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The Analysis of Risk Causes of Building Failure Using Confirmatory Factor Analysis (CFA) Method of Building Condition Index Figures In Educational Buildings

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Abstract

This research aims to analyze the building condition index numbers. These risk factors cause building failure using the Confirmatory Factor Analysis (CFA) method, dominant factors of risk that cause building failure, and the strategies used to minimize the risk of building failure in state asset buildings in Jember Regency. The object of research was state buildings in 3 city sub-districts in Jember Regency. This research used risk variables and building condition assessments. Data analysis used Confirmatory Factor Analysis (CFA). The research results showed that the assessment of the building's condition contained serious deterioration or damage, but the function of the building was still sufficient. The results of Confirmatory Factor Analysis include force advancement, material and labor risks, management risks and maintenance risks.

Keywords: risk; failure; building; CFA and index numbers.

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1. Introduction

Using a building for a long period of time can create a risk of damage to building components. Risk is an undesirable event and often has a negative effect on the achievement of a project [1]. Risk arises because of uncertainty, or it can also be said that a risk will arise if there is an unplanned deviation from an event or a certain condition. There are several risk variables that cause building failure. Failure is an accumulation of various factors, "Construction defects" in America are caused by human factors (54%), design (17%), maintenance (15%), materials (12%), and unexpected things (2%) [2]. There are two categories: caused by random factors and due to human error [3] .

Buildings that fail are due to the strength and stiffness of the structure and are not limited to after the time of delivery but have started since implementation. The existence of non-functioning building components due to depreciation, the end of the life of the building, or human activity due to natural behavior (earthquakes, land subsidence, floods, etc.) or excessive functional loads, or also due to physical influences/ chemical/insect damage is called building damage [4].

Every development has aspects that need to be considered, namely the potential for damage to old or relatively new buildings, which is very large. Building damage is visible after the building is used or operated. When damage to the building occurs, identification is carried out as early as possible regarding any damage to each building item that can cause adverse effects on the building. Building damage must be identified on building elements by seeing that there is so much damage to buildings with different causes.

Confirmatory Factor Analysis (CFA) was used to test how well the measured variables can represent previously formed constructs or factors. Confirmatory Factor Analysis (CFA) method because in this method, the model is formed first, the number of latent variables is determined by analysis, the influence of a latent variable on the observed variable is determined first, some of the direct effects of the latent variable on the observed variable can be set equal to zero or a constant, measurement errors may be correlated, covariance of latent variables may be estimated or set at a certain value, and identification of parameters is required [5].

Jember Regency has facilities and infrastructure spread across 31 sub-districts in carrying out construction of the education department where it is visually observed that most of the building conditions with approximately 70 percent of them are less than optimal, so currently, it is necessary to check the condition of the buildings and the risk of building damage is not reached. occurs by overcoming the factors that cause building failure. One of the educational building facilities is an elementary school building, which is in an area prone to floods and landslides, so the condition of the building is vulnerable to damage if a disaster occurs. Currently, repairs and maintenance have been carried out on the elementary school building, but it is not yet optimal, so the condition of the elementary school building was found to be damaged in parts of the building, which could cause a disaster. Therefore, it is necessary to analyze the condition of elementary school buildings and the level of risk so that damage to them can be identified, efforts can be made to anticipate building failures, and strategies can be found for handling each building failure.

The research has several objectives, including 1) analyzing the risk factors that cause building failure in state asset buildings in Jember Regency; 2) Knowing the building failure rate index for state asset buildings in Jember Regency; 3) analyzing the correlation of risk factors causing building failure with the building failure rate index figures for state asset buildings in Jember Regency.

2. Literature Review

2.1Building Failure

State assets, according to Republic of Indonesia Law No. 2 of 2017 concerning construction services, are buildings for official purposes that become/will become State property, such as office buildings, school buildings, hospital buildings, warehouses, and state houses, and are provided with funding sources originating from APBN funds, and/or other legitimate acquisitions. Construction is the activity of constructing buildings carried out through the stages of technical planning, construction implementation, and construction supervision/construction management (MK), whether in the form of new construction, partial or complete repairs, or expansion of existing buildings, and/or continuation of construction of existing buildings. unfinished, and/or maintenance (rehabilitation, renovation, restoration).

There are several types of failure: construction, construction work, and building failure. Construction failure is a failure that occurs during construction [5]. Another definition of structural failure is the loss of capacity to support the load of components or members in a structure or the structure itself. Structural failure occurs when the material reaches its strength limit and causes fracture (crack) or excessive deformation. In good design, localized failure should not cause sudden collapse of the entire structure.

Ananda Coomarasamy, Senior Civil Engineer, Construction and Maintenance Department Port of Singapore Authority, "Construction Related Structural Failures", International Conference on Structural Failure, ICSF 87, Singapore, 30-31 March 1987 (Steffie, 2006) defines structural failure as behavior or The performance of the structure is not in agreement with the expected conditions of stability and desired services. Failure can also refer to complete collapse and imperfections that cannot be repaired or are not economical to repair for proper use [6].

The Construction Services Development Agency (LPJK) has issued regulation number 02/LPJK of 2007 concerning the Determination and Implementation of Construction Failure Benchmarks. The benchmarks used in determining construction failure are applicable laws, government regulations, regional regulations, Indonesian national standards, international standards stated in contracts, and guidelines enforced by building failure professional associations, service users should learn to rely on professional construction personnel. who are qualified rather than ordinary craftsmen, and use the building according to the function of the building [7].

2.2Risk management

Risk is a form of uncertainty about a situation that will occur in the future, with decisions made based on various current considerations [8]. Risk is the possibility of an event occurring in the activity process, which can have

a negative impact on achieving the set targets [9]. Risk management is a process where the methods used by a company to manage its risks are related to achieving company goals, and risk is part of a business [10].

2.3Confirmatory Factor Analysis(CFA)

According to Joreskog and Sorborn, CFA tests the unidimensionality, validity, and reliability of measurement models for constructs that cannot be measured directly. Measurement models, also called descriptive models [11], measurement theories, or confirmatory factor models, show the operationalization of research variables or constructs into measurable indicators, which are formulated in the form of certain equations and/or path diagrams [12]. The reflective indicator model assumes that the variation in construct measurement scores is a function of the true score plus error. This model is often called the principal factor model, where the covariance of indicator measurements is influenced by latent constructs or reflects variations in latent constructs [13].

3.Methods

This research focuses on state buildings in 3 city sub-districts in Jember Regency. These buildings are one manifestation of public services in the Jember Regency. The data used in this research are 1) Primary Data, namely data obtained directly from sources or research locations. The data in this research was collected by interviewing respondents who used the research object. Field visualization data of building damage; 2) Secondary Data is a research source obtained indirectly through intermediary media. Secondary data in this research was obtained from articles, journals, statutory regulations, websites, and building planning data.The population in this research includes parties involved in building buildings, such as owners, consultants, and building contractors with buildings ages over 10 years and under 10 years. The samples in this research are 1) Planning consultants who have planned buildings, 2) Contractors who have built buildings using buildings, and 3) building samples: buildings over 10 years old and under 10 years old. The variables of this research include:Risk variables are variables that often occur in building construction projects. Risk variables are grouped into four parts: force majeure risk, material and labor risk, management risk, and maintenance risk. The measurement scale given by the scale criteria used in assessing the potential probability and impact of risk on time and costs in the questionnaire is the Likert scale. [14].

The data used is through physical and non-physical data collection, among others

a. Primary data

The most important thing for this activity before proceeding is to carry out task assistance during the contract implementation of data collection on buildings in 3 sub-districts of Jember city to understand the directions and steps better clearly as well as the desired results of the work on data collection on state buildings belonging to the Jember Regency Government.

b. Secondary Data

1) Review of previous research

2) The building condition index assessment form in accordance with the Building Construction Law Number 20 of 2002 and PP Number 36 of 2005 comes from the Ministry of Public Works (Appendix A).
3) Final Report on the Implementation of Building Data Collection for Jember Regency FY 2020
4) Indonesian National Standards (SNI) as well as regulations relating to building condition indices.
5) Data and other supporting information.

Data analysis techniques include 1) conducting data validity and reliability tests, conducting an analysis of the risk causes of building failure using the Confirmatory Factor Analysis (CFA) method for building condition index numbers in state asset buildings, and determining the risk of causes of state building failure in 3 sub-districts. city in Jember Regency using the Confirmatory Factor Analysis (CFA) method with alternative final results, namely (1). Maintenance, (2). Treatment and (3). Reconstruction.

4. Results and Discussion

4.1Risk Factors Causing Building Failure in State Asset Buildings in Jember Regency

This research has as its object elementary school buildings that are prone to landslides and floods in Jember Regency in eight (8) sub-districts that are prone to landslides and floods, namely Arjasa, Patrang, Sukorambi, Gumukmas, Tempurejo, Panti, Sumber Baru and Silo sub-districts. The list of names of sub-districts and elementary schools that experienced damage is explained in Table 1 below.

Table 1: List of Districts Prone to Disasters and Number of Elementary Schools Suffering Damage

No	Subdistrict	Number of elementary schools that were damaged			
		Light Damage	Moderately Damaged	Heavy Damaged	Total
1	Arjasa	145	0	0	0
2	Patrang	125	0	0	0
3	Sukorambi	71	0	0	0
4	Gumukmas	167	0	0	0
5	Tempurejo	182	4	1	0
6	House	120	0	0	0
7	New Source	252	16	13	0
8	Silos	221	0	0	0

Data source: processed

Table 1 explains that the number of damages to elementary schools was in the Sumber Baru area, totaling 281 damages. This is because the Sumber Baru area often experiences floods or disasters, so many elementary

schools are damaged. Meanwhile, the area that experienced the least damage was Sukorambi District, which had 71 light damages. Factors causing damage to elementary school buildings in disaster-prone areas in Jember Regency using the Confirmatory Factor Analysis (CFA) method with alternative final results for risks including force advance, material and labor risks, and maintenance risks. The CFA stages are explained as follows.

a. Variable feasibility test

1. Kaiser-Meyer-Olkin (KMO) and Barlett's Test of Sphericity or MSA. The requirement for carrying out CFA testing is that the Measure of Sampling Adequacy (MSA) number is 0.671, and the Chi-Square value is 2742.796 with degrees of freedom (df) of 136 with a significance level of 0.000. If the KMO number is > 0.5, then it can be processed further, as shown in Table 2.

Table 2: KMO and Barlett's Test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,671
Bartlett's Test of Sphericity	Approx. Chi-Square	2742,796
	df	465
	Sig.	,000

Source: Processed data, 2020

2. Anti Image Matrices

Based on the Anti Image Correlation table (bottom of the Anti Image Matrices table), there are a number of numbers in the form of a diagonal marked "a." This "a" sign indicates the Measure of Sampling Adequacy (MSA) of a variable. The MSA number ranges from 0 – 1, with the criteria (Ghozali, 2002: 254). If MSA < 0.5, the variable cannot be predicted and cannot be analyzed further or excluded from other variables. Based on the results of the analysis, only 3 factors have an Eigenvalue > 1. The first factor has an Eigenvalue of 5.812, the second factor has an Eigenvalue of 5.082, the third factor has an Eigenvalue of 2.217, the fourth factor has a value of 1.554, and the fifth factor has a value of 1.148. So, from the 20 existing variables, only 5 factors were formed that represent them.

After the process of grouping variables based on factor rotation, the next step is to interpret the factors. In factor analysis, variables that have undergone extraction are grouped and given names according to the variables included in the factor. Sometimes, the naming of factors is not appropriate because it is difficult to generalize existing variables. However, a factor must be given a name that reflects the contents of the factor as far as possible. The factors formed are priorities for risks based on their components as follows.

Priority 1 = Force Majuare risk

Priority 2 = material risk

Priority 3 = labor risk

Priority 4 = maintenance risk.

Based on the results of factor analysis, the factors causing building damage using the Confirmatory Factor Analysis Method include:

a. *Force consisting of earthquakes, floods,* and unpredictable weather.
b. Risk materials and labor consist of an insufficient number of skilled workers, low labor productivity, increases in material prices, damage or loss of materials, lack of waste disposal sites, accidents, and worker safety.
c. Risk management consists of poor human resource allocation, cost estimation errors, and lack of control and coordination.
d. Risk maintenance of damage to building structural components, damage to architectural components, damage to building structural components, damage to electrical components, damage to external components of the building, and damage to building housekeeping components

4.2Highest Risk Factors Cause of Primary School Building Failure in Jember Regency

Results of questionnaire analysis of risk factors causes of failure of elementary school buildings in disaster-prone areas in Jember Regency. Based on the score ranking order, the dominant risk factors for building failure are shown in the following table.

Table 3: Building Failure Risk Rating

No	Types of risk	Means	Rating
1	*Force Majuare*	3.70	3
2	Material Risk	3.54	4
3	Management Risk	3.93	1
4	Maintenance Risk	3.91	2

Source: Data processed

Based on Table 3, it is explained that the most dominant building failure risk ranking is management risk. Then maintenance risk is ranked second, force Majure is ranked third, and material risk is fourth. The risk ranking graph is explained in Figure 1 below.

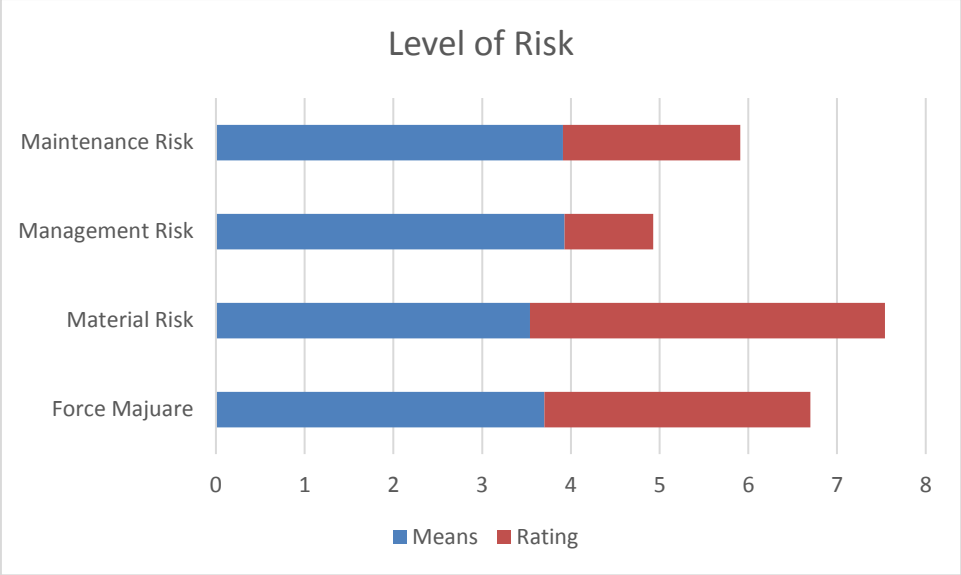

Figure 1: Risk Ranking of Causes of Building Failure

Based on the results of Figure 1, it can be concluded that the risk factor variables that influence the causes of building failure are:

a. The highest level of risk is management risk, which consists of poor allocation of human resources, financial conflicts within the company, cost estimation errors, and lack of control and coordination.
b. The second level of risk is the maintenance risk of damage to building structural components, damage to architectural components, damage to building structural components, damage to electrical components, damage to external components of the building, and damage to building housekeeping components.
c. The third level of risk is force advance, which consists of earthquakes, floods, and erratic weather.
d. The fourth level of risk is material and labor risk, consisting of an insufficient number of skilled workers, low labor productivity, increase in material prices, damage or loss of material, lack of waste disposal sites, and accidents and worker safety.

5. Conclusions and Recommendations

Based on the results of the data analysis, several conclusions can be explained as follows.

a. The lowest IKB value in the value range is 40-54, namely the lowest IKB value is 54.07, namely elementary schools in the Sumber Jati sub-district. This shows that the assessment of the condition of the building shows serious deterioration or damage, but the function of the building is still sufficient. The highest IKB value is in the range75.28is in the range of 70-84, which is in good condition: there is a slight deterioration or minor damage.
b. Based on the results of factor analysis, the factors causing building damage using the Confirmatory Factor Analysis Method include:

1. *Force consisting of earthquakes, floods,* and unpredictable weather.
2. Risk materials and labor consist of an insufficient number of skilled workers, low labor productivity, increases in material prices, damage or loss of materials, lack of waste disposal sites, accidents, and worker safety.
3. Risk management consists of poor human resource allocation, cost estimation errors, and lack of control and coordination.
4. Risk maintenance of damage to building structural components, damage to architectural components, damage to building structural components, damage to electrical components, damage to external components of the building, and damage to building housekeeping components

c. Strategies to minimize the risk of building failure include:

1. Strategies to overcome maintenance risks are carried out with the system maintenance and repairs, and a maintenance system table is created in accordance with the regulations of Public Works Regulation Number: 24/PRT/M/2008
2. Strategies for overcoming material and labor risk factors such as checking and ensuring that work is carried out in accordance with the As-Built Drawing, rejecting concrete quality that does not comply with specifications, conducting outreach, and requiring workers to use PPE
3. Strategies to minimize the risk of Force Majeure due to disasters include:

a) Condition of foundation soil
b) Limitations resulting from construction above them
c) Boundaries from the surroundings
d) Time and cost of work

4. Strategy to minimize management risk.

Strategies that can be used to minimize risks include:

a) Conduct intensive coordination meetings between the owner and contractor
b) Analyze the obstacles that occur in the field
c) Control the materials that will be used so that their quality and quality are maintained
d) Evaluate the project schedule and identify critical paths

Suggestions that can be put forward in this research include:

a. There is extensive evaluations and a more in-depth study of the risks that cause building failure, especially architectural and structural components. Explanations in regulations regarding building maintenance components should be given more standardization in maintenance.
b. Needed periodic checks and updates regarding buildings in 3 city sub-districts in Jember Regency with science and technology.
c. Building repairs are prioritized on components that really need repair and damage has occurred.

d. Contractors should pay more special attention to technical risks during work implementation, which have a significant impact on work completion and on time and cost savings.

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