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Research Paper

A Risk Management Analysis by AS/NZS 4360:2004 Method (A Study of the Worship Building at Malang State University, Indonesia)

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ABSTRACT : *The construction project of Worship Building belongs to Malang State University has been planned in a professional way, however in reality, this construction project also posed several risks in its implementation. This research aims to identify type of risk from the Worship Building construction project at Malang State University also how to respond at these risks. A descriptive method was applied to this research with a qualitative approach by using the AS/NZS 4360:2004 standard. Data sources for this research were primary data documents in the form of questionnaires to the contractor staff experts, and the secondary data in the form of cost budget plan and time schedule documents from the Learning Support Building of Malang State University. The result of the research is the Preparatory and Ground Work is classified to have a low risk level, the Concrete Structure Work is classified to have a moderate risk level, and Roof Work (Mosque Dome) is classified to have a moderate risk level. Final step of this research was to control the highest risks, where the risk control was carried out upon works that classified to have high risks such as Unprofessional Workers (A3) and Design Changes (B1) with expectation to the existing risks can be controlled in proper ways.*

KEYWORDS: *Risk Identification, Risk Management, and Worship Building Construction.*

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I. INTRODUCTION

A Religious Worship building (*Gedung Peribadatan* in Indonesia term) at Malang State University was one construction project organized by Malang State University (*Universitas Negeri Malang*) and took a form of a three-story mosque. The construction process for this mosque was carried out in 2021 – 2022 for 281 calendar days with an implementation contract value of IDR 62 billion.

The condition of the construction site was located between lecture buildings became one serious consideration during the construction of the building, and material procurement also experienced a slight delay because of the outer road, the Veteran Street was prone to traffic jams. Also, long access to arrive at the construction location which located in the middle of the Universitas Negeri Malang campus area as well as mobilization of human resources (HR) that unable to be maximized since construction location and condition of the building was built in a very close range to the old lecture buildings gave additional consideration not to damage parts of the old buildings. The risk from weather condition also plays influential part at the start of the implementation time, where the weather was less favorable with many rain occurrences happened almost every day.

The project implementation process was likely headed to complexity problems and required longer time so that many uncertainties happened and ultimately ended to the emergence of work risks. These risks will bring significant impact on the project budget, project quality and project productivity. [1]

Risk management is a method used to estimate the uncertainty factor within a project in an active way to get the desired project performance level by reducing certain undesirable matters. The ability to perform risk identification to the project will affect the project performance, in which by risk management, it can control risks before a project starts or when there is a risk occur, able to reduce delays, stress and cost of a project to ensure the project able to run well to meet certain requirements or able to achieve the work target. [2]

In practice, controlling unresolved risks that started from identifying risks until find a way to reduce their effects at level of project target is difficult, therefore, a flexible planning is needed to look at the risk probability also the contingency planning that focuses on risk factors both from inside and outside of the

organization. There is a possibility that the risk comes from the behavior of the project manager during the project's planning process and the project's implementation process. [3]

The capability needed in a project is the ability to know and anticipate any risk emergences that able to affect the work project such as ability to identify cause of risks which can be exemplified by the complexity project design and its implementation, have knowledge about surrounding environment of the project, or have knowledge on renewable technology while implementing the project, also the use of project's contract strategy. [4]

So far, not so many discussions related to Risk Management Analysis in the case of Worship Buildings at the Malang State University had been made by researchers, therefore, the study problems raised in this paper are (1) How the risk identification process works in the site of Worship Building construction project for the Malang State University? (2) How the result of risk assessment to the Worship Building construction project at Malang State University? and (3) what are efforts of risk controls to the case of Worship Building Construction project for Malang State University?

II. LITERATURE REVIEW

2.1. Construction Project

Ervianto, said a construction project is series of activities carried out in once with certain amount of time. Within these activities series, there is a process that organizes many project resources into activity result in the form of building while the work process in these series of activities involving related parties both in direct or indirect ways. There will be relationships between parties that involved in the project which later be clarified according to the work relationship and the functional relationship. With involvement of more parties in a construction project, the potentiality of conflict will be higher, so as tentative conclusion, a construction project has a high level of conflicts. Ervianto put the parties involved in a construction project in a diagram as shown in Figure 1 below. [5, 6]

Figure 1: Parties in the construction project [5]

2.2. The Definition of Irrigation

According to Putra et. al in Aldesra risks are uncertain because these risks occur due to less information or no information about what will happen to the work. This uncertainty may have negative but also positive impacts. When the uncertainty becomes positive then it is an opportunity, to the opposite, when the uncertainty becomes negative then it is a risk. Moreover, according to Wena and Suparno the possibility of risk occurrences in construction project is categorized into several groups [7, 8]:

1. An external-unpredictable risk, such as natural disasters, government laws, vandalism, along with other effects that were not previously predicted.
2. An external-predictable risk, such as finance and its interest, material availability, environmental impact, taxation, inflation, etc.

3. An internal or nontechnical risk, such as fund flow, work safety issues, profit plan, late schedule, work strikes, and bottleneck financial issue.
4. A technical risk, such as technology, design changes, implementation changes and maintenance problems which happens in the technology use within the project such as BIM changes and its adjustment.
5. A legal risk, such as license, patent, court, sub-contractor performance, contract failure, lawsuit, and force majeure.

2.3. Method in Risk Management

1. Risk Breakdown Structure (RBS) Method.
   This method is used to make a categorization over each risk. RBS is a way to group risks into logical, systematic and structured risk hierarchy in accordance with the applicable standards. This application can increase the understanding of risks in a project. [9]
2. Analytical Hierarchy Process (AHP) Method.
   It is a method used for decision making plan which developed by Saaty. AHP describes many multi-criteria problems into a hierarchy. Hierarchies able to decompose complex problems into certain criteria's and then organize and analyze them to make correct decision able to be taken. [10, 11]

2.4. Process in Risk Management

According to Australian Standard there are four steps of risk management procedures [12]:

1. Establish the Context. It is determining the problem by setting the internal and external parameters for matters which will be discussed in the risk management. Then, the scope of work is determined and a risk analysis will be carried out. Scope of work is determined and a risk analysis is carried out.
2. Identify Risk. Risk identification is stages of obtaining the appropriate risk problem variable. By risk identification, it can obtain a list or risk sources and events that have impact on achieving the project target.
3. Analyze Risk. Risk analysis is stages of considerations from risk sources, consequences, and probability of these risks. Risks are analyzed by combining likelihood (frequency/probability) and consequences (effect/impact) values. The likelihood and impact of each risk will determine the risk level.
4. Evaluate Risk. Risk evaluation involves and compares the risks that exist during the analysis process with predetermined risk criteria. The result is a list of prioritized risks to be followed up in the next step.
5. Treat Risk. Risk treatment is a way to minimize risks as can be termed with risk mitigation where the analyzed risks sometimes cannot be completely eliminated and can only be minimized, thereby, giving rise to residual risks.

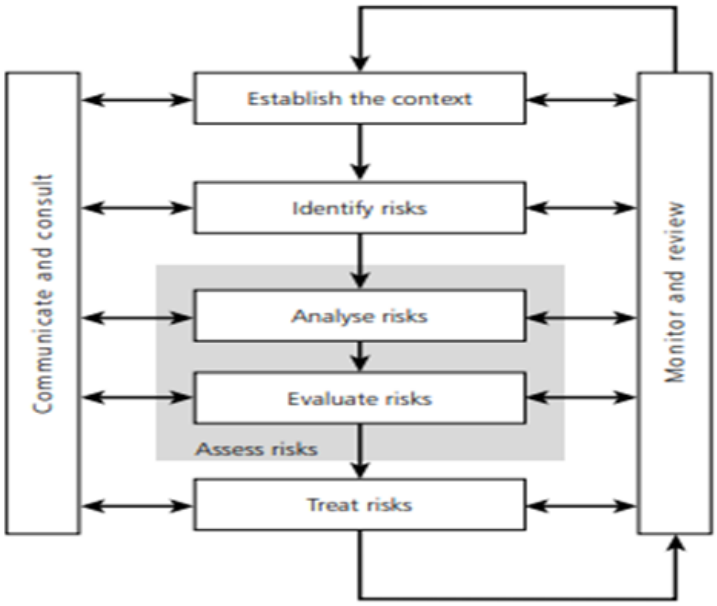

Figure 2: The risk management flow chart [12]

2.5. Risk Identification

Sumajouw and Sompie stated that risk identification process is recognizing types of risks which are likely to occur and will commonly occur during works. The risk identification is a systematic and continuous process for identifying potential risks that can affect project goals. In addition, the PMBOK GUIDE Sixth Edition also supported the risk identification by giving data collection techniques in obtaining the problem information that can be used such as [13, 14]:

1. Brainstorming technique. It is carried out by collecting ideas to find solution to problems like in the risk of project accident, there are several frameworks and ideas are used to minimize the work accidents.
2. Checklist technique. The checklist technique is examining list of work items and possible risks which can be occurred to be developed for getting information about how to prevent these risks.
3. Interview technique. Interview technique is carried out by interviewing significant person in the project such as the project manager, site manager, QHSE/Quality Health Safety and Environment, also experts to obtain information on risk of the work accidents.
4. Root cause analysis technique. This technique carried out by searching the root cause of the problem, identifies the problem in a specific way to find the main cause of the problem for further handling.
5. Assumption and constraint technique. This technique is used to identify inaccuracy, instability, inconsistency, also make assumption to minimize risks.
6. SWOT/Strength-Weakness-Opportunity-Threat technique. The SWOT analysis technique is carried out by evaluating strengths, weaknesses, opportunities and any threats in the work project.
7. Document analysis technique. Document analysis techniques are carried out by identifying project documents such as agreement documents, technical documents, contract documents, constraints and other project archive documents.

2.6. Risk Analysis

According to Thompson & Perry, a qualitative risk management has two directions for identifying risks and assessing risks. In qualitative analysis, the value of risk can be found by multiplying probability factor by the impact of the risk, if the probability is high and the impact is high, then it will produce a high level of risk. On the contrary, if the probability is low and the impact is low, then it will produce a low level of risk. After the value of risk has been found, then the main risks will be handled with a way called risk mitigation. [15]

Furthermore, the Australian Standard/New Zealand Standard explains about each risk that will be assessed in qualitative method by five categories. The measurement of each likelihood and consequences is presented in Table 1 and Table 2 below. [12]

Table 1. The Risk Probability Assessment [12]

No	Definition	Explanation
1	Rare	Very Seldom/may occur under particular circumstance
2	Unlikely	May occur in some circumstances but is unlikely
3	Moderate	May occur in certain conditions
4	Likely	May occur in almost all conditions
5	Almost Certain	May occur in all conditions

Table 2. The Impact/Risk Consequences Assessment [12]

No	Definition	Explanation
1	Insignificant	No injury or wound, low scope of loss, impact scope is small
2	Minor	Requires first aid, impact scope is small
3	Moderate	Requires medical aid, financial loss is quite high
4	Major	High loss, production ability declines, the impact is large
5	Catastrophic	Loss of life (death), major damage, a very high financial loss

2.7. Risk Evaluation

Risk evaluation has a purpose to help in making decision based on the result analysis. The risk evaluation process will determine which risks that have the highest priority to be handled. Risk evaluation carried out by categorizing the probability and impact values into a risk matrix. Once the probability and impact values are known, these numbers can be included into the risk matrix. An example of a risk matrix according to AS/NZS 4360:2004 is presented in the following table 3.

Table 3. Risk Matrix [12]

L/C		**CONSEQUENCES**				
PROBABILITY		1	2	3	4	5
		Insignificant	Minor	Moderate	Major	Catastrophic
5	Almost Certain	5	10	15	20	25
4	Likely	4	8	12	16	20
3	Moderate	3	6	9	12	15
2	Unlikely	2	4	6	8	10
1	Rare	1	2	3	4	5

Note:

Very High : No tolerance and needed immediate handling
High : Unwanted and needs special attention
Moderate : Accepted with agreement and high responsibility
Low : Accepted with agreement by the management team
Very Low : Could be ignored but regularly controlled

The result of risk evaluation is a risk rating which requires further research on the basis of residual risk and an effective risk control.

2.8. Risk Management

According to Planagan & Norman in Putra et al., there is four matters in managing risks [16]:

1. Risk retention. Accepting or retaining the impact of risks that have a low/acceptable level of loss.
2. Risk reduction. Study the risk further to initiate the efforts to prevent these risks by combining efforts to make the occurrence of risks will not accumulate. This act often causes residual risk and requires an assessment available on this stage.
3. Risk transfer. Act of transferring part of the risk or total risk to something else. Activities with a high level of risk will be transferred to other parties who have good capabilities to handle and control these risks.
4. Risk avoidance. Act of avoiding work that has a very high level of weakness. The action can be taken by refusing to carry out a high-risk project where one of the examples is to terminate the contractual relationship (contract breaching).

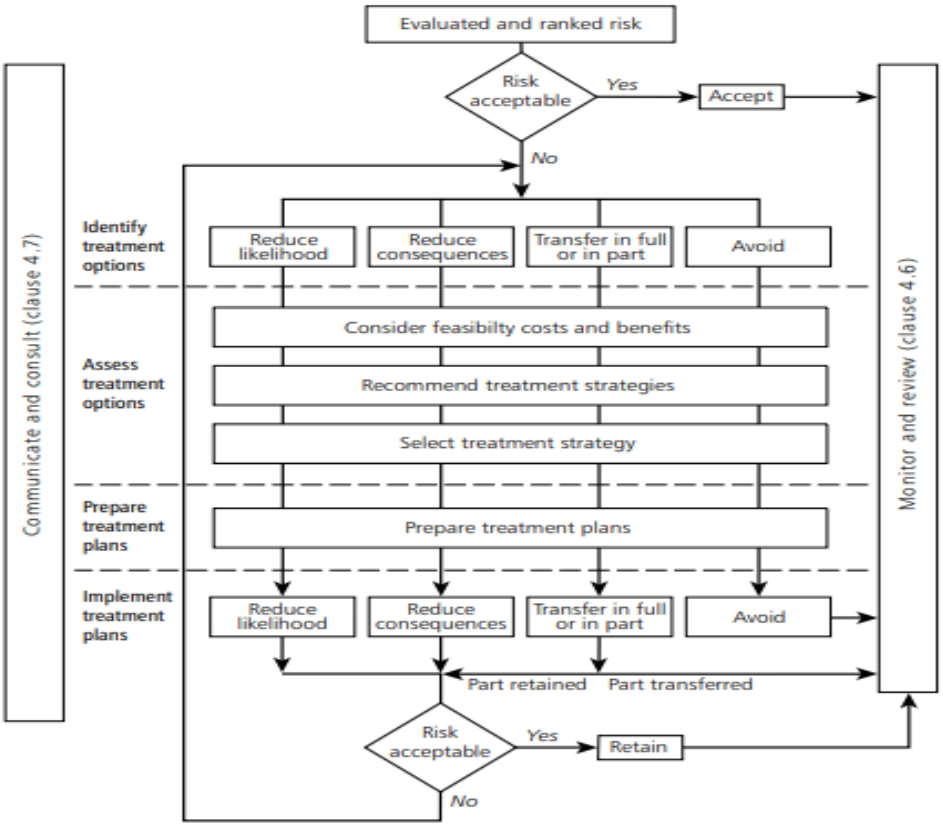

Figure 3: The process of risk management [12]

III. RESEARCH METHOD

3.1. Research Object

This research was held on construction project of Worship Building in Malang State University at Semarang St. No. 5 Malang city, East Java, Indonesia.

- Project's Name : *Gedung Peribadatan* at Malang State University
- Project's Location : Semarang Street No.5, Malang, East Java, Indonesia.
- Project's Value : IDR. 62,824,277,963.19
- Project area : ± 9000 m2
- Implementation Time : 240 calendar days
- Planning Consultant : PT. Yoda Karya
- Contractor : HIMINDO – INDOPORA, KSO
- Consultant : PT. Delta Buana Konsultan
- Total number of stories : 3 stories.

3.2. Research Method

The method applied in this research was a descriptive method with a qualitative approach, in a purpose as attempts to describe an event according to what happened in the work field with result in a form of written reports.

Primary data; Primary data for this research was obtained from questionnaire from the expert staff of the related contractor of the project, the project manager from PT. HIMINDO-INDOPORA, KSO which has 20 years of expertise to this matter.

Secondary data; Secondary data for this research was obtained from the Budget Plan and Time Schedule documents of Worship Building construction project at Malang State University which will be analyzed for the risks according to theory from AS/NZS 4360:2004.

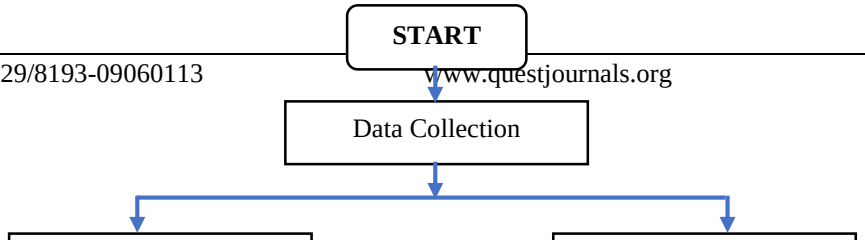

Figure 4: The research flowchart

IV. RESULT AND DISCUSSION

4.1. Risk Identification

The construction project of Worship Building for Malang State University was a three-story building construction within the campus area where the surrounding condition, both from campus environment or the outer environment have a very congested transportation routes with dense traffic jams likely to occur around the Veteran Street lines, the outer road that connects to the campus area.

Therefore, several impacts occurred during the work implementation, which started from difficulty in bringing and placing heavy equipment's into the campus area with the same time of teaching and learning activities on progress in the area around the construction project, until mobilizing and securing roads where the works with heavy equipment were took place. From this information, a risk identification was set up by obtaining the following identifications:

Table 4. The Impact/Risk Consequences Assessment

No	Work Item	Type of Risk	Risk Code	Probability					Impact				
				1	2	3	4	5	1	2	3	4	5
1	Preparatory and Ground Work	Unprofessional Workers	A3		**x**					**x**			
		Conflict between workers	A6	**x**					**x**				
		Utility/Equipment Safety	C8	**x**						**x**			
		Incorrect Work Method	D8		**x**					**x**			
		Poor OSH Management	D9		**x**						**x**		
		Environmental Pollution	F4	**x**					**x**				
2	Concrete Structure Work	Unprofessional Workers	A3			**x**						**x**	
		Injury/Work Accident	A4			**x**					**x**		
		Conflict between workers	A6		**x**					**x**			
		Design Changes	B1			**x**						**x**	

		Design Error	B2		x						x	
		Design Complexity	B4		x						x	
		Material Delay	C2			x				x		
		Material Incompatibility	C3			x				x		
		Utility/Equipment Safety	C8		x					x		
		Incorrect Work Method	D8		x						x	
		Poor OSH Management	D9			x				x		
		Natural Disaster	F1		x					x		
		Environmental Pollution	F4		x					x		
3	Roof Work (Dome of Mosque)	Unprofessional Workers	A3			x					x	
		Injury/Work Accident	A4			x				x		
		Conflict between workers	A6		x					x		
		Design Changes	B1			x					x	
		Design Complexity	B4		x						x	
		Utility/ Equipment Safety	C8		x					x		
		Incorrect Work Method	D8		x						x	
		Poor OSH Management	D9			x				x		

4.2. Risk Evaluation

After the stage of risk identification completed by obtaining identification data through the work items which had been carried out, the part of item and type of risk that work item contained were found. For list of work items presented above, it can be classified into 3 (three) sections:

- There are 6 (six) type of risks in the work items of Preparatory and Ground work with time duration of 4 (four) weeks.
- There are 13 (thirteen) type of risks in the work items of Concrete Structure work with time duration of 10 (ten) weeks.
- There are 8 (eight) type of risks in the work items of Roof structure work with time duration of 4 (four) weeks.

These data will be included into the risk evaluation assessment as stated in Table 5 below.

Table 5. The Risk Evaluation on the Worship Building Construction Project at Malang State University

Type of Work	Code	P	I	P x I	Average
Preparatory and Ground Work	A3	2	2	4	**3.00**
	A6	1	1	1	
	C8	1	2	2	
	D8	2	2	4	
	D9	2	3	6	
	F4	1	1	1	
Concrete Structure Work	A3	3	4	12	**7.69**
	A4	3	3	9	
	A6	2	2	4	
	B1	3	4	12	
	B2	2	4	8	
	B4	2	4	8	
	C2	3	3	9	
	C3	3	3	9	
	C8	2	2	4	
	D8	2	4	8	
	D9	3	3	9	
	F1	2	2	4	

	F4	2	2	4	
Roof Work (Dome of Mosque)	A3	3	4	12	**8.25**
	A4	3	3	9	
	A6	2	2	4	
	B1	3	4	12	
	B4	2	4	8	
	C8	2	2	4	
	D8	2	4	8	
	D9	3	3	9	

Table 6. Matrix of Risk Distribution on the Worship Building Construction Project

L/C		**CONSEQUENCES**				
PROBABILITY		1	2	3	4	5
		Insignificant	Minor	Moderate	Major	Catastrophic
5	Almost Certain					
4	Likely					
3	Moderate			A4, D9	A3, B1	
2	Unlikely		A6, C8, F4		B4, D8	
1	Rare					

The explanation of risk value in the construction project of the Worship Building/Learning Support Building of Malang State University are:

1. High risk

   - A3 : Unprofessional Workers
   - B1 : Design Changes

2. Moderate risk

   - A4 : Injury/ Work Accident
   - B4 : Design Complexity
   - D8 : Incorrect Work Method
   - D9 : Poor OSH Management

3. Low risk

   - A6 : Conflict between Workers
   - C8 : Utility / Equipment Safety
   - F4 : Environmental Pollution

4.3. Risk Management or Risk Control (Treat Risk)

In this research, the stage of risk control is carried out by identifying risk that potentially have high risk level namely: unprofessional workers (A3) and design changes (B1).

4.3.1. The risk from unprofessional worker (A3) was able to be controlled through several way as listed below:

1. A strict recruitment process
   - Screening and verification
     Carries out a strict selection process by verifying the qualification, work experience, and references of the prospective workers.
   - Capability test

Held and arrange test to assess skills and technical interview to confirming the prospective workers have the required capabilities.

2. Training and development
   - Basic training
     Provides initial training on the overall work scopes; specific tasks, safety procedures, and quality standards before workers begin to work on the project.
   - Ongoing training
     Hold an ongoing training program to ensure the workers always up-to-date to the latest technology, methods and work regulations.
3. Certification and license
   - Professional certification
     Make sure the workers have relevant certifications for the work tasks that they will perform, such as certification in welding, electricity, or construction safety.
   - License monitoring
     Regular check to the workers' license to ensure their license are legal and still valid to be used.
4. Supervision and control
   - Strict supervision
     Assigning experienced supervisors to handle workers in the field, ensuring them to follow the proper work procedures.
   - Quality check
     Conducting regular quality check for ensuring the work is carried out according to the established standard.
5. Documentation and work performance assessment
   - Work documentation
     Keep record of detailed of each worker work performance also inspections and work performance records.
   - Periodic assessment
     Conducting periodic work performance assessment to identify which areas of work that require improvement also providing constructive feedback.
6. Transparent work contract and clear agreement
   - Work specifications
     Confirming the work contract is put with a clear explanation of the work specification, the quality standard which must be met and the responsibility of each party.
   - Sanctions and incentives
     Apply sanctions for work violation and also incentives for good work performance to conforming the compliance to the work standards.
7. Effective communication
   - Daily briefing
     Hold daily briefing to discuss the progress of the work, any emerging problems also the work plans.
   - Communication channel
     Provides a clear and open communication channel between workers, supervisors and the management to report any work issues or suggestions.

4.3.2. The risk of design changes (B1)

A decision-making process by using multi-criterion can be done by applying the Analytical Hierarchy Process method. In applying the AHP method, decomposing problem is necessary as conducted in steps of identifying criteria and sub-criteria that will be used. Main criteria in selecting a strategy for the urgency of improvement in the irrigation buildings

1. A comprehensive planning and information collection
   - Demand analysis
     Conduct a detailed requirement analysis with all stakeholders to ensure all project requirements have a clear explanation since the beginning of the construction project.
   - Feasibility study
     Carries out a feasibility study to evaluate many technical, economic, legal and environmental aspects of the project before the design stage begin.
2. Stakeholders' involvement
   - Intensive collaboration

Involve all key stakeholders including the clients, architects, engineers and contractors since the early stage to obtain a comprehensive input.

- Feedback session
  Hold a regular feedback session with stakeholders to discuss design progress and address concerns or any desired changes.

3. Detailed design and a clear specification
   - Complete documentation
     Arranges and prepares a complete and detailed design documentation which include documents of technical drawings, material specifications and construction procedures.
   - Design standard
     Follows the agreed design standard also make sure all specifications meet the applicable regulations.
4. Effective change management
   - Change management procedures
     Implementing a strict change management procedure to review, approve, and manage any design changes.
   - Impact evaluation
     Evaluates any proposed changes by giving consideration to their impact on the budget, schedule, and quality of the project before reaching an approval.
5. Technology use and design applications
   - BIM (Building Information Modeling)
     Applies BIM to create 3D models to help creating visualization, clash detection and analysis to design changes in more effective way.
   - Design software
     Uses advanced design software to create more accurate and detailed designs also facilitates collaboration between design teams.
6. Quality control
   - Design audit
     Conduct a regular design audit to ensure compliance to the established specification and standard.
   - Construction supervision
     Performs supervision to closely monitor construction process to ensure the work implementation is in accordance to the approved design.
7. Effective communication
   - Regular project meeting
     Hold a periodic project meeting to discuss progress of the work, discuss on any emerging issues, and potential design changes.
   - Documentation of the communication
     Put all communication also the decisions regarding design changes into documented reports to ensure transparency and accountability of the construction project maintained.
8. Evaluation and learning from the previous projects
   - Input (lesson learned) from the previous project
     Identifies and documenting every input from the previous projects to avoid same mistakes and enable to implement the best practices to the construction work.

In general, the risk control of the Worship Building construction project at Malang State University is presented in the table below.

Table 7. The risk control of worship building construction project at Malang State University

Code	Type of Risks	Risk Score	Risk Category	Control
A3	Unprofessional Workers	12	High	Conduct a strict supervision, Make documentation and work performance assessment
B1	Design Changes	12	High	Engage an effective communication, Evaluate and learn from the previous similar project
A4	Injury/Work Accident	9	Moderate	Wearing a complete safety standard,

				Strict supervision to the workers
B4	Design Complexity	8	Moderate	Engage a serious communication Do supervision and control in proper manner
D8	Incorrect Work Method	8	Moderate	Use the correct equipment for every work Strict supervision to the workers.
D9	Poor OSH Management	9	Moderate	Engage an effective communication, Make documentation and report to every completed work.

V. CONCLUSION

1. The risk evaluation analysis draws result which concludes that the preparatory and ground work is classified into low risk level with an average value of 3.00, while the concrete structure work is classified into moderate risk level with an average value of 7.69 and roof work (the Mosque dome) is classified into moderate risk level with an average value of 8.25.
2. The risk identification conducted at the construction of Worship Building project of Malang State University found that the Unprofessional workers (A3) and Design changes (B1) are variables that classified into high risk level which followed by Injury/Work Accident (A4), Design Complexity (B4), Incorrect Work Method (D8) and Poor OSH management (D9) that classified into moderate risk level and the last are Conflict between workers (A6), Equipment Safety (C8) and Environmental Pollution (F4) that classified into low risk level.
3. The risk control is carried out in risk identification stage to variables that has a high-risk level, mentioned as the Unprofessional workers (A3) and Design changes (B1).
    - Minimizing the risk to Unprofessional workers (A3) in the construction project requires a comprehensive approach starting from the recruitment process, training, supervision until the work performance evaluation to the workers.
    - Reducing the risk of Design changes (B1) in the construction project requires a careful planning, effective communication, and the use of appropriate technology to deal with this factor. The involvement of stakeholders from the beginning of the project, also managing changes with strict procedures, and ensuring the design and construction quality in accordance to the standard will minimize the risk induced by design changes, so that, the project can run more smoothly and in accordance to the plan.

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