Structural Equation Model (SEM) between risk, safety control systems of risk, and OHS programs on OHS costs in rusunawa projects

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Abstract. There is a continuous hampering of Occupational Health and Safety (OHS) in the construction budget due to its consideration as an extra cost. This means decisions on OHS are usually made based on the economics aspect instead of focusing on the ethics and basic rights to a safe workplace. This research was, therefore, conducted to analyze the relationship between risk, its safety control systems, OHS programs, and OHS costs, and also to determine the factors with the dominant effects on OHS costs using the Structural Equation Model - Partial Least Square (SEM-PLS) with the use of Rusunawa projects as a case study

1. Introduction
In recent years, safety in construction has become a global problem and a serious concern for the government. This is mostly reflected in the absence of enough data or correct information to assess the safety of a construction site [1].

One of the risk factors considered to be very influential to the performance of a company in the construction sector is the risk of work accidents. A more complex construction design has been discovered to have a higher risk as well as the OHS costs required to prevent accidents. Therefore, OHS Construction Risk is defined as the measure of the possibility of loss associated with public safety, property, human life, and the environment due to certain sources of hazards during construction [2]. There is, however, a continuous hampering of Occupational Health and Safety (OHS) in the construction budget due to its consideration as an extra cost. The decisions on this concept are, therefore, usually made based on the economics aspect instead of focusing on the ethics and basic rights to a safe workplace [3].

This research was, therefore, conducted to analyze the relationship between risk, its safety control systems, OHS programs, and OHS costs, and also to determine the factors with the dominant effects on OHS costs [4].

2. Literature review
2.1. OHS cost for rusunawa project
Indonesia is a developing country with low per capita income and the second-highest number of workers in the world. Moreover, Southeast Asia has also been placed second highest among the regions with the occupational accident fatality rate [6]. This is mainly due to the non-inclusion of safety or accident prevention costs in the project budget in order to reduce the expenses for the contractor. Meanwhile, some of the costs affiliated with accident prevention are as follows [7]:

- First Aid Facilities
- Personal Protective Equipment (PPE)
- Safety Training
- Safety Promotion
- Security Personnel

Statistics showed the highest mortality rate is in the construction industry sector and this majorly due to the poor management of OHS by contractors because of the inadequate value placed on the need to comply with the regulations. Meanwhile, the items required to be included in the cost evaluation [8] include:

- Worker Insurance
- OHS Inspection
- OHS Meeting
- OHS Training
- Payment to safety officers/consultants
- Safety Tool
- Personal Protective Equipment
- Supporting equipment for administration, management, and documentation

Several construction site’s employees are being killed or injured every year while others suffer from poor health due to causes related to work. The risk is also not limited to the employees as observed with the frequent deaths and injuries usually recorded in a community when construction activities are not properly monitored. Therefore, some of the items required to be monitored to ensure basic health and safety include [9]:

- Access Location
- Location Limits
- Welfare Facilities
- Sanitation
- Washing Facilities
- Rest Facilities
- Personal Protective Equipment (PPE)
- Storage Areas and Waste Materials
- Lighting
- Emergency Procedure
- First aid
- Reports of Accidents and Dangerous Events

2.2. OHS risk in rusunawa project
According to Flanagan & Norman (1993), the risks in construction projects include [10]:

- Failed settlement according to the design or construction time
- Failure to obtain drawings and planning/permit details on time.
• Unexpected Soil Conditions
• Very Bad Weather
• Labor Strike
• Unexpected increase in price for labor and materials
• Accidents at locations causing injuries
• Damage caused to the structure due to poor work methods
• Unexpected events such as floods, earthquakes, etc.
• Claims from contractors due to loss as well as the costs incurred due to production delays caused by the design team
• Failure to complete the project with a predetermined budget.

2.3. Safety control systems of risk
According to ISO 45001: 2018, the control hierarchy in the safety, health, and occupational health system include [11]:

• Elimination
• Substitution
• Engineering Control
• Administrative Control, and
• Personal Protective Equipment (PPE)

2.4. OHS programs
The details of the Activities of Implementing a Construction Safety Management System based on the Circular Letter of the Minister of PUPR Number 21/PRT/M/2019 are presented as follows [12]:

• Preparation of RKK
• Socialization, promotion, and training
• Work Protective Equipment (APK) and Personal Protective Equipment (PPE)
• Insurance and Licensing
• OHS construction personnel
• Medical facilities, infrastructures, and devices
• Signatures needed
• Consultation with experts regarding construction safety according to the scope of the field works
• Miscellaneous related to construction safety risk control

2.5. The theory of the relationship between risk and OHS costs
Risk Management is defined as the process of identifying, measuring, and financial control of a risk threatening the assets and income of a company or project and with the ability to cause damage or loss. Meanwhile, OHS risk management is a comprehensive, planned, and structured effort to manage OHS risk in order to prevent unwanted accidents in a good system. It is majorly related to hazards and risks with the potential to cause harm in the workplace [13].

According to the PUPR PERMEN Number 21 of 2019 concerning the Construction Safety Management System Guidelines, Article 26, the Construction Safety Risks are classified into [12]:

• Small
• Moderate
• Big

This, therefore, means there is an effect of OHS risk on real-life implementation costs of the concept in construction projects.
2.6. The theory of the relationship between OHS programs and OHS costs

The Occupational Safety & Health Plan is a key document which is usually used as a reference to ensure job safety performance on projects with the focus on workers and other personnel in the field. It contains general regulations on reducing accidents and protecting assets and properties and the estimated costs which are expected to be included in the project budget include [14]:

- Registration and administration fees
- Training costs
- Promotion fee
- OHS operational costs

This means the OHS program to be implemented in the Rusunawa project has the potential to affect the OHS Cost.

2.7. The theories of the relationship between risk safety controls system and OHS costs

The hierarchy of control is one of the things highly considered in OHS risk assessment activities and this is due to the importance of the choice made in providing effective and efficient benefits by reducing the risks to an acceptable level which is also known as the acceptable risk in an organization. Meanwhile, the first control hierarchy is believed to provide higher effectiveness than the second, and this is associated with two basic ideas which are reducing the probability as well as the severity of an accident or exposure. [11]

3. Methodology

This research was conducted with the use of a quantitative survey and this involved taking a sample of at least predetermined 200 respondents from one population while questionnaires were used to obtain primary data.

![Figure 1. Research Methodology](image-url)

The first stage involved determining the outputs expected to be used as indicators from each variable. This was followed by the second stage which was validating indicators using expert judgment by applying google docs. The third stage was the distribution of the questionnaires to the...
respondents while the last step was processing data obtained from the third stage using the SEM PLS program. The process is graphically represented in the Figure 1.

4. Result
The primary data was directly sourced using questionnaires and based on certain criteria one of which is requiring the respondents are construction project professionals with a minimum of 1 year experience in Indonesia and results obtained are presented in the following table.

Table 1. The Relationship Between Variable based on SEM-PLS Result

| Relationship                  | Original Sample (O) | T Statistics | Information     |
|-------------------------------|---------------------|--------------|-----------------|
| X1\(^b\) -> Y1\(^c\)         | 0.104               | 1.712        | Not Significant |
| X1 -> Y2\(^d\)               | 0.096               | 1.822        | Not Significant |
| X2\(^e\) -> Y1               | 0.196               | 2.253        | Significant     |
| X2 -> Y2                     | 0.028               | 0.361        | Not Significant |
| X3\(^f\) -> Y1               | 0.497               | 6.491        | Significant     |
| X3 -> Y2                     | 0.666               | 10.690       | Significant     |

\(^a\) Relationship between X and Y Variable which obtained from SEM PLS Program
\(^b\) Risk Variable
\(^c\) OHS General Cost Variable
\(^d\) OHS Specific Cost Variable
\(^e\) Safety Control Systems of Risk Variable
\(^f\) OHS Programs Variable

The results for the relationship between the variables are attached at the end of this paper after it has been tested by an expert in OHS.

5. Conclusion, limitation, and recommendation
It is recommended that all the indicators for the variables be comprehensively developed to achieve the best result in the next research based on the regulation of the Minister of Public Works and Housing regulations (PUPR) requiring the OHS cost is well presented in constructing the Rusunawa projects.

This research is limited by the inadequate numbers of experts needed to test the validity of the results. It is also possible to develop it by adding more indicators or variables influencing the OHS costs in Rusunawa Projects in order to identify the competency gaps required to be improved.

6. Appendix

Table A. Outer Loading Value Result for Intern Relationship (Between Indicators and Variables)

| RELATIONSHIP                   | ORIGINAL SAMPLE | T STATISTICS | SIGNIFICANCY\(^a\) |
|--------------------------------|----------------|--------------|---------------------|
| X1.1 << Risk                   | 0.785          | 13.251       | Significant         |
| X1.2 << Risk                   | 0.938          | 38.986       | Significant         |
| X1.3 << Risk                   | 0.660          | 8.100        | Significant         |
| X2.1 << Safety Control System of Risk | 0.574        | 8.493        | Significant         |
| X2.2 << Safety Control System of Risk | 0.723        | 12.887       | Significant         |
| X2.3 << Safety Control System of Risk | 0.816        | 23.093       | Significant         |
| X2.4 << Safety Control System of Risk | 0.764        | 20.923       | Significant         |
| X2.5 << Safety Control System of Risk | 0.774        | 23.751       | Significant         |
| No  | Relationship Between Variable                  | Original | T Statistics | Significance |
|-----|-----------------------------------------------|----------|--------------|--------------|
|     |                                               | Sample(O) | (|O/STDEV|)          |              |
| 1   | Risk → Safety Control System of Risk           | 0,369    | 5,383        | Significant  |
| 2   | Risk → OHS Program                             | 0,157    | 2,091        | Significant  |
| 3   | Risk → OHS General Cost                        | 0,104    | 1,712        | Not Significant |
| 4   | Risk → OHS Specific Cost                       | 0,096    | 1,822        | Not Significant |
| 5   | Safety Control System of Risk → OHS Program    | 0,541    | 9,216        | Significant  |
| 6   | Safety Control System of Risk → OHS General Cost| 0,196 | 2,253        | Significant  |
| 7   | Safety Control System of Risk → OHS Specific Cost| 0,028 | 0,361        | Not Significant |
| 8   | OHS Program → OHS General Cost                 | 0,497    | 6,491        | Significant  |
| 9   | OHS Program → OHS Specific Cost                | 0,666    | 10,690       | Significant  |

Significant if the T Statistics value > 1.96

**Table B. Path Coefficient Significance Relationship Between Variables**

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