Developing Financial Risk Strategy Decisions for Construction Projects From Perspective of the Project Owner

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Abstract— Project funding risks can arise from sources of funds, which mostly come from equity and bonds. In addition, the impact is in the form of cost overruns and delays in project completion. Identification of the risk probability that may occur is the first step in controlling the achievement of targets as expected by measuring each risk level that may occur and mapping each level of risk. Then proceed with the mitigation process and monitoring methods. The proper mitigation will undoubtedly bring benefits to the project owner. Hence, the need arises for Developing Financial Risk Strategy Decisions for Construction projects from the project owner's perspective. We use Risk Index and AHP (Analytical Hierarchy Process) to get decision strategy in financial risk.

Keywords*:* Risk Index, AHP (Analytical Hierarchy Process), Risk Management.

1. INTRODUCTION

Construction projects are dynamic strategic projects and have various risks that can cause results not to be as planned. Risks that arise can impact the performance and financial cost limits of the project, both from pre-construction, construction and post-construction, which are very significant for the sustainability of the project. The success of the construction project implementation can be seen from maintaining triple constraints (cost, quality, and time). Risk analysis on a project for long-term investment and project development success according to planning is fundamental, so it is necessary to carry out modeling to mitigate risks, especially financial risks due to the complexity of the problems faced in multi-year projects.

The success of the project management process, especially long-term (multi-year) construction projects, really depends on the project manager's ability (Suparno, 2013). This success is also based on the success of risk control, namely by carrying out comprehensive identification to mitigate potential risks, especially the potential for financial risks that significantly affect the project's success. The most significant risk in a multi-year project is defined as financial risk (Dixit and Pindyck, 1994); this financial risk takes various forms, the most common of which are volatility in the investment market, bankruptcy, high inflation, and recession. Financial risk is one of the main concerns of any business across fields and geographies. Definition of project financial risk is one type of high priority risk for any business. Financial risks caused by market movements and market movements can include some factors. Based on this, financial risk can be classified into various types such as market risk, credit risk, liquidity risk, operational risk and legal risk.

According to Hopkinson (2011), risk management is an activity to respond to known risks. Therefore, implementing risk management will always begin with setting goals and processes or aspects to achieve them. However, everything related to achieving goals is

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never separated from the uncertainty factor that can occur due to the absence or lack of information about events in the future, both positive and adverse events. Meanwhile, Minister of Finance Regulation No. 191 / PMK.09 / 2008, risk management is a systematic approach to determine the best course of action in conditions of uncertainty.

The construction project for constructing a diesel power plant is one of the construction projects included in the multi-year project criteria because the procurement and construction installation process can last more than 1 (one) year. For example, a diesel power plant in North Sumatra, where construction work was planned to run for one year, was delayed by up to 10 months. This is detrimental not only to the project owner but also to the managing contractor. The project owner will get an opportunity lost because of 10 months of delay. The construction owner should be able to sell the results. In addition, construction owners also experience material losses due to delays which lead to overrun costs. The many problems that become obstacles in this development. Of course, these experiences become a reference in determining the potential risks that may occur in subsequent.

2. RISK IDENTIFICATION

Risk is uncertainty that has an impact on the target (objective centric). The influence of uncertainty is centered on the achievement of company goals or targets. Influence is defined as a discrepancy (deviation) to something predicted and can be positive or negative. Meanwhile, uncertainty is defined as a lack of information (both information about the likelihood of its occurrence and its impact) related to an event.

Project funding risks can arise from sources of funds, which mostly come from equity and bonds. In addition, the impact is in the form of cost overruns and delays in project completion. Cost overrun results in losses for the contractor because the contracts used are engineering, procurement & construction (EPC) contracts. The project owner (owner) impacts the construction work implementation schedule, which could potentially experience delays. Therefore it is imperative to identify potential risks in order to reduce the losses that may be caused.

Identification of the risk probability that may occur is the first step in controlling the achievement of targets as expected by measuring each risk level that may occur and mapping each level of risk. Risk identification is a combination of deterministic, probability, and quantitative methods. Risk management is a coordinated activity to direct and control an organization in managing risk [5]. Then proceed with the mitigation process and monitoring methods.

3. RISK MANAGEMENT

Understanding this risk is important because if there is an error in determining an event as a risk that is not a risk, it will result in incorrect handling. That is why it is important to distinguish what is a risk and what is not a risk but is a problem. The way of dealing with problems is very different from the way of dealing with risks. Handling risk is more about anticipating what will happen while handling problems than dealing with something that has already happened. Understanding the concept of risk in broad terms is an essential basis for understanding risk management concepts and techniques [1]

Financial risk management is defined as fluctuations in the company's financial targets or monetary measures due to fluctuations in various macro variables. Financial measures can be cash flow, company profits. Economic value added (EVA) and sales growth. Financial risk is divided into three types of risk: liquidity risk, credit risk, and capital risk.

The average duration of an activity is determined by the duration of the same activities on previously worked projects and the number of workers and equipment used as a guide in new activities. Therefore, delays in project completion can cause cost overrun. For the analysis of the relationship between project time and cost, it can be defined as follows:

1. The standard period is the time required to carry out project activities to completion efficiently but beyond the consideration of overtime work and rental of sophisticated tools.

2. Normal costs are direct costs required to complete activities within a standard period

3. Crash time is the shortest time in completing activities that are technically still possible (assumption: resources are no constraints).

So the delay in activities and an increase in costs is a directly proportional relationship. Therefore, controlling the project completion time has a significant effect on the increase in overall project costs. Therefore, the action in determining the project's progress is to pay attention to the number of work units in the field which are reported regularly / daily, examined physically and compared with the report images previously submitted.

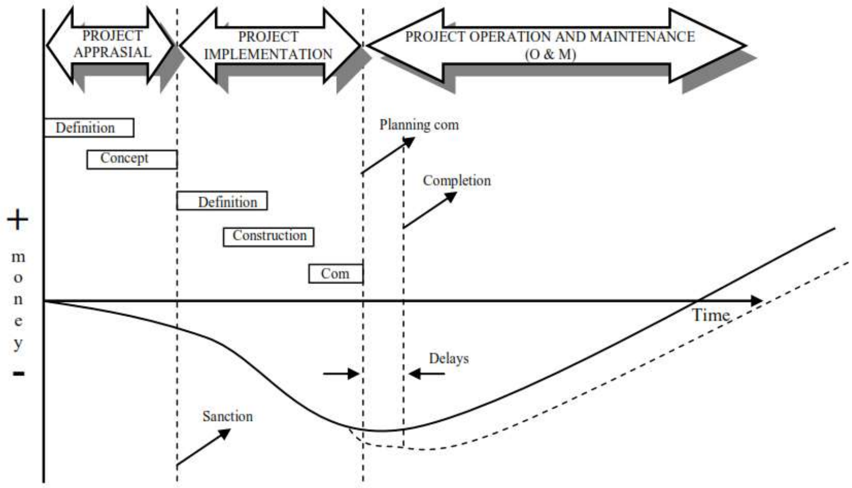

Figure 1. Project Time and Cost Relationship [12]

4. DECISSION MAKING APROACH

To make a decision, we use causal effect research. The causal effect research in question aims to determine the relationship or influence between two or more variables [9]. The causal effect research in this study is used to identify and analyze the effect of project financial investment analysis on risk sources that can occur in the project development plan.

4.1 Determining the Scope of the Context of Risk

The scope of the risk context is multiyear project. Based on this context, identifying the risk event profile and sources that cause the risk event is obtained using the financial risk approach. Survey and inventory of field data to determine the process flow construction or similar projects. Identifying risk events is carried out using the primary reference from the data on constructing a similar project and brainstorming with several employees who have important roles in these projects.

In carrying out the risk identification process with proven methods and approaches, several methods can be used that can be developed:

1. Testing / reviewing documents during the preparation of the organization's business plan and focusing on potential risks that could hinder the achievement of short-term and long-term goals of the organization. The result is a list of risks, both internal and external.
2. Brainstorming is used to obtain a comprehensive list of project risks. Brainstorming is done by inviting several people and gathering them in a room to share ideas about project risks. Ideas about project risks are generated with a facilitator.
3. The Delphi Technique is a way of reaching consensus from experts in participating project risk areas and is facilitated with a questionnaire to get an idea of the dominant project risks. The responses are summarized and then recirculated to the experts for further comments. Delphi technique helps reduce bias to the data and keeps you from being influenced by undue opinion.
4. Interviewing or interviews is a technique for collecting risk data on project team members and other stakeholders experienced in project risk.
5. Root Cause Identification is carried out to determine the fundamental causes of risk, and which will sharpen the definition of risk, which is then made into groups based on causes.
6. SWOT analysis (Strength, Weakness, Opportunities, and Threats) is carried out to improve a broader understanding of risks. The main result of the identification process is a risk register that must be documented as part of the project management plan.

4.2 Risk Profile Analysis

The risk event profile and sources that cause the risk event are then analyzed to obtain a risk index. The analytical method used is by conducting a questionnaire and interviewing the stakeholder/risk owner to obtain an assessment. The questionnaire results were analyzed with a Likert scale to determine the index for ranking risk factors.

4.3 Risk Index Analysis

The evaluation of the risks in a project depends on the likelihood of the risk occurring (frequency of occurrence) and the impact of these risks. A risk index using risk index analysis is often used to compare project options and the various risks associated with them. The risk index does not play an essential role in the choice of action against the failure mode but instead is the threshold value in evaluating the action. The risk index can be calculated by multiplying the likelihood of a risk occurring or (frequency of occurrence) and the impact of that risk.

The level of importance of risk (necessary level), according to Zhi, 1995, can use the equation below (Zhi, 1995):

1. Knowing the importance of the risks (critical level)

Level of importance of risk = frequency x impact (1)

Where:

a. Frequency: the probability that the risk occurs frequently

b. Impact: how much influence a risk has on the cost, quality and time of the project

2. Sorting the risk based on the level of risk

To sort the risk of the multiplication result between the frequency and impact scale, arranged from largest to smallest.

Value of the level of importance of risk = a x b = c (2)

Overall importance level = (∑ ci) / z (3)

Where:
1. Number of risk factors: z
2. Value on frequency: a (1-5)
   1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always
3. Value on impact: b (1-5)
   1 = Very Small, 2 = Small, 3 = Medium, 4 = Large, 5 = Very Large

4.4 Risk Map Analysis

The output of the risk index, which is reflected in the value of the risk index, is to determine the areas that need the most attention. The failure mode having the highest risk index should be given the highest priority for corrective action. This means that it is not always the failure mode with the highest impact value that must be fixed first. There may be failures that are less severe but which occur more frequently and are less detectable. After the values are allocated, recommended actions with targets, responsibilities and implementation dates are recorded. Such actions may include specific inspections, test or quality procedures, redesign (such as selecting new components), adding more redundancy, and limiting environmental stresses or operating range. Once the action has been implemented at the design or process stage, a new risk index should be checked to improve.

		1	2	3	4	5
		Dapat diabaikan	Kecil	Sedang	Kritis	Sangat parah
5	Hampir pasti	Tinggi	Tinggi	Tinggi	Ekstrim	Ekstrim
4	Kemungkinan Besar	Sedang	Sedang	Tinggi	Tinggi	Ekstrim
3	Mungkin	Rendah	Sedang	Sedang	Tinggi	Tinggi
2	Kemungkinan Kecil	Rendah	Rendah	Sedang	Sedang	Tinggi
1	Tidak Mungkin	Rendah	Rendah	Rendah	Sedang	Sedang

Figure 2. Risk Map [5]

Testing in the form of a risk map graph. Based on the risk map, it is found that risk events have the most elementary level of urgency to mitigate their risks immediately so that the output of this analysis is to provide input on mitigation measures that are the focus of research attention.

Risk map using the term likelihood of the term probability for likelihood and impact or severity for impact. The company is free to use which terms are used, provided that the terms used must be consistent within the company. A risk map can only be created after the likelihood and impact of risks have been measured. The placement of risk on the risk map is adjusted to the measurement results. However, beforehand, it is necessary to determine the boundary between likelihood and high probability and the boundary between small impact and high impact. This is done to limit each risk because I do not need to control each risk in the quadrant. Only risks in quadrants II, III, and IV need to be controlled. Control priorities are adjusted according to the risk status.

4.5 Risk Mitigation Identification

At this stage, the identification of mitigation steps is carried out by carrying out a Focus Group Discussion (FGD) with the leadership and several relevant divisions. The results of this FGD are a list of various proposed mitigation measures for risks with the highest risk index. To find out the priority of mitigation steps that need to be done by distributing Questionnaires II. The questionnaire was arranged in the form of a pairwise comparison matrix. Questionnaire II was distributed to the Directors, Managers and Heads of the relevant Division.

4.6 Risk Mitigation Analysis with AHP as Decision Strategy

The data collected from questionnaire II will be analyzed using the AHP method to determine the priority order of risk mitigation steps. Quantitative risk analysis is carried out on a list of risks that have been carried out in a qualitative manner which has potential and substantial impact on project performance. Quantitative risk analysis is the process of analyzing the impact of risk events and giving priority in the form of numbers to the risk list. This analysis is used to determine the level of risk that has the most potential to affect the project's success.

An easy way to comply with the principle of arranging a hierarchy is to describe and describe hierarchically by solving problems into separate elements. You do this by breaking down our knowledge, complex thoughts into parts of its main elements, then into its parts and so on hierarchically.

Table 1. Saaty Scale [10]

Scale	Definition of "Importance"
1	*Equal Importance*
3	*Slightly more Importance*
5	*Materially more Importance*
7	*Significantly more Importance*
9	*Absolutely more Importance*
2,4,6,8	*Compromise values*

4.7 Implementing AHP as Decission Strategy

4.7.1 Create a matrix of proportions with size (n x n)

Table 2. Example of a pairwise comparison (preference) matrix [10]

C	**A_1**	**…..**	**A_n**
A_1	W_1 / W_1	…..	W_1 / Wn
A_2	W_2 / W_1	…..	…..
…..	…..	…..	…..
A_n	W_n / W_1	…..	W_n / Wn

In the pairwise comparison matrix, the A1 elements in the column on the left are compared with the elements A1, A2, A3 and so on which are in the top row with respect to the property C in the upper left corner. Then repeat with A2 elements and so on.

4.7.2 Perform pairwise comparisons in order to obtain a total judgment of n (n-1) pieces, where n is the number of elements being compared.

4.7.3 Normalization of the pairwise comparison matrix using mathematical formulations in the AHP model

In a sub operating system there are n operating elements, namely A1, A2, .., An. Then the results of the pairwise comparison of these operating elements will form a comparison matrix. Pairwise comparisons start from the highest hierarchical level, where attributes are used as the basis for comparison actions.

Table 3. Pairwise Comparison Matrix Synthesis [10]

C	A_1	…..	A_n
A_1	a_{11}	…..	a_{1n}
A_2	a_{21}	…..	…..
…..	…..	…..	…..
A_n	a_{n1}	…..	a_{nn}
Σ	C_{a1}	…..	C_{an}

Matrix A with size n x n is a reciprocal matrix. And it is assumed that there are n elements, namely w1, w2, ..., wn, which will be assessed in comparison. Value (judgment) pairwise comparison between (wi, wj) can be presented like the matrix:

$$\frac{w_i}{w_j} = a_{(i,j)} \; ; i, j = 1,2 \ldots n$$
(4)

Where: wi and wj = value (judgment) pairwise comparison

The comparison matrix is the matrix A with the elements a (i, j) where I = 1st, 2nd,…, n and j columns = 1st, 2nd,…, n rows. If Ci is the number of comparison scales in the i-column, so it can be expressed as in the equation below:

$$C_i = \sum_{i=1}^{n} a_{ij} \tag{5}$$

If the weighting vector of the operating elements A1, A2, .., An is expressed as the vector w = (w1, w2,…, wn), then the value of the intensity of importance of the operating elements A1, compared to A2 can be expressed as a comparison of the weights of the operating elements A1 to A2. namely w12, so that it can be compiled:

Table 4. Pairwise Comparison Matrix Synthesis after Weighting [10]

C	A_1	…..	A_n	Bobot
A_1	W_{11}	…..	$W_{1}n$	W_{a2}
A_2	W_{21}	…..	$W_{2}n$	Wa_1
…..	…..	…..	…..	…..
A_n	W_{n1}	…..	W_{nn}	W_{nn}

If the number of pairwise comparison scales in the 1st column is Ci, then the weight of each element in each column can be expressed as in the equation

$$w_{ij} = \frac{a_{ij}}{C_i} \tag{6}$$

Where: wij = priority weight of elements in row i and column j that have been normalized.

While the normal weight of the pairwise comparison matrix of each level in the decision structure is the average of the value of each row as shown in the equation:

$$w_{ij} = \sum_{j=1}^{n} \frac{w_{ij}}{n} \tag{7}$$

Where: wi = relative normal weight which shows the priority order of the elements of a level in the decision structure.

4.7.4 Performing a hierarchical synthesis, namely calculating the eigenvalues of the existing attribute weights and adding up all the eigenvector weights of the respondent's results.

$$\lambda_{max} = \sum_{j=1}^{n} C_i \, . \, w_i \tag{8}$$

Where:

λmax = maximum eigen value
n = number of matrix orders
Ci = number of scale comparisons in the ith column of a matrix
wi = relative weight indicating the priority order of the matrix elements

4.7.5 Calculating consistency index (CI) and *Consistency Ratio* (CR)

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (9)$$

$$CR = \frac{CI}{RI} \quad (10)$$

RI = random index value

Table 5. RI (Random Index) [10]

Matrix	1	2	3	4	5	6	7	8
RI	0,00	0,00	0,58	0,90	1,12	1,24	1,32	1,41
Matrix	9	10	11	12	13	14	15	
RI	1,45	1,49	1,51	1,48	1,56	1,57	1,59	

If the CR value does not exceed 0.1 (CR <0.1) then the results of the assessment can be accepted or accounted for, but if it exceeds 0.1 the comparison matrix is not consistently reviewed and corrected again.

5. CONCLUSSION

Risk events that are identified in a construction project with owner perception, after measurement and analysis are carried out, risk priorities are obtained that must be managed first, including:

a. Risk event management.

b. Project cash flow management.

c. Material fulfillment difficulties.

d. Contract detail specification.

After the risk event we carried out mitigation risk:

1. Identify critical processes and alternatives that can be done.
2. Optimization of work methods and resources that are implemented in the schedule.
3. WBS implementation in project work schedule planning
4. Periodic Monitoring and Progress Evaluation.
5. Project financial resource planning
6. Good job scheduling and project resource management according to a cash flow plan
7. Creating a planning schedule for budget verification and control
8. Project progress on time with project documentation according to procedures
9. Implementation of the Quality Management System 9001: 2015
10. Simple bureaucratic coordination and processes
11. Contract with the material provider so that the Material is ordered in advance (either using DP or not) for arrival according to the project schedule

12. Monitoring and evaluation of material procurement according to the project schedule
13. Material Manufacturing alternative planning
14. Similar material substitution and reengineering
15. Contracting with the expedition so have control over the delivery of Material
16. A detailed explanation of technical specifications during analyzing
17. Have a reliable engineering and construction team
18. Contract details, both drawings and detailed material requirements
19. Perform design modeling following changes

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