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Risk management: Factors Influencing the Failure of Residential Infrastructure Development in Bekasi, West Java

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Abstract

Infrastructure development in a residential area has a high economic and social impact, so the success of infrastructure development is very important for the community, which will have a wider impact on life. Bekasi Regency is the area with the largest population in the Jakarta area, so infrastructure development is carried out massively to meet the needs of the population in order to develop its area economically and socially. The problem of infrastructure development currently often fails, where the function of infrastructure cannot be utilized optimally by the community. This study aims to evaluate the factors that influence the failure of residential infrastructure development in Bekasi, West Java. The failure of infrastructure development is an obstacle to development and improving the quality of life of the community in Bekasi, West Java. Through a quantitative method with 200 respondents, the results were then analyzed using SEM (structural equation model). This study maps that there are 3 (three) dimensions of risk that must be considered in influencing the failure of infrastructure development in Bekasi, with a total of 32 factors considered to influence it. The results of this study indicate that a number of external risk factors have a significant impact on the failure of infrastructure development in Bekasi, while internal risk factors and project risks are considered to be risks that can be controlled by the contractor. If managed properly, they do not have a significant impact. This study will provide an evaluation of project risk management in residential infrastructure development in Bekasi, which can be utilized by contractors, local governments, academics, the community, and anyone who wants to conduct evaluations and implement strategies to avoid failure in infrastructure development in the future.

Keywords: External risk, Failure infrastructure, Infrastructure, Risk management, SEM.

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1. Introduction

Project risk management is an effort to identify sources of risk and find solutions to mitigate risks in the long term so as to prevent and minimize the impact of risks on infrastructure projects being built [1-4]. Risks that are successfully mitigated and treated appropriately will result in a small impact and make the project successful in having high performance in terms of cost, quality, time, safety and environment [5-16]. A project has having good project performance is the hope of every stakeholder in a project, including the owner, contractor, designer and subcontractor involved in the project, because a project that is successful in the long term will provide continuity and good lessons learned for those involved [17-20].

Bekasi Regency is an area with the highest population in the Jakarta Area where infrastructure development is managed by the Regional Government. From the data of the last three years of residential road infrastructure development in Bekasi, at least 23% of infrastructure projects are in poor to very poor condition due to inadequate project management. This number is very significant considering that Bekasi Regency is an economic center at the entrance to the capital city of Jakarta. The failure of infrastructure development that causes infrastructure to have a short lifespan is detrimental to the wider community, considering that it will impact the community's economy. Mapping the causes of the risk of infrastructure failure must be carried out because early recognition of the factors that cause it can help avoid such issues, ensuring that the infrastructure will have good quality and longevity [21].

Research related to infrastructure failure was presented in several previous studies. Okolie [22] states that project failure is when the project objectives are not met in relation to project performance. The cause of project failure must be evaluated, and a solution must be sought for the dominant cause. Briggs et al. [23] state that infrastructure failure is caused by design and natural behavior, which are external factors on which the infrastructure is built. Splichalova and Flynnova [24] state that infrastructure failure is caused by key elements that must be examined more deeply in relation to the limitations used in these key elements. This study will evaluate the risk of infrastructure development failure caused by internal factors, external factors, and project factors so that the identified dominant influencing factors can be mitigated early on in infrastructure development in Bekasi, West Java.

2. Theoretical Literature Review

2.1. Failure of Infrastructure Development

Infrastructure failure can be caused by technical and non-technical factors; these factors are related to deviations in the process during construction or the lack of competence of the business entity or human resources managing the project [25]. Construction failure is a condition where the results of the work do not match the specifications of the work in the contract, either partially or completely, causing the service life of the infrastructure to not be in accordance with the target. Construction failure in America was caused by 54% (human), 17% (design), 15% (maintenance), 12% (materials), dan 2% Wiyana [25]. Valentin and Vorster [26] states that infrastructure failure is influenced by factors related to the contractor's control, as a result of the actions of the employer or owner, due to the conditions of the contract or the type of contract between the parties, can be attributed to the architect or engineering consultant or other entity appointed by the employer to act on its behalf, due to changes in government laws or changes in economic conditions, force majeure, and as a result of the actions of subcontractors and suppliers. Luiz Eduardo Junqueira [27] states that large-scale construction projects tend to have a high failure rate, around 65%, according to his definition of failure as causing investors to lose large amounts of money and delaying or even failing their infrastructure projects. Damoah and Akwei [28] state that Project failure is defined in terms of what is considered project failure, the intended time frame for project evaluation, and the criteria used in assessing project performance. The factors used to determine project success/failure depend on different stakeholders' perceptions of what constitutes project failure/success. Gamil and Abdul Rahman [29] stated that a number of dominant factors that caused the failure of infrastructure development include poor construction management, frequent change of design, continues suspension work, shortage of raw materials, hiring uneducated contractor, low salary for engineering, cash flow and financial difficulty, delay of progress payment to subcontractor, financial difficulty faced by owner and poor financial control and management.

2.2. Risk Management

Okudan et al. [30] define Risk Management as a series of efforts made to increase the probability and/or impact of positive risks and to reduce the probability and/or impact of negative risks. Given the fact that unmanaged risks have the potential to deviate a project from its original objectives, Project Management Institute [31] directly links the effectiveness of project Risk Management to project success. Szymański [10] divides the various project risks as follows.

Based on the frequency of occurrence and scope of impact, they are grouped as follows.

- Risk based on frequency

1. Systematic risk, or market risk beyond the entity's control.
2. Specific risks associated with a particular project and all its variants.

- Risks based on scope of impact

1. Fixed risk, which concerns the entire economic system.
2. Variable risk, or non-fixed risk, which concerns a particular company.

In addition to the above risks, there are several risks as follows

1. Financial risk.
2. Time-related risk, risk associated with failure to implement individual efforts or activities.
3. Technical risk, associated with failure to provide the quality of completed projects.
4. Economic risk.

5. Risks associated with human factors and workplace safety, risks inherent in the executive team.

Risk management in construction projects is to effectively deal with uncertainties and unforeseen events that can affect the successful and timely completion of a project. If risks are not identified early on during a project, it will introduce many risks and uncertainties to the project life cycle, affecting aspects such as cost, schedule, and quality of the project. In addition, it can also pose risks in the areas of Health, Safety, and Environment. Therefore, risk management enables project managers to identify, analyze, respond to, and control project risks. This is why risk management is critical to the successful achievement of a project. In drafting a contract, the contract strategy must clearly define the responsibilities of the client and the contractor and it must be specific and understandable. This is to ensure that the risks are clear to the contractor and the client, thus avoiding future disputes [32].

2.3. Project Performance

The construction industry experiences many failed projects, although several studies have documented factors that influence project success, often referred to as critical success factors [33]. Five measures were selected to represent the overall cost and schedule performance of the project as dependent variables in the analysis: unit cost, cost growth, schedule growth, construction speed, and delivery speed. These measures are objective and measurable based on historical project records and are commonly used in project delivery research. Unit cost is calculated by dividing the total project cost, including all design and construction services, at final completion by the gross square footage of the building. Cost growth is the percentage change in project cost from contract award to final completion. The contract price for design and construction services is used as the basis for the measure. Schedule growth is the percentage change in the overall project duration from design initiation to substantial completion compared to the duration specified in the contract award. Construction speed is calculated by dividing the gross square footage of the building by the duration of construction work in months, taken from the notice to proceed to substantial completion. Delivery speed is calculated in a similar manner, but divided by the overall project duration in months, taken from design initiation to substantial completion. The units for construction speed and delivery speed are in square feet per month. All schedule measures use the substantial completion date to mark the end of the project, which is a well-documented contractual commitment and is consistent with studies [34].

3. Materials and Methods

This research uses a quantitative method by distributing questionnaires to 200 respondents Hair et al. [35]. The questionnaire consists of 64 questions that aim to explore factors that are considered to influence the risk of failure of residential infrastructure development in Bekasi, West Java. Furthermore, data processing uses SEM (structural equation model) to determine the relationship between variables. Hair et al. [35] and Pervan et al. [36] to determine the factors that are considered to influence and have relationships with variables according to the statistical tests conducted. Below is a picture showing the details of the research method used in this study as follows.

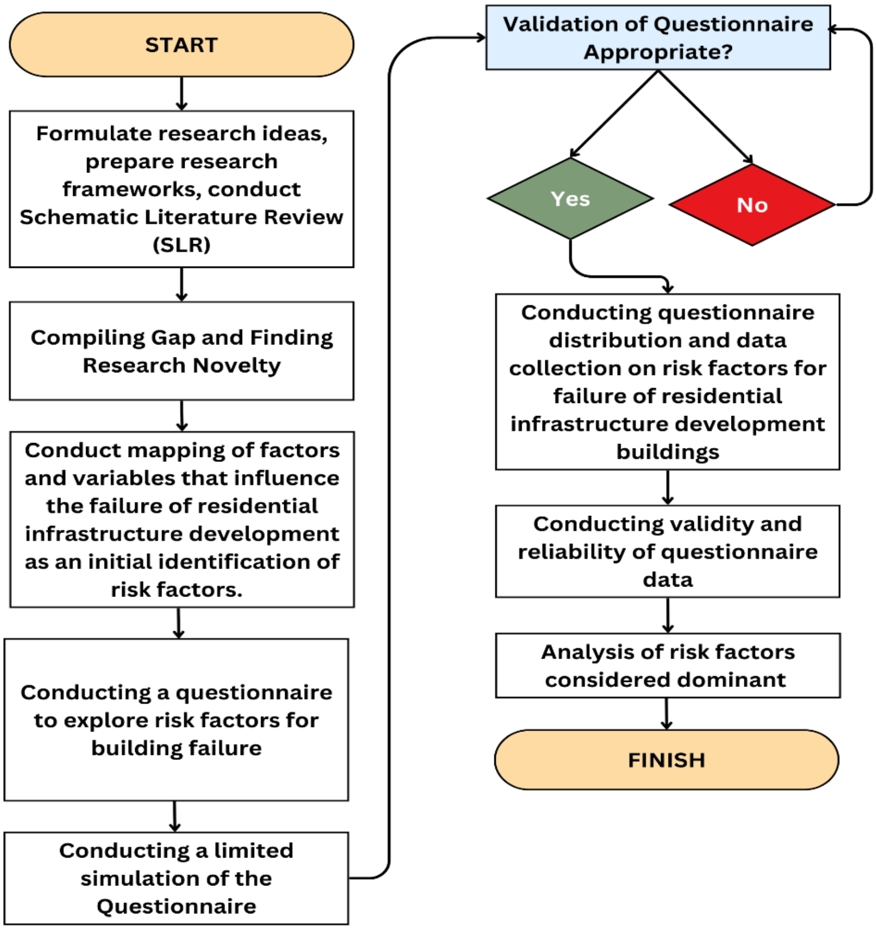

Figure 1.
Research Methodology.

Figure 1 above illustrates research methodology conducted to obtain the results of the study, where quantitative methods were used to explore the perceptions of 200 respondents regarding factors which is considered dominant in influencing the failure of residential infrastructure development in Bekasi, West Java. The profile of 200 respondents in this study is presented as follows.

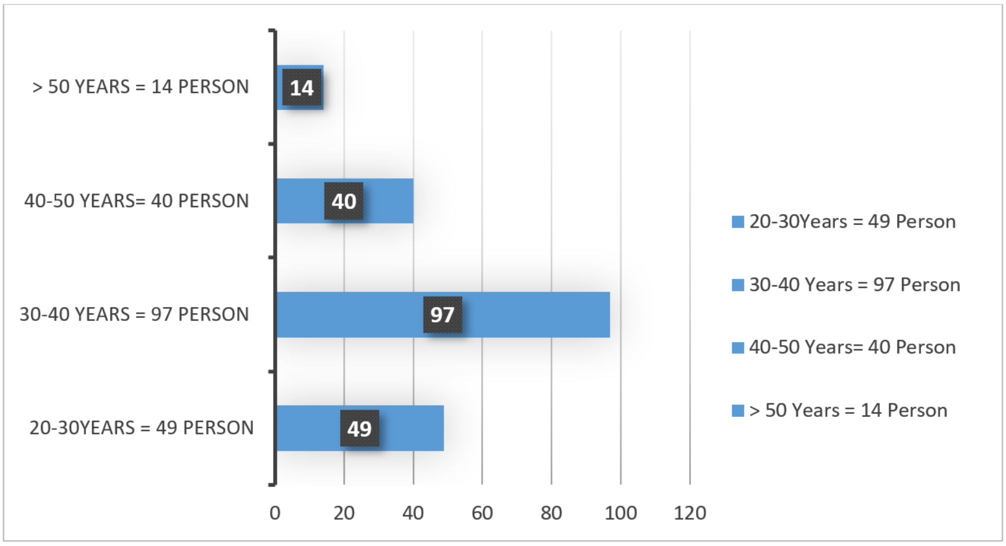

Figure 2.
Distribution age of respondents.

Figure 2 above shows that respondents are aged 20-30 years (49 persons), 30-40 years (97 persons), 40-50 years (40 persons), and > 50 years (14 persons).

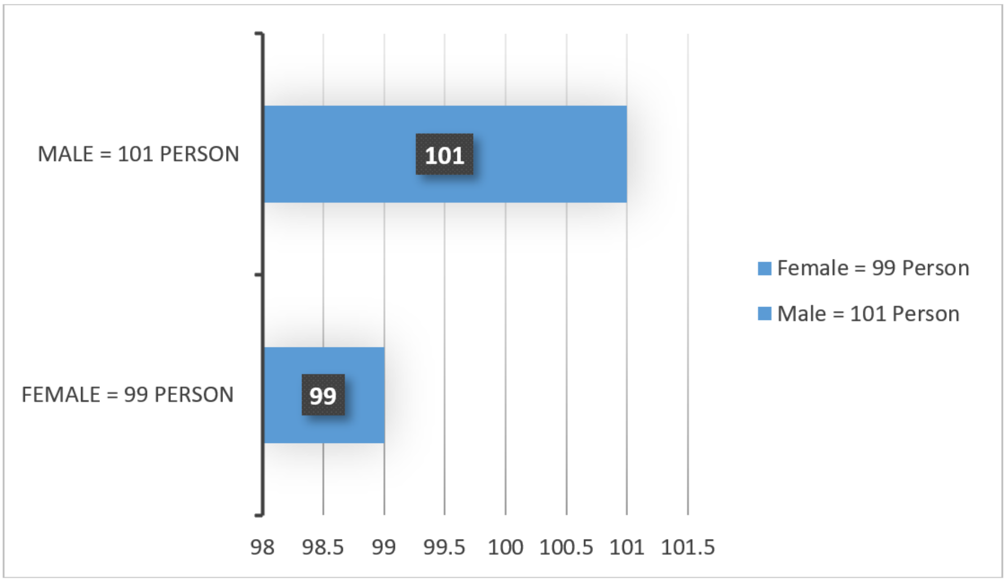

Figure 3.
Distribution of Gender Respondents.

Figure 3 above illustrates the distribution of respondent gender, consisting of male (101 Persons) and female (99 Persons).

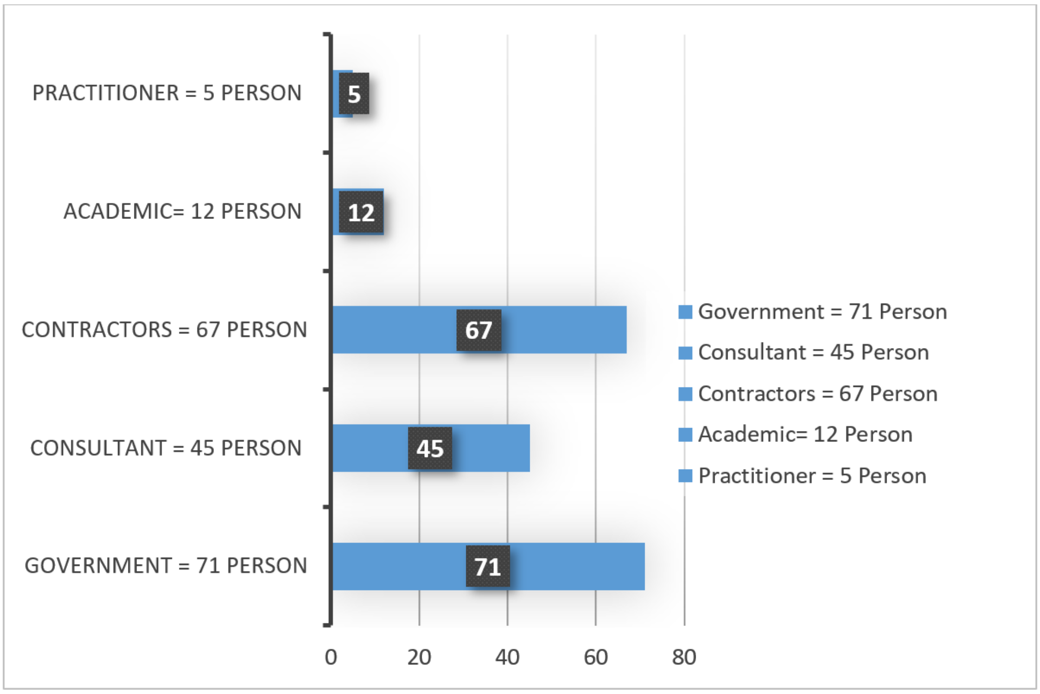

Figure 4.
Distribution of Institution respondents.

Figure 4 above illustrates the distribution of institutions of respondents, which consist of Government (71 persons), Consultant (45 Persons), Contractors (67 Persons), Academic (12 Persons) and Practitioner (5 Persons).

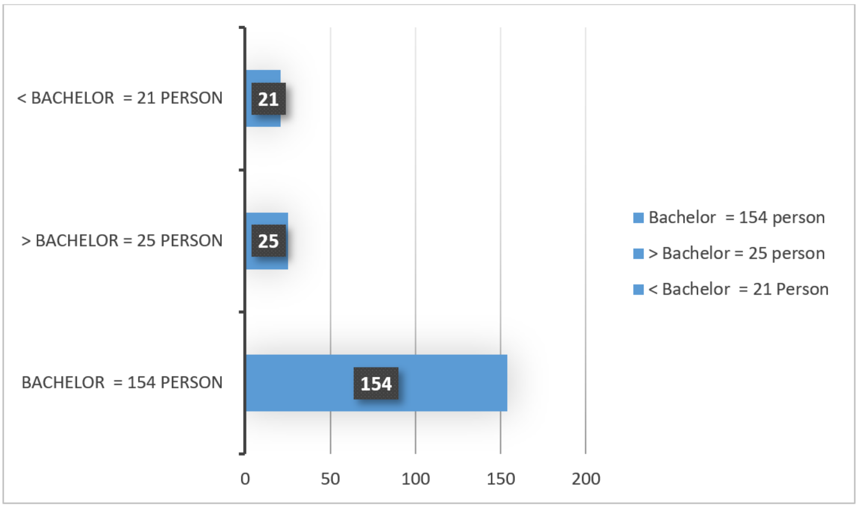

Figure 5.
Distribution of education respondents.

Figure 5. The above illustrates the level of education of respondents consisting of under bachelor degree (21 Persons), bachelor degree (154 persons), and above bachelor degree (25 Persons).

4. Results

The survey was distributed to respondents by meeting directly with 200 respondents using a printed questionnaire. Before the respondents filled out the questionnaire, permission was requested to request their willingness to fill out the questionnaire in the form of a consent form. Respondents consisted of various professions involved in the development of residential infrastructure in Bekasi, West Java. The next stage was mapping the relationship between variables in the study. The entire questionnaire consisted of 64 questions divided into dimensions of internal risk, external risk and project risk. In the first mapping of the relationship between variables, the loading factor value of each variable will be determined, where the loading factor value should be a minimum of 0.7 [35, 37]. In this case, the first one that has loading factors below 0.5 is selected to be removed from the variables in each dimension, then it will be run again using SEM to see the new loading factor after reducing the variables that have loading factors below 0.5. If in the reduction of items all variables have loading factors above 0.7, then the next step is to conduct statistical tests in the form of validity, reliability, HTMT, Fornell-Larcker criterion and Model fit. The image below is the result of reducing variables that have loading factors below 0.5, then it is run again and the loading factor results can be seen in table 1. Where each variable after the reduction of items has a loading factor above 0.7.

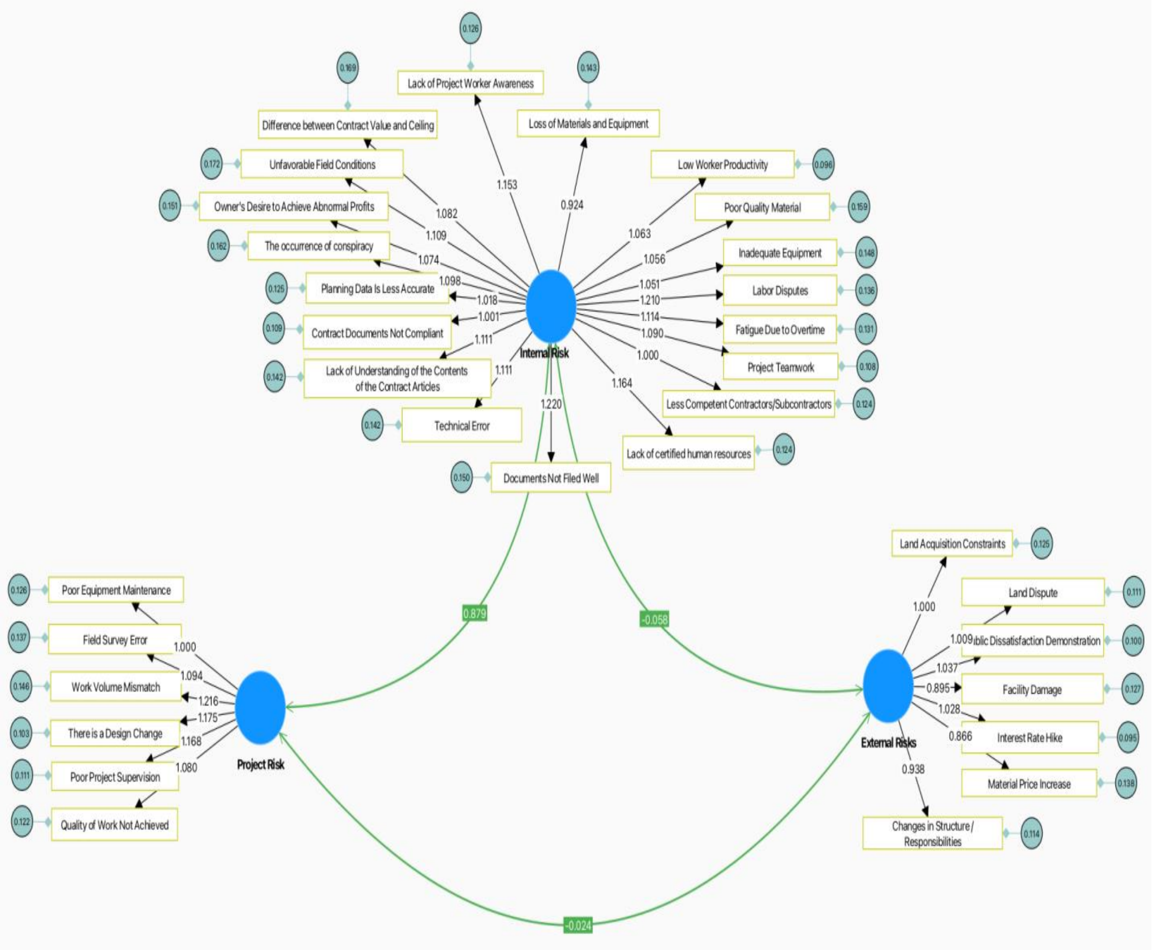

Figure 6.
Relationships variable research.

Figure 6 describes the relationships of variables from internal risk, project risk and external risk after reducing items for variables that have a loading factor value below 0.5. After reducing the variables, the loading factor value for each variable becomes above 0.7, this is in accordance with what was conveyed by Hair et al. [35] and Risher and Hair [37] an outer loading value ≥0.70 indicates that the indicator has a high correlation with the latent construct it measures. This value indicates that at least 50% of the variance of the indicator can be explained by the latent construct ($R^2 = 0.70^2 = 0.49$). If the outer loading value is below 0.70, the indicator needs to be further evaluated or removed because it does not have a significant contribution to the construct. The details for each loading factor are presented in Table 1.

Table 1.
Value of loading Factor.

Factors	**Outer loadings (standardized)**
Changes in Structure / Responsibilities <- External Risks	0.759
Contract Documents Not Compliant <- Internal Risk	0.755
Difference between Contract Value and Ceiling <- Internal Risk	0.707
Documents Not Filed Well <- Internal Risk	0.767
Facility Damage <- External Risks	0.725
Fatigue Due to Overtime <- Internal Risk	0.760
Field Survey Error <- Project Risk	0.721
Inadequate Equipment <- Internal Risk	0.720
Interest Rate Hike <- External Risks	0.813
Labor Disputes <- Internal Risk	0.781
Lack of Project Worker Awareness <- Internal Risk	0.777
Lack of Understanding of the Contents _of the Contract Articles <- Internal Risk	0.746
Lack of certified human resources <- Internal Risk	0.783
Land Acquisition Constraints <- External Risks	0.764
Land Dispute <- External Risks	0.785
Less Competent Contractors/Subcontractors <- Internal Risk	0.733
Loss of Materials and Equipment <- Internal Risk	0.681
Low Worker Productivity <- Internal Risk	0.793
Material Price Increase <- External Risks	0.698
Owner's Desire to Achieve Abnormal Profits <- Internal Risk	0.724
Planning Data Is Less Accurate <- Internal Risk	0.738
Poor Equipment Maintenance <- Project Risk	0.704
Poor Project Supervision <- Project Risk	0.777
Poor Quality Material <- Internal Risk	0.710
Project Teamwork <- Internal Risk	0.784
Public Dissatisfaction Demonstration <- External Risks	0.809
Quality of Work Not Achieved <- Project Risk	0.736
Technical Error <- Internal Risk	0.746
The occurrence of conspiracy <- Internal Risk	0.720
There is a Design Change <- Project Risk	0.790
Unfavorable Field Conditions <- Internal Risk	0.712
Work Volume Mismatch <- Project Risk	0.745

Table 1 illustrates that the results of the factor loading analysis reviewed based on the standardized outer loadings value, risk factors in construction projects can be categorized into internal, external, and project risks, with each factor having varying levels of influence. External risks with the highest outer loading values are Interest Rate Hike (0.813) and Public Dissatisfaction Demonstration (0.809), indicating that changes in interest rates and public dissatisfaction can be significant threats to the sustainability of the project. Meanwhile, the most dominant internal risks are Low Worker Productivity (0.793) and Lack of Certified Human Resources (0.783), highlighting the importance of workforce management and improving employee competency. In terms of project risk, there is a Design Change (0.790) that has a high influence, indicating that design changes can cause disruptions in project planning and implementation. Overall, internal risk factors have a greater number than external and project risks, emphasizing the need for a stronger mitigation strategy in the internal management aspect to improve project efficiency and success. The next stage is to conduct statistical tests to ensure that all variables have a good relationship and meet the rules of statistical tests as follows.

a. Nila*i construct reliability and validity*, nilai *Cronbach's alpha* dan *composite reliability (rho_c).*

The results of the reliability and validity tests for each dimension are presented in Table 2 as follows.

Table 2.
Results of Reliability and Validity.

Risks	**Cronbach's alpha (standardized)**	**Cronbach's alpha (unstandardized)**	**Composite reliability (rho_c)**	**Average variance extracted (AVE)**
External Risks	0.908	0.908	0.909	0.586
Internal Risk	0.959	0.959	0.959	0.554
Project Risk	0.882	0.881	0.883	0.557

Table 2. The above illustrates, based on the analysis of construct reliability and validity, the Cronbach's alpha and composite reliability (rho_c) values show that all constructs have very good reliability, with values above 0.7, which indicates high internal consistency in measuring variables. Internal risk has the highest reliability (Cronbach's alpha = 0.959, rho_c = 0.959), followed by external risk (Cronbach's alpha = 0.908, rho_c = 0.909), and project risk (Cronbach's alpha = 0.882, rho_c = 0.883). This shows that the measurement instrument for internal risk is the most stable and consistent compared to the other two categories. In terms of convergent validity, the Average Variance Extracted (AVE) value for all constructs is above 0.5 (External Risks = 0.586, Internal Risk = 0.554, Project Risk = 0.557), which indicates that each construct is able to explain more than 50% of the variance of its indicators, so it can be concluded that this model has good convergent validity. Thus, these results indicate that the instruments used in this study have strong reliability and validity to measure risk in construction projects.

b. Nilai Heterotrait-monotrait ratio (HTMT)

The results of the HTMT test are presented in detail in Table 3.

Table 3.
Results of HTMT.

Risks	External Risks	Internal Risk	Project Risk
External Risks			
Internal Risk	0.087		
Project Risk	0.122	0.890	

Table 3. The above illustrates that, based on the results of the Heterotrait-Monotrait Ratio (HTMT) analysis, the correlation value between constructs shows good discriminant validity. The low HTMT value between External Risks and Internal Risks (0.087) and between External Risks and Project Risk (0.122), indicates that the two constructs have clear differences and there is no high multicollinearity. However, the HTMT value between Internal Risk and Project Risk (0.890) is quite high, approaching the threshold of 0.90, which may indicate a strong relationship between the two variables. However, as long as the HTMT value is still below 0.90 or 0.85, it can be concluded that this model meets the criteria for discriminant validity, which means that each construct is able to measure different concepts effectively.

c. Nilai Fornell-Larcker criterion

The results of the Fornell-Larcker criterion test can be seen in Table 4 as follows.

Table 4.
Results of the Fornell-Larcker criterion.

Risks	External Risks	Internal Risk	Project Risk
External Risks	0.766		
Internal Risk	-0.058	0.745	
Project Risk	-0.024	0.879	0.746

Table 4. The above illustrates based on the results of the Fornell-Larcker Criterion analysis, the discriminant validity in this model can be evaluated by comparing the square root of the Average Variance Extracted (AVE) (diagonal value) with the correlation between constructs (off-diagonal value). The square root value of AVE for each construct is External Risks (0.766), Internal Risks (0.745), and Project Risks (0.746). Each diagonal value is greater than the correlation between the construct and other constructs, indicating that each latent variable has good discriminant validity.

The fairly high correlation between Internal Risk and Project Risk (0.879) indicates that these two constructs are closely related. However, because the square root of AVE is still greater than the correlation between constructs, this model still meets the discriminant validity criteria according to the Fornell-Larcker method.

d. Nilai Model Fit

The results of the fit model can be presented in Table 5 as follows.

Table 5.
Results of Model fit.

	Estimated model	Null model
Chi-square	1031.011	4989.939
Number of model parameters	67.000	32.000
Number of observations	199.000	n/a
Degrees of freedom	461.000	496.000
P value	0.000	0.000
ChiSqr/df	2.236	10.060
RMSEA	0.079	0.213
RMSEA LOW 90% CI	0.072	0.208
RMSEA HIGH 90% CI	0.085	0.219
GFI	0.756	n/a
AGFI	0.721	n/a
PGFI	0.660	n/a
SRMR	0.058	n/a
NFI	0.793	n/a
TLI	0.864	n/a
CFI	0.873	n/a
AIC	1165.011	n/a
BIC	1385.663	n/a

Table 5. The above illustrates based on the results of the model fit analysis, the estimated model shows a fairly good fit with the data. The Chi-square/df value of 2.236 is still within acceptable limits (<3), indicating that the model is not too complex compared to the data. The RMSEA value of 0.079 is in the category approaching good fit (<0.08), although it still needs to be considered to be more optimal. The SRMR value (0.058) indicates a good model fit because it is below 0.08. In addition, the Comparative Fit Index (CFI = 0.873) and Tucker-Lewis Index (TLI = 0.864) values are close to the threshold of 0.90, indicating a fairly good model fit, although not yet optimal. The Goodness of Fit Index (GFI = 0.756) and Adjusted Goodness of Fit Index (AGFI = 0.721) values are still relatively low, indicating that there is still room for model improvement to better fit the data. Overall, this model is quite good but could be improved to achieve a more optimal fit.

In the case of infrastructure failure in Bekasi, West Java, it can be concluded that there are 32 factors that are considered to influence the failure of residential infrastructure development, which are presented in detail as follows.

Table 6.
Conclusion of risk factors.

Internal Risks	Project Risks	External Risks
Contract Documents Not Compliant	Field Survey Error	Changes in Structure / Responsibilities
Difference between Contract Value and Ceiling	Poor Equipment Maintenance	Facility Damage
Documents Not Filed Well	Poor Project Supervision	Interest Rate Hike
Fatigue Due to Overtime	Quality of Work Not Achieved	Land Acquisition Constraints
Inadequate Equipment	There is a Design Change	Land Dispute
Labor Disputes	Work Volume Mismatch	Material Price Increase
Lack of Project Worker Awareness		Public Dissatisfaction Demonstration
Lack of Understanding of the Contents of the Contract Articles		
Lack of certified human resources		
Less Competent Contractors/Subcontractors		
Loss of Materials and Equipment		
Low Worker Productivity		
Owner's Desire to Achieve Abnormal Profits		
Planning Data Is Less Accurate		
Poor Quality Material		
Project Teamwork		
Technical Error		
The occurrence of conspiracy		
Unfavorable Field Conditions		

Table 6 above describes all the factors that are considered to influence the risk of failure of infrastructure development in Bekasi, West Java.

5. Discussion

Hair et al. [35] in his book A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM) explains that an outer loading value ≥0.70 indicates that the indicator has a high correlation with the latent construct it measures. This value indicates that at least 50% of the variance of the indicator can be explained by the latent construct ($R^2 = 0.70^2 = 0.49$). If the outer loading value is below 0.70, the indicator needs to be further evaluated or removed because it does not have a significant contribution to the construct. The results of the factor loading analysis reviewed based on the standardized outer loadings values, the risk factors in construction projects can be categorized into internal, external, and project risks, with each factor having varying levels of influence. The external risks with the highest outer loading values are Interest Rate (0.813) and Public Dissatisfaction Demonstration (0.809), indicating that changes in interest rates and public dissatisfaction can be significant threats to the sustainability of the project. Meanwhile, the most dominant internal risks are Low Worker Productivity (0.793) and Lack of Certified Human Resources (0.783), which highlights the importance of workforce management and improving employee competency.

In terms of project risk, there is a Design Change (0.790) has a high influence, indicating that design changes can cause disruption in project planning and implementation. Overall, internal risk factors have a greater number than external and project risks, emphasizing the need for a stronger mitigation strategy in the internal management aspect to improve project efficiency and success. In mapping the relationship between internal risk variables, there are 19 factors, project risk consists of 6 (six) factors and external risk consists of 7 (seven) factors.

Looking at the dominant factors, there is the influence of increasing bank interest rates as the dominant factor that has the highest loading factor value, this is in line with what was conveyed by Bigwanto et al. [38] that one of the unpredictable factors is the price of materials which will cause financial difficulties, so that it is necessary to have partnerships with subcontractors with long-term contracts Fath [39].

Fath [39] stated that the prediction of the increase in interest rates must be done since the procurement planning so that it can be anticipated and the failure of infrastructure development can be minimized. Public dissatisfaction in carrying out demonstrations is a political factor that must be anticipated because it will result in uncontrolled project risks, in-depth communication and collaboration with the community are needed in anticipating this risk [4, 40]. Design changes are the most common problem in government projects, with 62% of government projects failing due to design changes [41]. This is proven by the comparison of government project performance between Design Bid Build (DBB) and Design & Build (DB), which provides significant differences in design changes [42-45]. So this is an important thing to pay attention to in government projects.

6. Conclusions

From the research results above, the following can be concluded.

a. There are 32 factors that are considered to influence the failure of residential infrastructure development in Bekasi, West Java, consisting of 19 factors from internal risk, 7 factors from external risk, and 6 factors from project risk. This is the result of processing a questionnaire that previously consisted of 64 questions as factors generated from various studies through previous research literature studies.
b. Several factors are considered dominant with high loading factor values, namely interest rate increases, demonstrations by the community due to dissatisfaction, low worker productivity and design changes. These factors are important to carry out further mitigation and anticipation because they have the potential to cause infrastructure development failure in Bekasi, West Java.
c. Strategies need to be implemented to anticipate various risks, as external risks must be foreseen and collaboration carried out since the project has not started. This ensures that there are no problems with local communities regarding land acquisition, road access, and economic access that could result in community demonstrations and even damage or vandalism. The increase in interest rates is an important consideration because it is related to the rise in material prices, which are the main key in infrastructure development. Procurement management with umbrella contracts is crucial to ensure that there is no increase in material prices.
d. Design changes are anticipated by recruiting professional designers who have the competence to ensure that design changes are not major and are used as the main document in conducting tenders by contractors.

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