Risk analysis study on building projects in Pidie District

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Abstract. This study aims to determine the dominant risk factors occurring during the implementation of building construction and to know how to control and handle the risk factors that occur. The methodology used is a quantitative method with a questionnaire as a research instrument. The number of samples used was 55 respondents from a population of 121 companies. Based on the analysis of frequency index (FI), there are dominant risk factors that occur in the implementation of building construction in Pidie District. The dominant risk factors are skills and expertise, weather, access to the project location, unequipped workers with protective equipment, wrong implementation method, the expensive material, incomplete design data, low quality of material, damage to the tool, and a lack of workers. Furthermore, the ways to control and handle risks that occur during the construction project are increasing the trust of the owner, having knowledgeable company management and competent workforce, reducing security disturbances, increasing collaboration with local village officials, minimizing equipment damage, managing material purchases before the prices rise, and mastering the implementation method.

1. Introduction
The development of construction projects in Pidie District is quite significant from year to year. This condition can be seen from the growing number of companies that are constantly increasing. The competition that occurs among contractors in obtaining work will be increasingly stringent. Therefore, companies that have good performance will continue to survive, while companies that have poor performance will continue to lag. In terms of improving performance, contractors as service providers are fully responsible for the success of a project and ensure that the development process goes according to plan. Uncertain events or conditions that occur in the field are a project risk that must be minimized. If the risk occurs, then it will have an impact both positively and negatively on the project objectives so that the conditions that occur will directly affect the performance of the company.

In 2016, besides local contractors, there were also contractors from outside the district who carried out the project in Pidie District. This condition is a form of decline in the performance of local companies that are unable to compete with other companies. Such conditions indicate that there is no increase in the performance of any local company in Pidie District. If this fact continues, then the existing local company would be inactive because one of the conditions in participating in the tender is the company's involvement in the construction project for the last three years. Therefore, a study and analysis are needed to find out the risk factors in the building construction project in Pidie District.

Based on the background, the formulation of the problems in this study are:
1. What are the dominant risk factors that occurred during the construction of building construction projects in Pidie District?
2. How to control and handle risk factors that occur during construction?

The objectives of this study are as follows:
1. To find out the dominant risk factors that occur during the construction of a building construction project in Pidie District.
2. To find out the control and the way to handle the risk factors that occur during construction

2. Literature review

2.1. Risk management
Risk management is a process of identifying, measuring, and controlling the financial risk that threatens the assets and income of a company or project; this financial risk can cause damage or loss to the company [1]. Risk management is a process of both identifying and measuring risk and forming strategies to prevent the occurrence of the risk. Risk management actions are taken by the company to respond to various risks. Risk management involves preventing and improving. The act of preventing being used to reduce, avoid, or transfer risk in the initial stages of a construction project [2].

2.2. Risk identification and classification
Risk identification and classification is a process of assessing risk and uncertainty that carried out systematically and continuously. The first step is to identify the types of risks: business risks and pure risk. Project risk is classified as pure risk. This project risk is identified based on potential sources of risk or the impact on the project objectives. The approach used in identifying this risk is the diagrams of cause and effects, namely by analyzing what will happen and the potential consequences that will be caused [3]. The most common risks found in practice are as follows [4].
1. Physical risk
   The risk relates to physical conditions, for example, the land, physical conditions that cause damage, damaged or destructive material and working result, costs of testing and sampling, unfriendly weather conditions, improper location provision, the absences of workers and staff, plant, time, and funding;
2. Risk of delay and dispute
   This risk includes the location ownership, land acquisition, late supply of information, implementation of ineffective work, delays outside the control of the parts, the disputes;
3. Risk of management and supervision
   The presence of incompetent supervisors, errors in documentation, unclear and unspecified requirements, inaccurate choice of consultants, etc;
4. Risk of loss to people and property
   Negligence and non-fulfillment of guarantees, limited time and events covered by insurance, and others;
5. Risk due to external factors
   Changes in government policies on taxes, labor, security laws and disturbances, social unrest, labor strikes, etc.;
6. Payment risk
   This risk includes devaluation, high inflation, currency fluctuations, the bankruptcy of one of the parts involved, costs for plant and management replacements, etc.; and
7. Legal risk and dispute resolution
   This risk involves the length of time for resolving disputes, injustices, uncertainty over court decisions, changes in applicable legislation, fees for judicial or arbitration proceedings, etc.
2.3. Identification of risk factors

Identifying risk factors based on the results of research conducted by previous researchers can be seen in table 1 as follows.

| No | Category             | Risk factor                        | Source                                                                 |
|----|----------------------|------------------------------------|------------------------------------------------------------------------|
| 1  | Physical             | Natural disasters                  | (Suharti 2009), (Sari 2011)                                            |
|    |                      | Weather                            | (Suharti 2009), (Sari 2011)                                            |
| 2  | Labor and Experts    | Skills and expertise               | (Kangari 1995), (Sari 2011)                                            |
|    |                      | Discipline                         | (Suhani, 2009), (Sari 2011)                                            |
|    |                      | Productivity                       | (Ahmed 1999), (Kangari 1995), (Santoso 2004), (El-Sayegh 2008), (Sari 2011), (Nizam 2012) |
|    |                      | The lack of workers                | (Laia 2010), (Sari 2011)                                               |
| 3  | Contractor           | Contractor Ability                 | (Ahmed 1999), (Kangari 1995), (Kartam 2001), (Santoso 2004), (El-Sayegh 2008), (Nizam 2012) |
|    |                      | Financial constraints              | (Ahmed 1999), (Kangari 1995), (Kartam 2001), (Santoso 2004), (Nizam 2012) |
|    |                      | Design error                       | (Ahmed 1999), (Santoso 2004), (El-Sayegh 2008), (Sari 2011)             |
| 4  | Consultant           | Design data is not complete        | (Laia 2010), (Ahmed 1999), (Kangari 1995), (Kartam 2001), (Santoso 2004), (El-Sayegh 2008), (Sari 2011) |
|    |                      | Delays in information from the planner | (Suharti 2009), (Sari 2011)                                           |
| 5  | Owner                | Owner financial failure            | (Ahmed 1999), (Ahmed 1999), (Kangari 1995), (Kartam 2001), (Santoso 2004), (Sari 2011) |
|    |                      | Change order                       | (Suharti 2009), (Ahmed 1999), (Kangari 1995), (Kartam 2001), (Santoso 2004), (Sari 2011) |
| 6  | Material             | Delays in delivery                 | (Suharti 2009), (Sari 2011), (Nizam 2012)                                |
|    |                      | Damage during shipment             | (Suharti 2009), (Sari 2011), (Nizam 2012)                                |
|    |                      | Low material quality               | (Suharti 2009), (Ahmed 1999), (Kangari 1995), (Kartam 2001), (Santoso 2004), (El-Sayegh 2008), (Sari 2011), (Nizam 2012) |
| 7  | Equipment            | Number of equipment                | (Suharti 2009), (Sari 2011)                                            |
|    |                      | Condition of equipment that is not suitable for use | (Suharti, 2009), (Sari 2011), (Nizam 2012)                                |
|    |                      | Tool damage                        | (Suharti 2009), (Sari 2011), (Nizam 2012)                                |
| 8  | Construction Process | Quality (quality) of work is not good | (Ahmed 1999), (Kangari 1995), (Kartam 2001), (Santoso 2004), (El-Sayegh 2008), (Sari 2011) |
|    |                      | Communication and coordination problems | (Ahmed 1999), (Kangari 1995), (Kartam 2001), (Santoso 2004), (El-Sayegh 2008), (Sari 2011) |
|    |                      | Wrong implementation method        | (Laia 2010), (Sari 2011), (Nizam 2012)                                  |
| No | Category                     | Risk factor                                                     | Source                                      |
|----|------------------------------|-----------------------------------------------------------------|---------------------------------------------|
| 9  | Project Neighborhood         | Access to project location                                      | (Suharti, 2009), (Sari, 2011), (Nizam. 2012) |
|    |                              | Security disorders                                              | (Suharti 2009), (Sari 2011), (Nizam 2012)   |
| 10 | Safety and Accidents         | The machine is not checked before operating                     | (Laia 2010), (Sari 2011), (Nizam 2012)      |
|    |                              | Workers are not equipped with protective equipment               | (Laia 2010), (Sari 2011), (Nizam 2012)      |
|    |                              | Safety regulations are violated                                  | (Suharti 2009), (Sari 2011), (Nizam 2012)   |
| 11 | Finance                      | The price of material is more expensive                         | (Suharti 2009), (Sari 2011)                 |
|    |                              | Additional equipment rental fees                                 | (Ghosh 2004), (Sari 2011)                   |
|    |                              | Wages for workers are more expensive                            | (Suharti 2009), (Sari 2011)                 |

2.4. Population and sampling techniques
Population can simply be said as all objects of research. Population value is all the values of both the results of calculations and the measurements [5]. Based on the number of members of the population, the population can be divided into limited population (finite) and unlimited population (infinite). Based on its nature, the population can be homogeneous and heterogeneous [6]. Sampling techniques are a technique for getting samples in a study so that the sample is representative of the population that represents it [7].

2.5. Frequency index (FI)
Frequency Index is calculated using equation (1) [8].

\[
Frequency \ Index \ (FI) = \frac{\sum_{i=1}^{5} a_i n_i}{5N}
\]  

Information:
- \(i\) : response category index (1, 2, 3, 4, and 5);
- \(a_i\) : weights associated with the first response value (1, 2, 3, 4 and 5 respectively);
- \(n_i\) : frequency from the second response as a percentage of the total respondents for each factor; and
- \(N\) : total number of respondents.

2.6. SWOT analysis
The tool used to develop strategic factors is the SWOT matrix. This matrix can clearly illustrate the interaction between the internal strategic analysis factors and external factor analysis strategies [9]. This matrix can produce four sets of possible strategic alternatives, as shown in table 2 as follows.

|   | Strengths (S)                        | Weakness (W)                      |
|---|--------------------------------------|----------------------------------|
|   | Determine internal strengths factors | Determine internal weakness factors |
Opportunities (O)
Determine external factors

Strategi SO
Create a strategy that uses power to take advantage of opportunities

Strategi WO
Create strategies that minimize weaknesses to take advantage of opportunities

Threats (T)
Determine external threat factors

Strategi (T)
Create a strategy that uses strength to overcome threats

Strategi WT
Create strategies that minimize weaknesses and avoid threats

3. Research methodology

3.1. Research objects and locations
The research location is Pidie District, Aceh Province, which area is 3,087 km².

3.2. Primary and secondary data collection

3.2.1. Preliminary. The pre-survey was conducted to obtain secondary data, which would later become the research sample. The technique used is in the form of random sampling, in which the selection of prospective respondents is randomly selected. While secondary data is collected in the form of maps, literature studies, the company data is obtained from the institution in charge of construction service development—called LPJK. The company data is also obtained from the previous studies, which will later be used as guidelines in this study.

3.2.2. Fill out the questionnaire. The filling out of the questionnaire was carried out by the company director or project manager who worked on the building construction project in Pidie District. Questionnaires given to prospective respondents are closed; each question has been provided with an alternative answer.

4. Results and discussion

4.1. Characteristics of respondents
The characteristics of respondents, based on the position, were 30 directors and 25 project managers. Based on the respondents’ highest education, senior high school alumni are 12 people, diploma alumni are 4 people, and the bachelors are 39 people. For the work experience of the respondents, 11 people have 3-5 years of experience, 21 people have 5-8 years of experience, and 23 people have more than 8 years of experience. Based on the company experience, 2 companies have 0-3 years of experience, 10 companies have 3-5 years of experience, 28 companies have 5-7 years of experience, and 15 companies have more than 7 years of experience. In terms of the project value, 11 companies have managed the project with a value of IDR 500 million - 1 billion, and 44 companies have managed the project with a value of more than IDR 1 billion.

4.2. Validity & reliability analysis
In determining the accuracy of a measuring instrument, the questionnaire was tested using validity analysis. In order to test the questionnaire feasibility, the C-alpha method was used. From the calculation results, it is obtained that the coefficient alpha value for the risk factor in the contractor is 1.01, which is higher than the requirement of 0.6. This means that the questionnaire is feasible and can be used as a tool for research.
4.3. Risk analysis
The results of the analysis of frequency index (FI) on 11 variables can be seen in table 3.

Table 3. Analysis of frequency index (FI).

| No. | Variable                      | Number of answers | FI   | Interpretation of scores |
|-----|-------------------------------|-------------------|------|--------------------------|
|     |                               | VNI   | NE | LI | TE | VI |      |             |
| I   | Physical                      |        |    |    |    |    |      |              |
| P1  | Natural disasters             | 18    | 6  | 13 | 6  | 12 | 0.56 | Less influential |
| P2  | Weather                       | 0     | 0  | 17 | 2  | 36 | 0.87 | Very influential |
|     |                               |        |    |    |    |    |      |              |
|     | Average FI                    |        |    |    |    |    | 0.71 |              |
| II  | Labor and Experts             |        |    |    |    |    |      |              |
| P3  | Skills and expertise          | 0     | 0  | 3  | 20 | 32 | 0.91 | Very influential |
| P4  | Discipline                    | 18    | 6  | 13 | 6  | 12 | 0.56 | Less influential |
| P5  | Productivity                  | 3     | 4  | 31 | 8  | 9  | 0.66 | Take effect |
| P6  | The lack of workers           | 0     | 4  | 29 | 16 | 6  | 0.69 | Take effect |
|     |                               |        |    |    |    |    |      |              |
|     | Average FI                    |        |    |    |    |    | 0.70 |              |
| III | Contractor                    |        |    |    |    |    |      |              |
| P7  | Contractor Ability            | 5     | 11 | 26 | 3  | 10 | 0.61 | Take effect |
| P8  | Financial constraints         | 26    | 19 | 10 | 0  | 0  | 0.34 | No effect |
|     |                               |        |    |    |    |    |      |              |
|     | Average FI                    |        |    |    |    |    | 0.47 |              |
| IV  | Consultant                    |        |    |    |    |    |      |              |
| P9  | Design error                  | 22    | 12 | 20 | 1  | 0  | 0.40 | No effect |
| P10 | Design data is not complete   | 0     | 0  | 21 | 11 | 23 | 0.81 | Very influential |
| P11 | Delays in information from the planner | 11 | 20 | 24 | 0  | 0  | 0.45 | Less influential |
|     |                               |        |    |    |    |    |      |              |
|     | Average FI                    |        |    |    |    |    | 0.55 |              |
| V   | Owner                         |        |    |    |    |    |      |              |
| P12 | Owner financial failure       | 22    | 2  | 3  | 21 | 7  | 0.56 | Less influential |
| P13 | Change order                  | 12    | 6  | 11 | 16 | 10 | 0.62 | Take effect |
|     |                               |        |    |    |    |    |      |              |
|     | Average FI                    |        |    |    |    |    | 0.59 |              |
| VI  | Material                      |        |    |    |    |    |      |              |
| P14 | Delays in delivery            | 28    | 5  | 2  | 7  | 13 | 0.50 | Less influential |
| P15 | Damage during shipment        | 23    | 10 | 13 | 3  | 6  | 0.45 | Less influential |
| P16 | Low material quality          | 0     | 0  | 23 | 27 | 5  | 0.73 | Take effect |
|     |                               |        |    |    |    |    |      |              |
|     | Average FI                    |        |    |    |    |    | 0.56 |              |
| VII | Equipment                     |        |    |    |    |    |      |              |
| P17 | Number of equipment           | 30    | 10 | 2  | 6  | 7  | 0.42 | Less influential |
| P18 | Condition of equipment that is not suitable for use | 26 | 5  | 7  | 11 | 6  | 0.48 | Less influential |
| P19 | Tool damage                   | 0     | 2  | 19 | 32 | 2  | 0.72 | Take effect |
|     |                               |        |    |    |    |    |      |              |
|     | Average FI                    |        |    |    |    |    | 0.54 |              |
| VIII| Construction Process          |        |    |    |    |    |      |              |
| P20 | Quality of work is not good   | 25    | 8  | 3  | 7  | 12 | 0.50 | Less influential |
| No. | Variable                                                                 | Number of answers | FI | Interpretation of scores |
|-----|--------------------------------------------------------------------------|-------------------|----|--------------------------|
|     |                                                                          | VNI | NE | LI | TE | VI |     |      |
| P21 | Communication and coordination problems                                  | 23  | 9  | 3  | 8  | 12 | 0.52| Less influential |
| P22 | Wrong implementation method                                              | 0   | 0  | 2  | 41 | 12 | 0.84| Very influential  |

| IX  | Project Neighborhood                                                      | Average FI        |
|-----|--------------------------------------------------------------------------|-------------------|
| P23 | Access to project location                                               | 0.87              |
| P24 | Security disorders                                                       | 0.56              |

| X   | Safety and Accidents                                                      | Average FI        |
|-----|--------------------------------------------------------------------------|-------------------|
| P25 | The machine is not checked before operating                              | 0.56              |
| P26 | Workers are not equipped with protective equipment                       | 0.85              |
| P27 | Safety regulations are violated                                          | 0.40              |

| XI  | Finance                                                                  | Average FI        |
|-----|--------------------------------------------------------------------------|-------------------|
| P28 | The price of material is more expensive                                  | 0.83              |
| P29 | Additional equipment rental fees                                         | 0.47              |
| P30 | Wages for workers are more expensive                                     | 0.64              |

4.4. Analysis of risk control and handling

Risk control and handling strategies are analyzed using SWOT analysis. Analysis of strategic factors is the beginning of the process of formulating strategies in controlling the risks that occur. This analysis aims to find compatibility between external opportunities and internal provisions while also pay attention to external threats and internal weaknesses. The SWOT analysis matrix controls and handles risks can be seen in table 4.

Table 4. Matriks SWOT.

| Internal factors | Strength (S) | Weakness (W) |
|------------------|--------------|--------------|
|                  |              | 1. Lack of workers |
|                  |              | 2. Damage to the tool |
|                  |              | 3. Low material quality |
|                  |              | 4. Incomplete design data |
|                  |              | 5. The price of material is more expensive |
|                  |              | 6. Wrong implementation method |
|                  |              | 7. Workers are not equipped with protective equipment |
|                  |              | 8. Access to the project location |
|                  |              | 9. Weather |
|                  |              | 10. Skills and expertise |
| External factors | Strategy (SO) | Strategy WO |
|                  |              |              |

7
1. Efforts to maximize the construction process
2. Trust owner
3. Government support

1. Increase owner trust
2. Selection of company management in accordance with their knowledge in the field of construction.
3. Choosing a competent workforce
4. Reducing the occurrence of security disorders
5. Increasing cooperation with the local village apparatus

1. Minimizing tool damage
2. Manage material purchases before prices rise
3. Mastering the implementation method
4. Equip protective equipment for workers
5. Predict the weather in planning project implementation.
6. Improve skills and expertise

| Threat (T) | Strategy (ST) | Strategy (WT) |
|-----------|--------------|---------------|
| 1. Political situation | 1. Improve company performance | 1. There needs to be an increase in HR for company managers to minimize the occurrence of risks during project implementation. |
| 2. The entry of an outside company | 2. Recruit supervisors who are competent with their work. | 2. Selected competent workers |
| 3. Environmental issues | 1. Minimizing tool damage | |
| | 2. Manage material purchases before prices rise | |
| | 3. Mastering the implementation method | |
| | 4. Equip protective equipment for workers | |
| | 5. Compile a work schedule so that at any time it does not stop when it rains | |
| | 6. Improve skills and expertise | |

Based on the SWOT Matrix, the risk control strategies that can be carried out are as shown in table 5.

Table 5. Risk control strategies.

1. Strategy S-O : 1. Increase owner trust
2. Selection of company management in accordance with their knowledge in the field of construction
3. Choosing a competent workforce
4. Reducing the occurrence of security disturbances
5. Increasing cooperation with the local village apparatus

2. Strategy W-O : 1. Minimizing tool damage
2. Manage material purchases before prices rise
3. Mastering the implementation method
4. Equip protective equipment for workers
5. Compile a work schedule so that at any time it does not stop when it rains
6. Improve skills and expertise

3. Strategy S-T : 1. Improve company performance
2. Recruit supervisors who are competent with their work.

4. Strategy W-T : 1. There needs to be an increase in HR for company managers to minimize the occurrence of risks during project implementation.
2. Choosing competent workers

4.5. Discussion
The degree of skills and expertise of contractors is essential to improve the performance. Having strong soft skills will have a direct impact on the implementation of construction projects. The essential soft skills for contractors are problem-solving (the ability of managers to solve problems effectively and efficiently), budgeting and cost skills (the ability to budget project costs, make investment feasibility so that project finance can run optimally), scheduling and time management skills (the ability to arrange project scheduling), technical skills (the technical ability to cover the knowledge and experience in implementing the project itself), leadership skills (having leadership in influencing others in acting and reacting to project issues), resource management and human relationship skills (the use of resources and their placement), communication skills (having good and effective communication in the team),
negotiating skills (reliable negotiation skills), marketing, contracting, customer relationship skills (the ability to market the results of their projects).

Predicting the weather in planning project implementation is very important to do especially related to earthworks such as basements, substructure, and roads. Many project conditions are misplaced due to not predicting the weather that will occur. So that it will have an impact on time and costs due to low productivity and manpower due to falling rain. Rain will also affect access to the project location; if the project location does not have road pavement, the access will be damaged and will have an impact on the inhibition of activities on site.

Protective equipment is very important when in the project location, the use of PPE (personal protective equipment) will reduce the risk of workplace accidents. Every worker is required to use PPE as stipulated in the Minister of Manpower and Transmigration Regulation of the Republic of Indonesia of Number Per.08/Men/VII/2010 concerning personal protective equipment. Workers need to anticipate any potential hazards that may arise during work. One of the anticipatory actions is to wear personal protective equipment while in the work environment. Syatauw [10] in his research also found that the risk impacts that occur in the implementation of construction projects in Jakarta and Depok are work accidents and non-operational procedures.

The dominant factor that occurs during the implementation of construction project work is that the method of implementing the project is wrongly implemented so that it impacts on the project being carried out. High material price increases also have an impact on the emergence of cost overrun. Furthermore, other risk factors can occur due to uncomplete the design data, low quality of material, damage to the tool, and a lack of workers. Therefore, there is a need for prevention that will affect the performance of contractors. So, the project being worked on can be completed properly.

The control and handle of the risks can be done by increasing the trust of the owner, selecting company managements in accordance with their knowledge in the field of construction, selecting competent workforce, reducing security disturbances, increasing collaboration with local village officials, minimizing equipment damage, managing material purchases before prices rise, and mastering the implementation method

5 Conclusions and recommendations

5.1. Conclusions

The conclusions that can be drawn from the results of research on risk factors in the implementation of building construction are as follows:

1. The dominant risk factors that occur in the implementation of building construction in Pidie Regency are obtained from the results of the analysis of frequency index (FI), namely:
   a. Skills and expertise;
   b. Weather;
   c. Access to the project location;
   d. Workers are not equipped with protective equipment;
   e. Wrong implementation method;
   f. The expensive material;
   g. Incomplete design data;
   h. Low quality of material;
   i. Damage to the tool; and
   j. Lack of workers.

2. Control and handling of risks that occur during the construction can be done as:
   a. Increasing owner trust;
   b. Selecting of company management in accordance with their knowledge in the field of construction;
   c. Selecting the competent workforce;
   d. Reducing security problems;


e. Increasing collaboration with local village officials;
f. Minimizing tool damage;
g. Manage material purchases before prices rise;
h. Mastering the implementation method.

5.2. Recommendations
1. This research has been carried out with a predetermined scope or limitation of the study.
2. In terms of reducing the risk of occurring in the field, the contractor or project manager must pay attention to the risks that occur in the field so that the planned project can run well.

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