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# Analysis Of The Causes And Consequences Of Work Accidents In Multi-Storey Building Construction

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## ABSTRAK

Pembangunan proyek gedung bertingkat merupakan salah satu pembangunan yang juga mempunyai risiko tinggi dalam hal kecelakaan kerja. Kecelakaan kerja di sektor konstruksi sebenarnya merupakan akibat dari mitigasi risiko yang tidak tepat sasaran. Berdasarkan data BPS pada tahun 2014, tercatat terdapat 105.383 kasus kecelakaan kerja. Data kecelakaan kerja didominasi oleh sektor konstruksi. Tujuan penelitian ini adalah untuk mengetahui faktor-faktor penyebab kecelakaan kerja pada proyek konstruksi yang melibatkan gedung bertingkat. Tahapan penelitian ini adalah studi literatur untuk menentukan variabel yang akan digunakan, dilanjutkan dengan merancang kuesioner penelitian kemudian mengumpulkan data dengan menyebarkan kuesioner kepada kontraktor dan konsultan pengawas dari beberapa proyek konstruksi. Pengolahan data menggunakan hasil kuesioner bersifat kuantitatif dengan bantuan program Microsoft Excel, IBM SPSS 23 dan SmartPLS. Data yang diperoleh dilakukan analisis multivariat dengan menggunakan uji instrumen penelitian dan uji asumsi klasik, kemudian dilakukan uji outer model dan inner model sehingga dapat diketahui variabel independen mana yang paling besar pengaruhnya. Pembahasan dalam penelitian ini dijelaskan melalui analisis korelasi Pearson, analisis multivariat dan analisis SEM. Hasil penelitian ini bertujuan untuk mengetahui faktor-faktor yang berkontribusi terhadap akibat kecelakaan kerja, yaitu faktor penyebab manusia mempunyai pengaruh positif terhadap kecelakaan kerja berat, semakin tinggi faktor penyebab yang disebabkan oleh manusia maka semakin tinggi pula risiko terjadinya kecelakaan kerja berat..

## *ABSTRACT*

*The construction of multi-storey building projects is one of the developments that also carries a high risk in terms of work accidents. Work accidents in the construction sector are actually the result of risk mitigation that is not well targeted. Based on data from BPS in 2014, there were 105,383 cases of work accidents recorded. The work accident data is dominated by the construction sector. The objective of this study is to examine the factors contributing to workplace accidents in construction projects involving multi-storey buildings. The stages of this research are a literature study to determine the variables to be used, followed by designing a research questionnaire and then collecting data by distributing questionnaires to contractors and supervising consultants from several construction projects. Data processing using questionnaire results is quantitative with the help of Microsoft Excel, IBM SPSS 23 and SmartPLS programs. The data obtained were subjected to multivariate analysis using research instrument tests and classical assumption tests, then outer model and inner model tests were carried out so that it could be seen which independent variables had the most influence. The discussion in this research is explained through Pearson correlation* *analysis, multivariate analysis and SEM analysis. The outcome of this study aims to identify the factors that contribute to the outcomes of work accidents, namely human causal factors have a positive influence on serious work accidents, the higher the causal factors caused by humans, the higher the risk of serious work accidents occurring*



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## 1. INTRODUCTION

In a country, the existence of construction projects has a very important meaning because from these activities it will make various development facilities and infrastructure. So that the quality of buildings in the area increases better and is suitable for use. The construction of a multi-storey building project is one of the developments that is also at high risk in terms of workplace accidents, especially if the multi-storey building being built has a high enough height that can pose a significant risk of workplace accidents.

According to research conducted by the National Safety Council (NSC) in 2011, 88% of workplace accidents are attributed to unsafe behavior or actions., 10% due to unsafe conditions, and 2% is unknown [1]. Work accidents can be caused by human factors (unsafe actions) and environmental factors (unsafe conditions) [2]. Accidents also arise as a result of a combination of several causal factors mentioned by NSC research. For example, a building construction project may not be equipped with sufficient safety equipment. A work accident occurs due to various factors and causes together in the workplace. From several studies, experts are of the view that the causes of work accidents do not occur by themselves, but occur by one or several factors that cause accidents together at a time [3].

Based on the findings of the research [4], The study revealed that to mitigate the risk of workers falling from heights, it is essential to promote the use of comprehensive personal protective equipment (PPE). Specifically, workers engaged in tasks at elevated levels must wear full-body harnesses. Additionally, strict management supervision is necessary to ensure compliance with occupational safety and health practices among workers., provide and use occupational safety and health signs, and daily inspections by all parties in supervising workers [5].

It is necessary to analyze to identify the factors that cause work accidents and their effects. In this study, the Multivariate Analysis Method and SEM Analysis were used to analyze the reasons and outcomes of work accidents. The use of Multivariate Analysis and SEM to assess how the causes of work accidents impact their consequences work accidents that occur.

## 2. METHODS

### 2.1 Location, Subject and Research Subject

The primary concern of this research building construction projects located in Surabaya and Sidoarjo. The method used to collect information to determine the The sample size in this study is determined by questionnaires with certain criteria, namely: building construction projects, government or private projects that are being implemented and have a minimum contract value of Rp5,000,000,000.00. The number of samples taken was 10 projects with 30 respondents.

### 2.2 Identification Of Causal Factors and Consequences of Work Accidents In Multi-Storey Building Construction Projects

Identification of factors that cause work accidents that affect the factors resulting from work accidents in building construction projects is by conducting a review of literature, drawing on findings from prior studies. Based on the findings of the literature review, there are 7 factors that affect the decline in the quality of building construction, namely human factors (X1), methodological factors (X2), material factors (X3), environmental factors (X4), design factors (X5), equipment factors (X6), and obtained indicators of these variables, namely:

Table 1. Variables List

| No | Variables Name |
|---|---|
| X1.1 | Workers in unhealthy condition |
| X1.2 | Workers do not use protective equipment |
| X1.3 | Workers deliberately ignore rules to increase work productivity |
| X1.4 | Lack of knowledge about HSE |
| X1.5 | Lack of concentration or focus on the work being done |
| X1.6 | Lack of working experience |
| X1.7 | Starting a job without knowing what to do |
| X1.8 | High level of stress of each worker |
| X2.1 | Lack of risk analysis for the work to be done |
| X2.2 | Lack of material planning related to the absence of Standard operating procedures |
| X2.3 | Worker equipment assignment error. |
| X2.4 | High action rate of unsafe behavior |
| X3.1 | Fine-grained materials that can enter the eye |
| X3.2 | Fine-grained materials that can be inhaled |
| X3.3 | Sharp materials |
| X3.4 | Concrete mixes that are not cleaned immediately |
| X4.1 | Work floor with slippery conditions |
| X4.2 | Excessive noise |
| X4.3 | Dim or low light conditions |
| X4.4 | Cramped and crowded workspace |
| X4.5 | Unconditioned air temperature |
| X4.6 | Building elevations that have significant differences in the work area |
| X4.7 | Scattered equipment or items |
| X5.1 | Lack of planner specifications |
| X5.2 | Low planner capability |
| X5.3 | Lack of planner experience |
| X5.4 | Lack of planner skills |
| X5.5 | Low accountability of planners |

| No | Variables Name |
|---|---|
| X6.1 | Low equipment efficiency |
| X6.2 | Lack of protection in the tower crane and material/passenger elevator area |
| X6.3 | Lack of standardized equipment usage instructions |
| X6.4 | No checking of tools before starting work |
| X6.5 | Lack of quantity and type of personal protective equipment |
| Y1.1 | Sprains |
| Y1.2 | Light cracks/breaks |
| Y1.3 | Scratches / cuts |
| Y1.4 | Blistering, Heatstroke |
| Y1.5 | Muscle injury |
| Y1.6 | Eye irritation |
| Y2.1 | Death |
| Y2.2 | Bone fracture |
| Y2.3 | Permanent Disabilities |
| Y2.4 | Blood Vessel Rupture |
| Y2.5 | Severe burns |

## 2.3 Method of Data Collection

The research employs a quantitative data collection method. Quantitative analysis uses questionnaire data to describe the magnitude of potential consequences and the likelihood that these consequences will occur. The research data was obtained through three types of data collection methods, namely:

1. Literature Study
2. Questionnaire
3. Observation

# 3. Results And Discussion

## 3.1 Validity Test

This study conducted a validity test to determine whether The data that will be analyzed is considered valid. It will be tested for significance at the 0.05 level, and each variable's correlation value must exceed the critical r-table value for validity. The following is the correlation value of each variable found in the corrected item-total correlation column in Table 2.

Table 2. Result of Validity Testing

| Factor | Variable | Revised Item-Total Correlation |
|---|---|---|
| Human | X1.1 | 0,822 |
| | X1.2 | 0,769 |
| | X1.3 | 0,865 |
| | X1.4 | 0,853 |
| | X1.5 | 0,875 |
| | X1.6 | 0,761 |
| | X1.7 | 0,868 |
| | X1.8 | 0,841 |
| Method | X2.1 | 0,772 |

| Factor | Variable | Revised Item-Total Correlation |
|---|---|---|
| | X2.2 | 0,911 |
| | X2.3 | 0,908 |
| | X2.4 | 0,773 |
| Material | X3.1 | 0,730 |
| | X3.2 | 0,786 |
| | X3.3 | 0,702 |
| | X3.4 | 0,765 |
| Environment | X4.1 | 0,668 |
| | X4.2 | 0,587 |
| | X4.3 | 0,833 |
| | X4.4 | 0,875 |
| | X4.5 | 0,783 |
| | X4.6 | 0,495 |
| | X4.7 | 0,752 |
| Design | X5.1 | 0,883 |
| | X5.2 | 0,911 |
| | X5.3 | 0,942 |
| | X5.4 | 0,956 |
| | X5.5 | 0,918 |
| Equipment | X6.1 | 0,752 |
| | X6.2 | 0,694 |
| | X6.3 | 0,892 |
| | X6.4 | 0,910 |
| | X6.5 | 0,917 |
| Consequences of Minor Occupational Accidents | Y1.1 | 0,916 |
| | Y1.2 | 0,880 |
| | Y1.3 | 0,804 |
| | Y1.4 | 0,747 |
| | Y1.5 | 0,859 |
| | Y1.6 | 0,837 |
| Consequences of Severe Occupational Accidents | Y2.1 | 0,952 |
| | Y2.2 | 0,928 |
| | Y2.3 | 0,928 |
| | Y2.4 | 0,894 |

## 3.2 Reliability Test

Reliability testing is considered successful if the cronbach's alpha coefficient value. is ≥ 0.60, if it is greater, it can be said that the results of the test are stable, accurate, and consistent. Cronbach's alpha coefficient the reliability test results are presented in Table 3.

Table 3. Result of Reliability Testing

| No | Variable | Cronbach's alpha value | Description |
|---|---|---|---|
| 1 | X1 | 0.934 | *Reliable* |
| 2 | X2 | 0.865 | *Reliable* |
| 3 | X3 | 0.714 | *Reliable* |
| 4 | X4 | 0.841 | *Reliable* |
| 5 | X5 | 0.954 | *Reliable* |
| 6 | X6 | 0.889 | *Reliable* |
| 7 | Y1 | 0.918 | *Reliable* |

| No | Variable | Cronbach's alpha value | Description |
|---|---|---|---|
| 8 | Y2 | 0.958 | *Reliable* |

Based on Table 3, the findings from the reliability test for all variables have very good reliability values because they have a Croanbach's alpha value greater than the Croanbach's alpha reference value. That way every variable in this study has been declared reliable or reliable.

### 3.3 Pearson Correlation Analysis Among Variables

The An analysis was conducted to assess the degree of correlation between variables obtained from 30 respondents, where these factors also have several variable indicators. This analysis is employed to ascertain the extent of proximity of each variable with other variables.

Table 4. Results of Pearson Correlation Analysis Between Variables X

| Factor | To | Correlation Coefficient | Coefficient Description | Significant Value | Description Significant |
|---|---|---|---|---|---|
| X1 | X2 | 0,851 | Very Strong | 0,000 | Significant |
| | X3 | 0.814 | Very Strong | 0.000 | Significant |
| | X4 | 0,839 | Very Strong | 0,000 | Significant |
| | X5 | 0,628 | Strong | 0,000 | Significant |
| | X6 | 0,781 | Strong | 0,000 | Significant |
| X2 | X1 | 0.851 | Very Strong | 0.000 | Significant |
| | X3 | 0,721 | Strong | 0,000 | Significant |
| | X4 | 0,797 | Strong | 0,000 | Significant |
| | X5 | 0,749 | Strong | 0,000 | Significant |
| | X6 | 0.772 | Strong | 0.000 | Significant |
| X3 | X1 | 0,814 | Very Strong | 0,000 | Significant |
| | X2 | 0,721 | Strong | 0,000 | Significant |
| | X3 | 0,830 | Very Strong | 0,000 | Significant |
| | X4 | 0.673 | Strong | 0.000 | Significant |
| X4 | X1 | 0,701 | Strong | 0,000 | Significant |
| | X2 | 0,839 | Very Strong | 0,000 | Significant |
| | X3 | 0,797 | Strong | 0,000 | Significant |
| | X4 | 0,830 | Very Strong | 0,000 | Significant |
| | X5 | 0.735 | Strong | 0.000 | Significant |
| | X6 | 0,764 | Strong | 0,000 | Significant |
| | X7 | 0,628 | Strong | 0,000 | Significant |
| X5 | X1 | 0,749 | Strong | 0,000 | Significant |
| | X2 | 0.673 | Strong | 0.000 | Significant |
| | X3 | 0,735 | Strong | 0,000 | Significant |
| | X4 | 0,663 | Strong | 0,000 | Significant |
| | X5 | 0,715 | Strong | 0,000 | Significant |
| X6 | X1 | 0.781 | Strong | 0.000 | Significant |
| | X2 | 0,772 | Strong | 0,000 | Significant |
| | X3 | 0,701 | Strong | 0,000 | Significant |
| | X4 | 0,764 | Strong | 0,000 | Significant |
| | X5 | 0.715 | Strong | 0.000 | Significant |

Tabel 5. Results of Pearson Correlation Analysis Between Variables Y

| Factor | To | *Correlation Coefficient* | Coeffisient Description | Significant Value | Significant Description |
|---|---|---|---|---|---|
| Y1 | Y2 | 0,565 | Strong Enough | 0,000 | Significant |
| Y2 | Y1 | 0,565 | Strong Enough | 0,000 | Significant |

Based on table 4, the outcomes of Pearson correlation analysis above indicates that the highest correlation value is factor X3 (Human Factors), X1 and X4 (Material Factors), and X3 (Environmental Factors), this shows that these three factors have a Very Strong relationship with a correlation value of 0.811 and 0.824. From the description of this value, It can be interpreted that factors related to humans, materials, and the environment in the running of construction work have a Very Strong causal relationship because these three factors influence each other so that they can increase the sense of security for workers who are carrying out construction work, with the presence of PPE equipment in the multi-storey building construction project environment and provide a sense of security for interested surrounding people who want to enter the construction project environment.

Table 5 displays the results of Pearson's correlation analysis, including the correlation coefficient., namely the Y1 factor to Y2, this shows that the two factors have a Strong enough relationship with a correlation value of 0.000 and 0.000. From the description of this value, it can be interpreted that the Y1 and Y2 factors in the running of construction work have a relationship due to work accidents that are Very Strong because these two factors influence each other so that they can increase a vigilant attitude towards the risks due to minor and severe category work accidents for workers who are carrying out construction work.

## 3.4 Bivariate Analysis

Bivariate analysis is the examination of data to explore correlations or relationships between two or more variables under study. In this study, prior to conducting data analysis, a normality test is first performed to determine whether the data is normally distributed or not. If the data is normally distributed, bivariate analysis is conducted using Spearman's rank correlation test because the data is in interval form. However, if the data is not normally distributed, the data scale is reduced to ordinal or nominal, and therefore, the bivariate analysis used is Spearman's rank correlation test. Data processing using the application yields the following results:

Table 6. Result Of Bivariate Analysis

**Correlations**

| | | | Light | Heavy |
|---|---|---|---|---|
| Spearman's rho | Light | Correlation Coefficient | 1.000 | .391* |
| | | Sig. (2-tailed) | . | .033 |
| | | N | 30 | 30 |
| | Heavy | Correlation Coefficient | .391* | 1.000 |
| | | Sig. (2-tailed) | .033 | . |
| | | N | 30 | 30 |

*. Correlation is significant at the 0.05 level (2-tailed).

If from the calculation of the table above, the significance value is 0.033, which is smaller than the 5% error level (0.05), it means there is an influence of variable Y1 on variable Y2, and they have a correlation value of 0.391, indicating a very strong relationship.

## 3.5 SEM Analysis

Structural Equation Modeling (SEM) is a statistical analysis method employed to construct and assess causal models. In this study, data processing utilizes statistical software called SmartPLS version 3.3. The data processing consists of two stages: Outer Model Testing and Inner Model Testing.

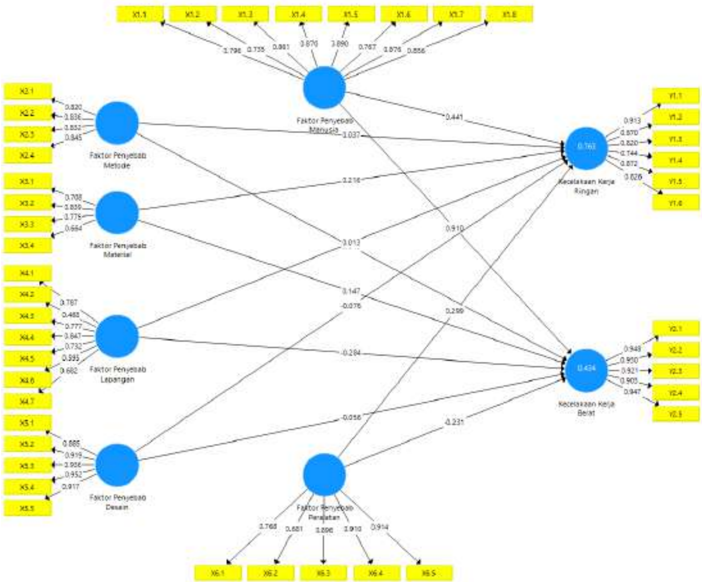

Figure 1. Results of the Outer Model Testing

Based on the testing of the outer model results, There are three tests, namely the test for convergent validity, Discriminant Validity Test, and Composite Reliability Test. The results obtained show that all X indicators are said to be valid and reliable because they have an AVE value greater than 0.5 [6]. The results of the descriminant validity test between response variables showed that the cross-loading value of all variables had the highest value within each group against the variable itself. This shows that all factors are valid data.

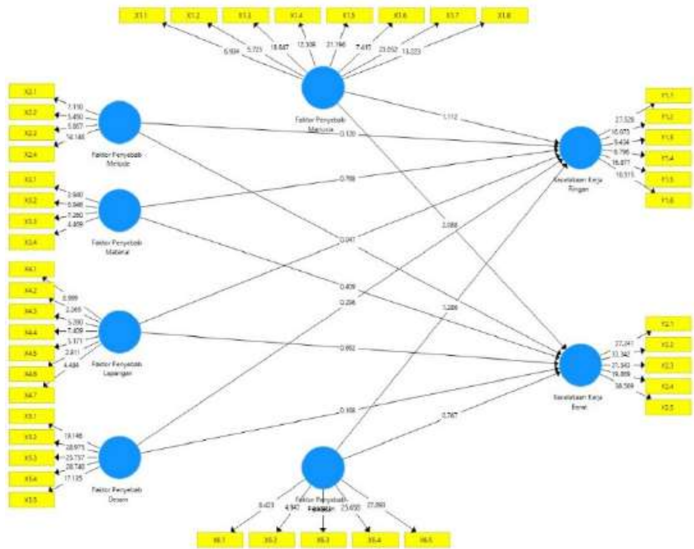

Figure 2. Results of the Inner Model Testing

Based on the findings from Inner Model testing, there are several tests, including the Coefficient of Determination (R2) analysis and the results obtained that variable Y is influenced by all X variables because the R-Square value of variable Y obtained is in the medium category, then Effect Size (F2) found that Environmental Causal Factors (X4), Human Causal Factors (X1), Equipment Causal Factors (X6) have an effect on Severe Accident Factors (Y2), and on Human Causal Factors (X1), Material Causal Factors (X3), and Equipment Causal Factors (X6) have an effect on Minor Accident Factors (Y1), in the Predictive Relevance (Q2) test it is found that all predictor variables (X) have a Strong predictive relevance on each response variable (Y). In the Goodness Of Fit (Gof) test, a value of 0.5867 was obtained, which means that this is large due to the three levels of GoF values, namely the GoF value of 0.1 indicates a small effect size, 0.25 indicates a medium effect size, and 0.36 indicates a large effect size [7]. and finally in the Path Coefficients test, it was found that the p-value and the original sample value testing the path coefficient of the predictor variable Human Causal Factor (X1) on the response variable Heavy Work Accident Result Factor (Y2) was the only relationship that had a positive influence because it had an Original Sample value of 2.088 (more than 1) and had a P-value of 0.037 (less than 0.05). So that these two conditions meet the requirements in determining the relationship between variables has a positive influence.

From the outcomes of the statistical tests is known that there exists significant positive relationship between human causal factors and factors resulting in severe work accidents as indicated by the p value of 0.037 ($p < 0.05$) and the original sample with a certain value of 2.088 (> 1), which means that workers who do unsafe activities while working are likely to experience the risk of severe work accidents. This is because behavior will affect the occurrence of accidents such as haste can always cause accidents, because they tend to ignore the dangers around them and the rules, otherwise if you work carefully, the potential for accidents is very small [8]. Attitude is a predisposition to behavior, so it is an initial response to a stimulus before someone does a behavior, so attitude will have an impact on the achievement of health indicators [9].

This study supports research [10] which states that there exists a correlation between education level, tenure and workplace accidents. Then research conducted by [11] states that attitudes are associated with workplace accidents. [12] also said that attitude is a response that is not directly observed that is still closed from a person to a stimulus or object. This research is in accordance with the opinion of the International Labor Organization (ILO) which states that a person's attitude can change through emphasis on safety during training and education courses. So that if workers' knowledge about the factors that cause work accidents is good, it can lead to a good attitude as well. If someone has a positive attitude, they will tend to behave positively and vice versa.

This positive behavior is expected to produce something positive and can avoid unwanted results such as work accidents[1]. Construction project workers who have a positive attitude will feel that prevention of unwanted events such as work accidents. They will feel and argue that occupational health and safety procedures and regulations are made and established to protect and increase worker productivity on multi-storey building construction projects.

## 4. CONCLUSION

Based on the findings of the distribution of questionnaires and data analysis, there are 6 factors that influence the causes of work accidents in multi-storey building construction consisting of human factors, procedural factors, material factors, environmental factors, design factors, and equipment factors. There are 2 factors that influence the consequences of work accidents in multi-storey building construction consisting of factors due to minor work accidents, and factors due to serious work accidents. The data analysis results yielded the P-value of the Path Coefficient test and found that the most influential variable is the human causal factor for severe work accidents. This variable has a p-value of 0.037 which meets the requirements in determining the relationship between variables. So the higher the causal factors caused by humans will increase the risk of severe work accidents occurring.

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