Medium Risk" (path coefficient: -0.372). It illustrates that contractors are positively affected by human risk and low risk, but negatively affected by moderate risk.
- v. High Risk: Has no direct path coefficients with other variables in the model. This suggests

- that "High Risk" has no direct relationship with other variables, so this variable may be more affected by variables not included in the model.
- vi. Low Risk: Has no direct path coefficients with other variables in the model. That is, "Low Risk" has no direct relationship with other variables, it may be more influenced by factors outside the model.
 - vii. Med Risk (Medium Risk): Has no direct path coefficients with other variables in the model. This suggests that "Medium Risk" has no direct relationship with other variables, so this variable may be more affected by external factors.
 - viii. Natural Risk: Positively affected by "Construction Failure" (path coefficient: 0.600). That is, natural risks increase positively with the failure rate of construction.
 - ix. Owner: Positively affected by "Human Risk" (path coefficient: 0.452). This suggests that the project owner is positively affected by human risk.
 - x. Consultant: Positively influenced by "Human Risk" (path coefficient: 0.762). This illustrates that consultants are positively influenced by human risk.

This path coefficient matrix helps illustrate how variables influence each other in the context of construction risk. This information can be used to design more effective risk management strategies and prevent potential failures in construction projects.

3.6. Risk Level

In risk analysis based on Value data and Risk categories (Medium, Low, High), where Probability multiplied by Impact is used to evaluate the level of risk, we can perform the following analysis:

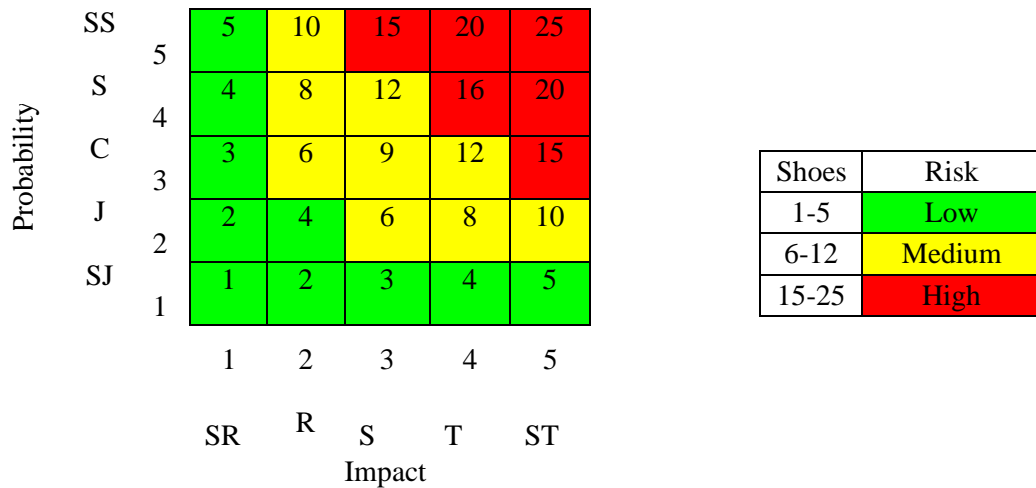
Table 4. Value Data and Risk Categories.

Variable	Value	Risk
Inadequate contractor finances	12	Medium
Low Project Manager Performance Factor	12	Medium
Late payment of progress to subcontractors	5	Low
Shortage of raw materials	12	Medium
Insufficient equipment availability	9	Medium
Poor design capacity and frequent design changes	5	Low
Quality of Labor Material	10	Medium
Lack of Coordination between Teams	9	Medium
Absence of Quality Control	10	Medium
The Problem of Ineffective Project Management and Supervision	8	Medium
Conflicts Between Parties to the Project	9	Medium
Inadequate client finances and payments for completed work	9	Medium
Conflicts Between Parties Outside the Project	9	Medium
Absence of maintenance and operational budgets	12	Medium
Negative and irresponsible behavior of Stakeholders	12	Medium
Damage to building structures	16	High
Due to Floods/Landslides	20	High
Impact of Earthquake above 6 on the Richter Scale	20	High

$$R = P \chi I \tag{1}$$

Where:

- R = Risk Level
- P = Probability of risk occurring
- I = Level of impact (Impact) of the risk that occurs



The variable with the risk level is "High" because it has the highest "Probability x Impact", which means that the risk has a high probability of occurring and if it occurs, can have a significant impact on the project or objectives being executed. Variables with a risk level of "Medium" also need to be considered and managed properly to ensure the smooth running of the project or goals. Risks with a "Low" risk level tend to have a limited impact and are less likely to occur, but still need to be monitored and managed appropriately.

4. Conclusion

Based on the results of quantitative and qualitative data analysis, as well as discussion, the conclusions of this study are as follows:

1. Risk Factors for Construction and Building Project Failure include inadequate contractor finances, inadequate equipment availability, low project manager performance, project management problems and ineffective supervision, late payments to subcontractors, shortage of raw materials, poor material quality, lack of coordination between teams, deviant changes in the initial function of the building, conflicts between parties inside and outside the project, absence of quality control, poor design capacity and frequent design changes. absence of maintenance and operational budgets, damage to building structures, negative behavior and irresponsibility of stakeholders, due to floods/landslides, and the impact of earthquakes above 6 on the Richter scale.
2. Risk categories in construction and building, as per Construction Services Law Number 18 of 1999, encompass financial constraints, management inefficiencies, material quality issues, and external conflicts. These factors pose potential risks to project progress, efficiency, quality, and safety. Examples include inadequate contractor finances, late payments to subcontractors, poor material quality, and conflicts between project stakeholders. Identifying and addressing these risks is crucial to ensure successful and safe construction and building projects in compliance with the relevant laws and regulations.
3. The risk analysis identified multiple risk factors affecting construction and building failures. Under Construction Failure, Medium Risk factors include ineffective project management, conflicts between parties, inadequate client finances, deviant building function changes, low project manager performance, raw material shortage, inadequate equipment, poor material quality, lack of team coordination, and absence of quality control. Low-risk factors are raw material shortage and late payment to subcontractors.

For Building Failure, High-Risk factors involve flood/landslide impact, earthquake impact above 6 on the Richter Scale, and structural damage. Medium Risk factors encompass conflicts between project parties, negative stakeholder behavior, absence of maintenance budget, and ineffective project management.

The study introduces an innovative risk assessment model for construction and building failures, offering a comprehensive framework to identify, analyze, and classify failure risk factors. This aids stakeholders in proactively minimizing risks, enhancing quality, and ensuring safety throughout construction projects and the building's operational lifespan.

References

- [1] Aslam, A., et al. (2020). *Risk Assessment of Construction Projects: A Comparative Study of Fuzzy Analytic Hierarchy Process (FAHP) and Monte Carlo Simulation (MCS)*
- [2] Al-Ageeli, H. K. & Alzobae, A. S. J. A. (2016). The most influential factor on the stumble and failure of the governmental projects *Journal of Engineering*, 22(2), 93-110
- [3] Aslam A et al 2020 *Risk Assessment of Construction Projects: A Comparative Study of Fuzzy Analytic Hierarchy Process (FAHP) and Monte Carlo Simulation (MCS)*
- [4] Assaf, S., Srour, O., & Hassanain, M. A. (2013). Causes of Failure of Small Contractors in Saudi Arabia *International Journal of Construction Management*, 13
- [5] Arslan, S., Kivrak, M. T., Birgonul, I., Dikmen, I. (2008). Improving Sub-contractor Selection Process in Construction Projects: Web-based Sub-contractor Evaluation System (WEBSITES), *Automation in Construction*, 17(4)
- [6] Gunaldi, G., Imaroh, T. S. (2022). *The Effect of Prevention Aspects, Assessment Aspects, Internal Failure Aspects, and External Failure Aspects on the Benefits of Construction Company Projects*
- [7] Ebrahimzadeh, Y., Najafi, S., Mahdavi, M. (2021). *Investigating the Causes and Effects of Failure in Construction Projects in the Health Sector using the Interpretive Structural Modeling Method*
- [8] Ren, Z., Zhang, L. (2010). *A Comprehensive Risk Assessment Model for Construction Projects*
- [9] Ren, S., Lu, W., & Zhang, Y. (2019). *Quantitative Risk Assessment of Construction Project Cost Overrun*
- [10] Wang, T. and Zuo, D. (2014). *Risk Assessment of Road Construction Projects using the Fuzzy Synthetic Evaluation Method*
- [11] Ye, W., Luo, Z., and Guo, Z. (2021). *The Impacts of Sub-contractors' Performance on the Quality of the Main Contractor's Work: The Mediating Role of Project Performance*