Causes of work accidents and its impact on the road and bridge construction projects

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Abstract. The work accident of road and bridge construction projects in Indonesia is quite severe. Every year there is always news about work accidents in the project. While the construction of roads and bridges, especially in Eastern Indonesia, continues to be carried out actively by the government. This research purpose of analyzing the causes of work accidents and their impact on the project. Data were collected at the research location, institutions related to the construction of projects, totaling 40 respondents. Based on the results of the analysis with a multiple linear regression method, it appears that 31 variables causing occupational accidents and 13 impact variables arising from accidents still occur and are very influential with high probability values. Four recommendations were made to prevent fatal accidents in the construction of roads and bridges, in Eastern Indonesia, to improve safety conditions in the construction industry.

1. Introduction

Construction is regarded as one of the most unsafe industries worldwide, [1]. The 2016, US Bureau of Labor Statistics shows that the incidence rate, which represents the number of injuries and illnesses in the construction industry is significantly higher than the national average of all industries in the United States, [2]. Similar challenges also exist in other countries, [3]. Worldwide the mortality rate is higher for construction works which are highlighted as industrial crises due to accidents, [4], [5]. This has also happened in Indonesia.

The Ministry of Labor noted that there had been an increasing trend of work accidents in Indonesia in recent years. During 2018 there had been 157,313 cases of work accidents or an increase compared to examples of work accidents that occurred in 2017 amounted to 123 thousand cases. To prevent work accidents from occurring this year, the Minister of Labor once again invited all employers, trade unions, workers and the public to continue to increase awareness of the importance of Occupational Health and Safety (OHS) and its supervision.

According to the Minister, work accidents not only cause death, material loss, morale, and environmental pollution but can also affect the productivity and welfare of the community. The Government of Indonesia is trying to perfect the laws and regulations as well as standards in the field of OHS, [6].

Work accidents in construction projects can make work stop, lower work morale so productivity decreases. The losses also include losses related to workers, equipment damage costs, material wasted due to the accident [7]. The high level of work accidents in the construction sector, due to changes that
shift from building low buildings to high-level buildings, changes in procurement methods, and changes in construction methods from conventional approaches to prefabricated construction [8]. While, according [9] and [10] in Indonesia the high level of work accidents is caused by among others the unique characteristics of construction projects (non-standard), location of the project being moved, influenced by the weather, limited implementation time, labor dominated by untrained workers, and construction work requires high physical endurance.

The level of work accidents in the construction of road and bridge construction projects in Indonesia is quite high, where from year to year, there is always news about work accidents in the project. While on the other hand the construction of roads and bridges in Indonesia, especially in Eastern Indonesia, continues to be actively carried out by the government. Implementation of the road and bridge infrastructure projects in Eastern Indonesia became one of the main priorities of the government to accelerate economic development in remote areas in the region [11]. Based on the background, this research purpose of analyzing the causes of work accidents and their impact on the implementation of road and bridge construction projects in Eastern Indonesia.

2. Construction project work accidents, their impact and prevention

The construction industry has a reputation as being one of the most dangerous industrial sectors, with accident and fatality rates being constantly much higher than the all-industry average, [12]. Whereas [13] state that the construction industry is dangerous. Widely recognized as having a high accident rate, which results in the absence of work, lost productivity, permanent disability, and even death. In addition to causing human tragedy, construction accidents also delay project progress, increase costs, and damage the reputation of the builder or contractor, [14].

An accident is an unexpected event, which causes damage or injury accidentally and suddenly. In the construction sector, accidents are unavoidable and have a higher risk compared to other jobs, [4][5]. Accidents result in construction delays, cost overruns and sometimes damage the reputation of the organization and loss of trust among workers or a ban on tenders by government authorities. This can cause dissatisfaction among stakeholders, become uncompetitive during tenders, financial losses due to property damage and penalties from the authorities, [15].

Some researchers have researched labor accidents on construction projects in the world, among others, [16] conduct empirical and statistical analysis of 9,358 accidents that occur in the U.S. construction industry between 2002 and 2011, which this study investigates the relationship between crashes and elements of injury, for example, type of injury, body parts, injury severity, and nature of construction injuries by accident type. The study then discusses the relationship between accidents and risks, including worker behavior, sources of injury, and environmental conditions, and identifies the principal risk factors and the combination of dangers that cause accidents. The results of the study will help safety managers prioritize risks according to the likelihood of accidents and injury characteristics, and pay more to balance a significant risk relationship in order to prevent accidents and achieve a safer work environment. Research by [17] providing more evidence through empirical investigations at limited severity, this study analyzed 24,764 construction accidents reported during 2002-2011 in South Australia. Conceptual models developed through literature use personal characteristics such as age, experience, gender and language background also analyzes work-related factors such as the size of the organization, the size, and location of the project, the mechanism of the accident and the location of the body from injury. This shows why some accidents only cause minor severity, while others are fatal. Factors such as accident time, days of the week, and season are not very related to the severity of the accident. When the factors that influence the severity of an accident are well understood, high-risk factors can be chosen, and specific preventative measures can be developed.

The results of literature studies on accident cases in the United Kingdom (UK), Singapore and Australia by [15] from 2011 to 2013 through identification of the critical causes and effects of construction accidents, stated that there was an accident relationship with additional project costs, time, the scope, reputation of the company and its impact on the national safety index. This research explores four problems, namely 1) the impact of the accident, 2) the contributory factors of the accident, 3) the
relationship between the human and financial aspects of the accident and 4) the possibility of performance improvement under the uncertainty factor of the accident that will occur. While humans are identified as the leading cause of construction accidents, neglect or error can occur due to uncertain circumstances. Therefore, inevitable accidents must be estimated in the construction industry. Commitment from all people involved, from project managers to workers to good practices will improve safety performance on construction sites.

Literature research conducted in China by [18] stated that fatal accidents often occur in building construction activities due to their dangerous nature. The purpose of this study is to explore the pattern of fatal accidents in building construction activities in China using frequency analysis, correlation coefficient analysis, and analysis of variance. The data presented in this study comes from a brief accident report published by the Ministry of Housing and Urban-Rural Development in China. By analyzing the factors related to the month, day of the week, time interval of the day, province, type of accident, and the severity of the crash, the results of the study showed that more fatal accidents occurred, namely: 1) in July and August, 2) in Monday and 3) during intervals of 10:00-11:00 and 15:00-16:00, and overtime working hours where there is still construction activity in the building. Also, it was found that relatively backward provinces had experienced higher mortality rates per hundred million yuan of gross domestic product in the building industry, especially Qinghai, Hainan, and Heilongjiang. In addition, falls are a significant type of fatal accident, accounting for more than 55% of all accidents. There is a significant correlation between the type of accident and the severity of the crash.

According to Cohen (1977) and Smith et al. (1978) in [1] accident prevention can be done if top management is committed to occupational safety and health. Confidence that high OHS standards are possible and efforts shown to ensure that these standards are met. The same thing was conveyed by [19]. Meanwhile, according to [20], the development and evaluation of interventions strategies to prevent workplace injuries vary widely and include engineering controls, protective equipment, education/training, and regulatory and management practices (including those that encourage safe behavior and practices). The same thing was conveyed by [21], who conducted Design for Safety (DfS) research, the prevention through design, which is the main way to deal with work-related problems, illness, and injury in construction. This research was conducted in Palestine as a developing country like Indonesia.

Worldwide, authorities are tightening safety, standards that have improved performance at construction sites. However, accidents still occur, and there is a need for further research on this crucial issue.

3. Construction project work accidents and its impact in Indonesia

Research in Indonesia concerning workplace accidents on construction projects has been carried out by several researchers including [22] which states that work accidents in construction projects can affect productivity and achievement of project goals. A literature review of work accident cases in construction projects from 2005 to 2015, shows the three types of accidents that most often occur in construction projects in Indonesia, namely, 1) being electrocuted, 2) struck by an object, and 3) falling. While the dominant source of accidents is the carelessness of workers, unsafe construction, and not using personal protective equipment.

Other research by [23] conducted in Jakarta stated that the most dominant cause of work accidents in construction projects was human error. While the predominant type of work accident is a fall, and the most dominant impact is the additional costs to the project.

Road and bridge project work accidents that occurred in Indonesia from 2017 to 2019, monitoring results [24] among others, mapped on Table 1 and Figure 1.
Table 1. Road and bridge project work accident and its impact.

| Project Name                                      | Year     | Accident         | Impact                           |
|--------------------------------------------------|----------|------------------|----------------------------------|
| Cibitung-Cilincing Section IV. North Jakarta      | 16-08-2019 | collapsed        |                                  |
| Bekasi-Cawang-Kampung Melayu Toll Road Development Project | 20-02-2018 | the pile collapsed | seven workers were seriously injured |
| Antasari Toll Road Interchange Construction Project, Antasar-Depok | 02-01-'18  | the girder fell  |                                  |
| Pemalang-Batang Toll Road Construction Project   | 30 -12- '17 | the girder fell  |                                  |
| Ciputrapinggan Bridge construction project       | 09-12- ‘17 | the girder fell  |                                  |
| Jakarta-Cikampek II toll road construction project | 16-11-'17 | the crane fell   |                                  |
| Pasuruan-Probolinggo Toll Road construction project | 29-10-’17 | the girder fell  | one worker was killed            |

4. Research method

The research method consists of data collection methods and data analysis methods. Data were collected in several places, namely, at the research location, at institutions related to the construction of road and bridge projects and to related parties, totaling 45 respondents. Data were collected from February to June 2019, and from July to September 2020.

4.1. Data collection

Primary data collection in the form of direct observation of road and bridge project development. In addition to conducting observations, in-depth interviews were also conducted with construction parties or respondents in the study area. The instrument used to verify observations is a list of questions that have been arranged in a structured and systematic manner. The contents of the issues that have been mapped in the questionnaire are derived from the results of a literature review regarding the causes of construction work accidents as well as observations at the project site with the hope that there is meaningful input from the parties associated with the project. Secondary data collection consists of contract documents from the object of research along with the documents and procedures for the implementation of OHS from the contractor of the construction of roads and bridges. The service user as a source of data is the government, and then service providers as data sources are the contractor and supervisor of road and bridge project development.

The results of identifying the causes of work construction accidents that occur and, their impact based on literature are mapped on Table 2, Table 3 and, Figure 2 which, are then used as material for questionnaires and interviews.
Figure 1. The collapse of the Bekasi-Cawang-Kampung Melayu Toll Road Construction Pile on D I Panjaitan street, Jakarta, Tuesday (2/20/2018).

Table 2. The cause of the accident.

| Code  | Category          | The cause of the accident                                                                 | References                        |
|-------|-------------------|------------------------------------------------------------------------------------------|-----------------------------------|
| CA1   | Unsafe acts       | The roles and influences of fellow workers                                               | [25], Respondents                 |
| CA2   | Unsafe condition  | Safety resources                                                                         | [25], Respondents                 |
| CA3   | Unsafe condition  | Safety climate in the construction industry                                              | [2], [25], Respondents            |
| CA4   | Unsafe acts       | Personal characteristics                                                                 | [3], [17], [25], Respondents      |
| CA5   | Unsafe condition  | Gender                                                                                    | [17], [25]                        |
| CA6   | Unsafe condition  | Marital status                                                                            | [25]                              |
| CA7   | Unsafe condition  | Education level                                                                           | [10], [25]                        |
| CA8   | Unsafe condition  | Unsupportive family                                                                       | [25]                              |
| CA9   | Unsafe condition  | Safety knowledge                                                                         | [25]                              |
| CA10  | Unsafe acts       | Drinking habit                                                                            | [25], Respondents                 |
| CA11  | Unsafe acts       | Smoking habit                                                                             | [25], Respondents                 |
| CA12  | Unsafe condition  | Not direct employer                                                                       | [10], [22]                        |
| CA13  | Unsafe condition  | Individual safety behavior.                                                               | [2], [25], Respondents            |
| CA14  | Unsafe condition  | Safety culture                                                                             | [2], [25], Respondents            |
| CA15  | Unsafe condition  | How long have worked in the construction industry                                         | [25]                              |
| CA16  | Unsafe condition  | Not have competence                                                                       | [10], [17], [25], Respondents     |
| CA17  | Unsafe condition  | Level of project complexity /country                                                       | [2], [10], [26]                   |
| CA18  | Unsafe condition  | Project location (size)                                                                    | [2], [10], [17], [27]             |
| CA19  | Unsafe acts       | Unsafe behaviors.                                                                          | [3], [12], [22], [23], Respondent |
| CA20  | Unsafe condition  | Age                                                                                      | [10], [17], Respondents           |
| Code  | Category                  | The cause of the accident                                      | References                                      |
|-------|---------------------------|-----------------------------------------------------------------|-------------------------------------------------|
| CA21  | Unsafe condition          | Language background                                             | Respondents                                     |
| CA22  | Unsafe condition          | Work environment variable (organization)                       | [17], [26], [27]                               |
| CA23  | Unsafe condition          | Weather                                                          | [10], Respondents                               |
| CA24  | Unsafe acts               | Inappropriate construction planning                              | [28], Respondents                               |
| CA25  | Unsafe acts               | Inappropriate construction control                               | [28], Respondents                               |
| CA26  | Unsafe acts               | Inappropriate construction operation [22], [23], [28], Respondents|                                                |
| CA27  | Unsafe condition          | Inappropriate site condition                                     | [28]                                            |
| CA28  | Unsafe acts               | Inappropriate operative action                                   | [28]                                            |
| CA29  | Unsafe acts               | Personal Protective Equipment (PPE)                              | [22], [23], Respondents                         |
| CA30  | Unsafe condition          | Working time over normal time (overtime)                        | Respondents                                     |
| CA31  | Unsafe acts               | Lack of Rest                                                     | Respondents                                     |

**Table 3. The impact of the accident.**

| No | The impact of the accident                  | References                                      |
|----|---------------------------------------------|------------------------------------------------|
| 1  | Fall from height                           | [2], [22], [26], Respondents                   |
| 2  | Permanent physical injury                   | [13], Respondents                              |
| 3  | Dead                                        | [4], [5], [6], [12], [13], Respondents         |
| 4  | Trauma                                      | [10], Respondents                              |
| 5  | Work is delayed;                           | [14], Respondent                               |
| 6  | Decreases of productivity                  | [13]                                           |
| 7  | Material loss                               | [6], Respondents                               |
| 8  | Additional cost                             | [15], Respondents                              |
| 9  | Loss of trust in the contractor             | [14], Respondent                               |
| 10 | The public held a demonstration / protest   | Respondents                                    |
| 11 | Legal process                               | Respondents                                    |
| 12 | Environmental pollution                     | Respondents                                    |
| 13 | National safety index                       | [15]                                           |
4.2. Data analysis

Data analysis is a process of inspecting, cleansing, transforming and modeling data with the goal of discovering useful information, informing conclusions and supporting decision-making, [29]. In this study, the sample data to be analyzed is data of respondents' answers regarding the causes and their impact of work accidents in the construction of road and bridge construction projects, especially in Eastern Indonesia.

4.2.1. Population and sample. The population in this study amounted to 45 respondents. While the sample that provides an opinion on each item in the questionnaire is 40 respondents who are deemed to have met the requirements, based on the Slovin formula, [30].

\[ n = \frac{N}{1 + Ne^2} \]  

with \( n \) = sample size, \( N \) = population size, and \( e \) = desired margin of error = 5%.

The Questionnaires were used to obtain data on the level of accidents that occur and their impact on the implementation of road and bridge projects based on their causes. Points were obtained from the results of literature studies and observations in the field.

4.2.2. Questionnaire measurement. Likert scales can be included in a larger group of measures that are sometimes referred to as summated (or aggregated) rating scales, since based on the idea that some underlying phenomenon can be measured by aggregating an individual’s rating of his/her feelings, attitudes, or perceptions related to a series of individual statements or items. Each item was a declarative statement,[31]. In this study, the level of agreement referred to in this Likert scale consists of 5 scale options which have a gradation from Strongly Agree (SA) to Strongly Disagree (SDA). The five options are shown in Table 4.

| Likert Scale | Gradation           |
|--------------|---------------------|
| 5            | Strongly Agree (SA) |
| 4            | Agree (A)           |
| 3            | Doubt (D)           |
| 2            | Disagree (DA)       |
| 1            | Strongly Disagree (SDA) |

4.2.3. Correlation product moment Pearson. The data obtained needs to be tested for validity and reliability to obtain a significant degree of accuracy using the correlation method. The strength of the
relationship between cause and work accidents used the correlation coefficient a number between −1 and +1 calculated to represent the linear dependence of the variable [32].

\[ r = \frac{N(\Sigma XY) - (\Sigma X)(\Sigma Y)}{\sqrt{[N\Sigma X^2 - (\Sigma X)^2][N\Sigma Y^2 - (\Sigma Y)^2]}} \]  

with, \( r \) = correlation coefficient, where \( r = 0.00 - 0.19 \) = very low relationship (VLR)
\( r = 0.20 - 0.39 \) = low relationship (LR)
\( r = 0.40 - 0.59 \) = medium relationship (MR)
\( r = 0.60 - 0.79 \) = strong relationship (SR)
\( r = 0.80 - 1.00 \) = very strong relationship (VSR)
\( N \) = number of data
\( X \) = independent variable
\( Y \) = dependent variable

4.2.4. Multiple Linear Regression. The multiple linear regression model is referred to as a model of relationship where the response depends on two or more predictor variables, use the formula [33]. In this study, the variables that cause work accidents are categorized into two categories, namely unsafe conditions and unsafe actions. The appropriate model for analyzing the causal relationship between these two categories and occupational accidents is a multiple linear regression model.

\[ \hat{Y} = \beta 0 + \beta 1 xi 1 + \beta 2 xi 2 + \ldots + e i \]  

where, \( i \) = number of respondents, \( xi 1 \) = unsafe condition, \( xi 2 \) = unsafe action, \( \hat{Y} \) is regression coefficient, the regression parameter, \( \beta 0, \beta 1, \beta 2 \) and so on are unknown. The response variable \( y \) in research was expected to be influenced by two input variables \( x 1 \) and \( x 2 \), and that the data relevant to these input variables are recorded along with the measurement of \( y \).

4.2.5. Questionnaire Measurement for the impact of work accident. Calculate the score on each item statement use formula, [32].

\[ \text{Score} = \frac{(4 \Sigma A) + (3 \Sigma B) + (2 \Sigma C) + (1 \Sigma D)}{n} \]  

with \( n \) = sample size, and \( A, B, C \ and \ D \) = uncertainty events for very high, high, low and very low
Using the formula above will get a score for each item that ranges from 0 - 4. Grouping criteria uses an assessment with interval scores 1 - 4, which is shown in Table 5.

| Interval | Criteria |
|----------|----------|
| 0 < score < 1 | Bad |
| 1 < score < 2 | Less |
| 2 < score < 3 | Enough |
| 3 < score < 4 | High |

Table 5. Assessment criteria for questionnaire measurement.
5. Results and discussion

The data obtained needs to be tested for validity and reliability so that further analysis can be made using predetermined methods because they are relevant to the research problem.

5.1. Validity and reliability

Testing the validity and reliability of the questionnaire data using the Pearson correlation formula, with the MS Excel application. Furthermore, it is verified by the “r” Table which is a table of numbers that is usually used to test the results of the validity test of a research instrument. The results are shown in Table 6 and Table 7. Significance level = 5%, df = 38

| Code | “r” count | “r” Table | Description |
|------|------------|-----------|-------------|
| CA1  | 0.766      | 0.3120    | SR, valid   |
| CA2  | 0.824      | 0.3120    | VSR, valid  |
| CA3  | 0.850      | 0.3120    | VSR, valid  |
| CA4  | 0.820      | 0.3120    | VSR, valid  |
| CA5  | 0.718      | 0.3120    | SR, valid   |
| CA6  | 0.705      | 0.3120    | VSR, valid  |
| CA7  | 0.890      | 0.3120    | VSR, valid  |
| CA8  | 0.855      | 0.3120    | VSR, valid  |
| CA9  | 0.825      | 0.3120    | VSR, valid  |
| CA10 | 0.805      | 0.3120    | VSR, valid  |
| CA11 | 0.765      | 0.3120    | SR, valid   |
| CA12 | 0.755      | 0.3120    | SR, valid   |
| CA13 | 0.850      | 0.3120    | VSR, valid  |
| CA14 | 0.756      | 0.3120    | SR, valid   |
| CA15 | 0.690      | 0.3120    | SR, valid   |
| CA16 | 0.785      | 0.3120    | SR, valid   |
| CA17 | 0.705      | 0.3120    | SR, valid   |
| CA18 | 0.672      | 0.3120    | SR, valid   |
| CA19 | 0.780      | 0.3120    | SR, valid   |
| CA20 | 0.720      | 0.3120    | VSR, valid  |
| CA21 | 0.754      | 0.3120    | SR, valid   |
| CA22 | 0.680      | 0.3120    | SR, valid   |
| CA23 | 0.835      | 0.3120    | VSR, valid  |
| CA24 | 0.940      | 0.3120    | VSR, valid  |
| CA25 | 0.958      | 0.3120    | VSR, valid  |
| CA26 | 0.869      | 0.3120    | VSR, valid  |
| CA27 | 0.852      | 0.3120    | VSR, valid  |
| CA28 | 0.835      | 0.3120    | VSR, valid  |
| CA29 | 0.960      | 0.3120    | VSR, valid  |
| CA30 | 0.825      | 0.3120    | VSR, valid  |
| CA31 | 0.815      | 0.3120    | VSR, valid  |
5.2. The relationship between USC(X1) and USA(X2) with work accidents
The results of the analysis the relationship between unsafe condition categories (X1) and unsafe actions (X2) with work accidents in the construction of road and bridge projects using multiple linear shown in the Table 8 below.

Table 8. Results data analysis of relationship accident work.

| Coefficients | Standard Error | t Stat  | P-value | Lower 95% | Upper 95% | Lower 95.0% | Upper 95.0% |
|--------------|----------------|--------|---------|-----------|-----------|-------------|-------------|
| Intercept    | 2.452206       | 0.164211| 14.93325 3.03E-17 | 2.119483 | 2.784929 | 2.119483 | 2.784929 |
| USC (X1)     | 0.419118       | 0.077355| 5.418122 3.85E-06 | 0.262382 | 0.575853 | 0.262382 | 0.575853 |
| USA (X2)     | 0.238238       | 0.056335| 3.218124 3.55E-05 | 0.237362 | 0.495673 | 0.132372 | 0.474864 |

Based on Table 8, the multiple linear regression equation models can be shown as follows:

\[ \hat{Y} = 2.45 + 0.42X1(USC) + 0.24X2(USA) \]  

The strength of the relationship between USC (X1) and USA(X2) with WA (Y) in the construction of road and bridge projects, can be seen in the analysis results for Multiple R, R Square, and Adjusted R Square. The analysis results are presented in the Table 9.

Table 9. The strength of the relationship between the USC and USA with WA.

| Regression Statistics |            |            |            |            |            |
|-----------------------|-------------|-------------|-------------|-------------|-------------|
| Multiple R            | 0.977842    |            |            |             |             |
| R Square              | 0.86089     |            |            |             |             |
| Adjusted R Square     | 0.853371    |            |            |             |             |
| Standard Error        | 0.102143    |            |            |             |             |
| Observations          | 40          |            |            |             |             |

Multiple R is a measure to measure the closeness of the linear relationship between the dependent variable and all independent variables together. In this study, the multiple of \( R = 0.98 \), which is close to 1, indicates a strong relationship unsafe condition categories and unsafe actions with work accidents in the construction of road and bridge projects.

R Square or the coefficient of determination is a measure of the suitability of the regression equation, namely the provision of a proportion or percentage of the total variation in the dependent variable explained by the independent variable. In the study, \( R^2 = 0.86 \), the resulting multiple linear regression equation model to analyze the relationship between unsafe condition categories and unsafe actions categories in road and bridge construction projects is very good.

P-value or significance F shows a measure of the significance level of the multiple linear regression model. The significance of F close to zero means that the input variable is very significant to the output, as shown in Table 10. below:

Table 10. p-value against alpha.

| P -Value | Alpha |
|----------|-------|
| USC (X1) | 3.85E-06 | 0.05 |
| USA (X2) | 3.55E-05 | 0.05 |
The p-value of the USC and USA < alpha = 0.05, this means the coefficient value of the two variables is significant.

F value, as F count in hypothesis testing, is compared to the F table value. If F count > F table, it can be stated that simultaneously the independent variable has a significant effect on the dependent variable. The results of the study are shown in Table 11.

|          | df | SS    | MS   | F      | Significance F |
|----------|----|-------|------|--------|----------------|
| Regression | 2  | 2.388971 | 1.194485 | 114.4886 | 1.42E-16 |
| Residual  | 37 | 0.386029 | 0.010433 |          |                |
| Total     | 39 | 2.775     |      |        |                |

The results of the data analysis presented in Table 11 show that the calculated F value = 114.49. With df numerator = 2, and df denominator = 37, and $\alpha = 5\%$, then F Table = 3.49. Thus, F count > F Table. This means that the resulting multiple linear regression equation models are significant.

5.3. Variable relationship model

The model of the relationship variable is presented in Figure 3. The model in Figure 3 shows that work accidents can occur due to many factors that contribute to USC and USA. The same thing was conveyed by several researchers as presented in Table 2, [19], as well as the opinions of respondents in this study. Furthermore, USC and USA flowed down resulting in work accidents on the implementation of road and bridge construction projects in Eastern Indonesia.

The USC and USA variables together have a significant effect on work accidents, as evidenced by the results of multiple linear regression calculations where the p-value is less than 5% and the F count for USC and USA is each greater than F table. Likewise, the value of t count is greater than the value of t table [33]. This shows that work accidents are still significant in this area.

![Figure 3. USC and USA with WA Relationship Model.](image-url)
5.4. Impact of accident of road and bridge construction project
The likelihood occurrence and magnitude of the impact of work accidents on the roads and bridges construction project in Eastern Indonesia based answer of the respondent are shown in Table 12 and Figure 4.

Table 12. The likelihood occurrence and magnitude of the impact of work accidents on the roads and bridges construction project.

| No  | Impact                                      | Probability occurrence by respondents | Mean value of impact accident [Formula (4)] |
|-----|---------------------------------------------|---------------------------------------|-------------------------------------------|
| 1.  | Fall from height                            | .80                                   | 3.621 (H)                                 |
| 2.  | Permanent physical injury                   | .95                                   | 4.000 (H)                                 |
| 3.  | Dead                                        | .98                                   | 4.000 (H)                                 |
| 4.  | Trauma                                      | .90                                   | 3.887 (H)                                 |
| 5.  | Work is delayed;                            | .80                                   | 3.621 (H)                                 |
| 6.  | Decreases of productivity                   | .80                                   | 3.177 (H)                                 |
| 7.  | Material loss                               | .80                                   | 3.621 (H)                                 |
| 8.  | Additional cost                             | .99                                   | 4.000 (H)                                 |
| 9.  | Loss of trust in the contractor             | .95                                   | 3.927 (H)                                 |
| 10. | The public held a demonstration / protest   | .75                                   | 2.435 (E)                                 |
| 11. | Legal process                               | .95                                   | 3.887 (H)                                 |
| 12. | Environmental pollution                     | .75                                   | 3.210 (H)                                 |
| 13. | National safety index                       | .85                                   | 3.927 (H)                                 |

Figure 4. Distribution of impact, likelihood occurrence, and magnitude of the impact.

Table 12 and Figure 4 show that the probability of impact that can occur due to work accidents to each individual and organization is high such as dead (0.98), additional cost (0.99), permanent physical
injury (0.95), loss of trust in the contractor (0.95), even up to the legal process (0.95) while the public held a demonstration / protest has a sufficient impact (0.75) which means that the possibility of a demonstration or protest by the community in the surrounding environment or the victim's family is likely sufficient. This result is corroborated by the mean value of impact accident. The results of this study are in line with previous studies as presented in Table 3.

6. Conclusion and Limited Research
The level of work accidents in road and bridge construction projects, especially in Eastern Indonesia, is still high. Based on the results of the analysis, 31 variables causing work accidents are classified into two categories, namely unsafe conditions and unsafe actions, and 13 impact variables arising from these accidents with high probability values even though the government continues to strive to improve quality. regulations and their implementation. This may be due to low awareness and inconsistent implementation of OSH or deviations from applicable regulations. Based on this, there is still ample space to conduct research on this theme for the central of Indonesia, western Indonesia, or Indonesian regions as a whole by considering ethnic diversity which is often correlated with behavior or habits, especially those related to compliance with OHS regulations.

7. Recommendation
Recommendations that may be conveyed in the context of preventing fatal accidents in the construction of roads and bridges, especially in Eastern Indonesia, are: first, the leadership's commitment to the rules that apply during project activities. This means that leadership commitment will make employees obey the rules. The same has been suggested by [19] in their study in the US on how committed transformational leaders are in organizations and support from colleagues for successful safety practices. [1] said the same thing.
Second, implementation of the OHS law and formulating a more effective accident prevention system. This recommendation has been reinforced by [1], that laws relating to OHS exist to identify the responsibilities of parties involved in industrial or commercial activities. To provide a clear set of responsibilities for management to protect the health and safety of their employees while they are working and to protect the rights of employees who are paid without suffering injury or illness. In Indonesia, the OHS law has been issued by the government since the 1970s as well as some of the latest regulations [34],[35], [36], [37] related to OHS in the construction project or industry, which clearly regulates the obligations of workplace leaders and workers in implementing work safety.
Third, periodically disseminates standard OHS practices. This recommendation is reinforced by [1] that Health and safety are considered a fundamental business activity, and therefore a realistic resource. Health and safety management, including the role of safety professionals, is integrated into daily business activities. Security is no longer seen as a burden, but as a good business practice that can win contracts and increase profits. Therefore, the organization should always communicate health and safety issues with its personnel on a regular basis. The same thing was also conveyed by [20]. Fourth, increase awareness and knowledge about OHS through training. An increase in awareness of OHS will automatically increase professional behavior towards OHS [38]. Meanwhile, training and implementation of research results are important for OHS skills [1]. The recommendations in this article can provide valuable references for both policymakers and construction companies to improve safety conditions in the industry of construction.

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