Imperial Journal of Interdisciplinary Research (IJIR)
Vol-3, Issue-8, 2017
ISSN: 2454-1362, http://www.onlinejournal.in

Risk Analysis of Pile Foundation Erection Work on High Rise Building Construction

Randy, Virdilla [1] & Amin, Mawardi [2]
[1] Student of Civil Engineering Departement, Mercu Buana University, Jakarta
[2] Lecturer, Civil Engineering Department, Mercu Buana University, Jakarta

***Abstract**: Every business activity, especially the construction industry business, profit and risk opportunities will always coexist. Uncertain events that have a positive or negative impact on at least one project goal (time, cost, scope, quality). Risk may have one or more causes, which in case of having one or more impacts. The complexity of the implementation of construction projects, especially the work of lower structures such as deep foundation work, the installation of a Sheet Pile wall by using the erection method makes it necessary to perform a risk management process to ensure the achievement of a project's success objectives. This research aims to determine the factors that potentially affect successfully in the implementation of a project at the stage of substructure construction work of buildings using the method of erection by performing risk analysis to minimize the things that are not desirable. This research was conducted by distributing survey questionnaires to several contracting companies, especially to construction service companies specialist foundation work to know the frequency and the influence of risk that becomes the most dominant factor and action steps that need to be done based on the recommendation from the expert.*

Keywords: *risk analysis of piling work, level of risk, risk response.*

1. Introduction

The construction sector has a very important contribution to the economic growth of a country, especially in supporting the pace of development for any nation. However, every business activity, including the construction industry, the opportunity to gain profit and the risk of losses will always appear side by side. An uncertain event which in turn has a positive or negative influence on at least one project goal (time, cost, scope, quality)[1]. Risk may have one or more causes, which in case of having one or more impacts. Understanding business risk is the potential occurrence of a situation or event or event, in the implementation of the process of business activities, which will have a negative impact on business goals that have been determined. Companies are always trying to find the best balance between the level of profit to be gained with the risks to be faced. So the problem that needs to be solved is how to determine or choose the right scale in the relationship between the level of profit and the risks that accompany it.

The use of formal risk analysis in construction services projects is generally very low[2]. With the weakness of the use of risk analysis can potentially threaten predetermined project objectives. The greatest risk allocation during the construction period is in the hands of contractors[3]. This is what underlies the need for a risk analysis in the implementation of construction projects for contractors, especially high risk projects.

This research aims to identify risks during construction of pile foundation erection work projects into research objects and classify those risks into specific categories, determine the risk level of identified risks and determine risk responses to high-risk risks.

The benefits of this research is useful for business actors in the construction industry, especially for service providers / contractors who carry out similar work with the object of this research that is knowing earlier what risks have high risk level on pile foundation erection work, by knowing the risk of having high risk level Risk, the contractor can mitigate for minimize probability and impact against existing risks to acceptable levels tailored to the circumstances under which the project will be handled. In addition, this analysis is also useful for researchers interested in risk analysis to be used as a reference in terms of risk identification to develop advanced research, especially in similar fields.

2. Literature Review

2.1 Foundation Work

The foundation is part of the structure of the building that is under (substructure)[4]. The foundation serves to pass the structural load of the building into the ground underneath it safely[5]. These structural loads include dead loads, earthquake loads, and wind loads. In order to carry out their functions, a foundation must be designed and constructed appropriately. A building, various factors should be considered. These factors include the following[6]:

1. Soil conditions
2. Load distribution patterns
3. The shape and dimensions of the building
4. Limitations of the surrounding location (project location)
5. Underground pipe
6. Environmental conditions
7. Etc.

There are two general types of foundations, which are as follows:

a. Shallow Foundation

The foundation that funnels the load to the ground where the distances traveled in the substructure are close enough. For example: Footings, spread footings, or mat foundation.

b. Deep Foundation

The foundation that distributes the load to the ground where the distances traveled are far enough in the substructure. For example: Piles, drilled piers, or drilled caissons.

2.2. Risk Management

One of the main goals in setting up a company is to make a profit. Each business activity will create an opportunity to gain profit that is always side by side with the risk of suffering losses either directly or indirectly. Therefore, one of the most important management functions is to implement risk management.

Risk has several different definitions from different experts, including the following:

a. Risk is a potential event, which can be avoided or minimized as little as possible, in order to minimize the impact as we have planned or that we can receive within the tolerable limits of tolerance, and do not interfere significantly with the established goals[7].
b. Risk is the possibility (probability) occurrence of events outside the expected[8].
c. Risk is a threat or an opportunity, where it can have a very unpleasant consequence or vice versa on the achievement of a project goal created[9].
d. The uncertainty of an event or situation, if it happens will affect the achievement of the project objectives
e. Risk is the possibility of events that bring undesirable consequences for goals, strategies, targets and or targets[10].
f. Events (events) that if it happens will affect the target project to be better or worse[11].
g. Risk is the possibility of an event (event) which, when it occurs, will affect the outcome of the project[12].
h. The uncertainty of an event or circumstance which if it occurs will have an impact at least one of the project objectives, which consists of the scope, time, cost and quality.

Risk has three main elements[13], namely:

1. Events or situations that occur at a certain place during a certain time interval.
2. Probability or likelihood is a qualitative description of probability or frequency.
3. Impact or consequences, that is the result of a work, either quantitative or qualitative, in the form of loss or loss.

Risks must be well managed so that all events can proceed accordingly with the plan. Thus the contractor's business risk management can be defined as a combination of art and science in identifying, analyzing, and responding to all risks identified in all business fields, and at all stages, to safeguard defined business objectives. The objectives of risk management are as follows:

a. Reduce the likelihood of occurrence of identified risks, from "frequent" to "non-occurring". Here it means to address the cause of the risk in question.
b. Reduces the magnitude of the impact that may have arisen from identified risks, from "fatal" conditions to "meaningless" conditions.

Risk management recognizes three factors, as follows:

1. Risk event status, which is a criterion of risk value or often called risk rating, e.g.: high, significant, medium, and low.
2. Risk probability, which is the probability of occurrence of a risk, is usually expressed in percent (%).
3. Risk consequences, which is the value of the effect if the risk is actually happening. This size depends on the risks, can be money, percent, time, number of events, and others.

Risk management consists of four stages of the process, as follows:

1. Risk Identification
2. Risk Analysis
3. Risk Response
4. Documentation (Monitoring and Controlling)

Determining the level of probability, is very subjective, difficult to measure accurately, but it is important to do. Therefore there are several techniques to determine the level of probability, which is in various ways as follows:

a. Brainstorming
b. Sensitivity Analysis
c. Probability Analysis
d. Delphi Method
e. Monte Carlo
f. Decision Tree Analysis
g. Utility Theory
h. Decision Theory

The best way is determined based on deep experiences and thoughts through brainstorming related experts. So also to determine the level of influence.

3. Research Method

To be able to carry out research in accordance with the expected goals, then the factors that need to be understood and studied are research variables, research instruments, data collection, and data analysis.

The research variables are secondary data obtained from literature studies, such as books, journals, papers, previous related studies and from interviews with relevant sources. The variables used are independent variables (variable stimulus / predictor / antecendent / exogen / free) that is the variables that affect or the cause of change or the emergence of the dependent variable (bound). Variables that depend on other variables are called independent variables[14]. Subsequently collecting data by distributing survey questionnaires to several contracting companies, especially to construction service specialist firms that know the frequency and influence of risks that are the most dominant factors.

The data and information that has been collected is then analyzed to produce a level of risk and response that needs to be done on these factors based on recommendations from experts. This research uses qualitative data types. Qualitative data because it is not the data of numbers in the real sense, can not be equated with the treatment of quantitative data[15]. Qualitative data (nominal and ordinal) typically use non-parametric statistical methods. Then the method of analysis used consists of:

1. AHP (Analytical Hierarchy Process)
   AHP was developed by Dr. Thomas L. Saaty of the Wharton School of Business in the 1970s and is a method used to make complex decisions in which there are dependencies and influences analyzed for benefits, opportunities, costs, and risks[16]. In this research, AHP is used to see the level of influence and frequency of project risk on pile foundation work.
2. Risk Analysis
   As described in the previous chapter, all identified risk identities have been sought, as appropriate, for their priority. The risk level group is divided into four, namely: high (H), significant (S), medium (M), and low (L). Determining the level of risk (risk level), determined based on two criteria, as follows:
   a) Frequency of events (probability)
   b) The impact of the event (impact / severity)
3. Delphi Method
   To validate the predominant risks that have been obtained, the Delphi method is used. Delphi method is a qualitative approach used to predict the trend of an event in the future[17]. A group of experts is used as a source of information. The purpose of this method is to combine expert opinion on a problem or event. Delphi method is done to perfect the existing opinion of the respondents.
   In this research, the method used to analyze the data is the Delphi method where the dominant risk has been obtained, summarized, and analyzed which then the results of the analysis is spread back to the experts to obtain optimal results accompanied by risk responses. So it is expected from the method used will be obtained very dominant risk occurs and the response in the implementation of driven pile foundation.

4. Analysis and Discussion

After collecting the data obtained through the distribution of questionnaires, the next stage is to perform data processing using tabulation data to then processed into the next stage to get the rank order on the effects that occur. The methods used to analyze data in this research is by AHP (Analytical Hierarchy Process).

4.1. Risk Analysis With AHP Approach

Data samples, each of which are frequency and risk impacts at each stage of work, then become input analysis with AHP method starting with matrix normalization treatment, matrix consistency calculation, hierarchical consistency and accuracy level, local frequency value calculation, and local impact value calculation , then from the results of this calculation will get the final value of risk and ranking based on the weight of the calculation results.

4.1.1. Matched Comparison and Matrix Normalization

Below is given a matrix paired for impact and frequency. To get weighting factor as multiplier value to get local value, then do approach as in table below:

Table 1. Matched Comparison Matrix.

C	A_1	A_2	...	A_n
A_1	a_{11}	a_{12}	...	a_{1n}
A_2	a_{21}	a_{22}	...	a_{2n}
:	:	:	...	:
A_m	a_{m1}	a_{m2}	...	a_{mn}

(Source; Presentation module of University Sematera Utara, 2016)

The value of a_{11} is the ratio value of element A_1 (row) to A_1 (column) stating the relationship:

a. How far the importance of A_1 (row) to criterion C is compared to A_1 (column) or
b. How far dominance A_1 (row) to A_1 (column) or
c. How many properties of criterion C are in A_1 (row) compared to A_1 (column).

Table 2. Matched Matrices for Risk Frequency.

Scale	Rare	Unlikely	Possible	Likely	Almost Certain
Rare	1	3	5	7	9
Unlikely	0,333	1	3	5	7
Possible	0,2	0,333	1	3	5
Likely	0,143	0,2	0,333	1	3
Almost Certain	0,111	0,143	0,2	0,333	1
Amount	**1,787**	**4,676**	**9,533**	**16,333**	**25**

(Source; The results of data processing, 2016)

Table 3. Matched Matrices for Risk Impact.

Scale	Negligible	Minor	Moderate	Major	Extreme
Negligible	1	3	5	7	9
Minor	0,333	1	3	5	7
Moderate	0,2	0,333	1	3	5
Major	0,143	0,2	0,333	1	3
Extreme	0,111	0,143	0,2	0,333	1
Amount	**1,787**	**4,676**	**9,533**	**16,333**	**25**

(Source; The results of data processing, 2016)

The numerical values used for all comparisons are obtained from the 1 to 9 scale comparison set by Saaty, as in the following table:

Table 4. Fundamental Scale of Absolute Value.

Intensity of Importance	*Definition*	*Explanation*
1	*Equal Importance*	*Two activities contribute equally to the objective*
2	*Weak or slight*	
3	*Moderate importance*	*Experience and judgement slightly favor one activity over another*
4	*Moderate plus*	
5	*Strong importance*	*Experience and judgment strongly favor one activity over another*
6	*Strong plus*	
7	*Very strong or demonstrated importance*	*An activity is favored very strongly over another; its dominance demonstrated in practice*
8	*Very, very strong*	
9	*Extreme importance*	*The evidence favoring one activity over another is of the highest possible order of affirmation*
1.1 – 1.9	*When activities are very close a decimal is added to I show their difference as appropriate*	*A better alternative way toassigning the small decimals is to compare two close activities with other widely contrasting ones, favoring the larger one a little over the smaller one when using 1 – 9 values*
Reciprovals of above	*If activity I has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i*	*Logical assumption*
Measurement from ratio scales		*When it is desired to use such numbers in physical applications. Alternatively, often one estimates the ratios of such magnitudes by using judgment*

(Source; Thomas L. Saaty, 1988)

4.1.2. Element Weight

The calculation of element weights for each element in the matrix for both frequency and for impact can be seen in the following table:

Table 5. Element Weight Calculation for Frequency Rate.

Scale	Almost Certain	Likely	Possible	Unlikely	Rare	Amount	Priority	Percentage
Almost Certain	0.5595	0.6415	0.5245	0.4286	0.3600	2.514	0.503	100.00%
Likely	0.1865	0.2138	0.3147	0.3061	0.2800	1.301	0.260	51.75%
Possible	0.1119	0.0713	0.1049	0.1837	0.2000	0.672	0.134	26.72%
Unlikely	0.0799	0.0428	0.0350	0.0612	0.1200	0.339	0.068	13.48%
Rare	0.0622	0.0305	0.0210	0.0204	0.0400	0.174	0.035	6.93%
Amount	1.0000	1.0000	1.0000	1.0000	1.0000	5.000		

(Source; The results of data processing, 2016)

Table 6. Calculation of Element Weight for Impact Level.

Scale	Extreme	Major	Moderate	Minor	Negligible	Amount	Priority	Percentage
Extreme	0.5595	0.6415	0.5245	0.4286	0.3600	2.514	0.503	100.00 %
Major	0.1865	0.2138	0.3147	0.3061	0.2800	1.301	0.260	51.75%
Moderate	0.1119	0.0713	0.1049	0.1837	0.2000	0.672	0.134	26.72%
Minor	0.0799	0.0428	0.0350	0.0612	0.1200	0.339	0.068	13.48%
Negligible	0.0622	0.0305	0.0210	0.0204	0.0400	0.174	0.035	6.93%
Amount	1.0000	1.0000	1.0000	1.0000	1.0000	5.000		

(Source; The results of data processing, 2016)

The value 0.5595 is obtained from the value 1 in the matrix table in pairs divided by the total of that column is 1.787 and so on. Then from each row the number is taken against all the columns. For "Almost Certain" and "Extreme" rows, the sum of 0.5595, 0.6465, 0.5245, 0.4286, and 0.3600 produces the number 2,514 and so on until the "Rare" and "Negligible" lines. Then the number of each row will be summed again starting from 2,514, 1,301, 0.672, 0.339, and 0.174 yielding the number 5. Then the value of each row is made priority weighting by the previous total. For example, the lines "Almost Certain" and "Extreme" have a weight of 2.514 / 5 to 0.503. And so on down to the line "Rare" and "Negligible". Furthermore, the "Almost Certain" and "Extreme" lines become the priority value reference for weighting percentages. For example, the "Almost Certain" and "Extreme" values of 0.503 are the priority reference values. So if the values "Likely" and "Major" 0.260 divided by the value of 0.44 (reference priority value) and multiplied by 100% to 51.75%. Thus we get the weighting value for each unit of scale in this research which is shown in table weight of the following elements:

Table 7. Weight Element for Frequency Level.

Scale	Rare	Unlikely	Possible	Likely	Almost Certain
Weight	0,069	0,135	0,267	0,518	1,000

(Source; The results of data processing, 2016)

Table 8. Element Weight for Impact Level.

Scale	Negligible	Minor	Moderate	Major	Extreme
Weight	0,069	0,135	0,267	0,518	1,000

(Source; The results of data processing, 2016)

4.1.3. Matrix Consistency Test, Hierarchy, and Level of Accuracy

The weight matrix of pairwise results must have a single and consistent diagonal. To test consistency, the maximum eigen value value (λmax) must approximate the number of elements (n) and the remaining eigen value is near zero.

The proof of consistency matrix paired with elements in each column divided by the number of columns concerned so obtained the following matrix:

Table 9. Matrix Weight Element for Frequency Level.

Scale	Almost Certain	Likely	Possible	Unlikely	Rare	Average
Almost Certain	0.5595	0.6415	0.5245	0.4286	0.3600	**0.50**
Likely	0.1865	0.2138	0.3147	0.3061	0.2800	**0.26**
Possible	0.1119	0.0713	0.1049	0.1837	0.2000	**0.13**
Unlikely	0.0799	0.0428	0.0350	0.0612	0.1200	**0.07**
Rare	0.0622	0.0305	0.0210	0.0204	0.0400	**0.03**

(Source; The results of data processing, 2016)

Table 10. Matrix of Element Weight for Impact Level.

Scale	Extreme	Major	Moderate	Minor	Negligible	Average
Extreme	0.5595	0.6415	0.5245	0.4286	0.3600	**0.50**
Major	0.1865	0.2138	0.3147	0.3061	0.2800	**0.26**
Moderate	0.1119	0.0713	0.1049	0.1837	0.2000	**0.13**
Minor	0.0799	0.0428	0.0350	0.0612	0.1200	**0.07**
Negligible	0.0622	0.0305	0.0210	0.0204	0.0400	**0.03**

(Source; The results of data processing, 2016)

Furthermore, the average is taken for each line that is 0.50, 0.26, 0.13, 0.07, and 0.03. The column vector (average) is multiplied by the original matrix to generate values for each row, where each value is subdivided by the corresponding vector value.

Table 11. Calculation Looking for λmaks for Frequency Rate.

Average Matrix (A)	Initial Scale Matrix (B)					Matrix (A)*(B)		verage Matrix (A		Result
0.50	1	3	5	7	9	2.74	:	0.50	=	5.46
0.26	0,333	1	3	5	7	1.41	:	0.26	=	5.43
0.13	0,200	0,333	1	3	5	0.70	:	0.13	=	5.20
0.07	0,143	0,200	0,333	1	3	0.34	:	0.07	=	5.03
0.03	0,111	0,143	0,200	0,333	1	0.18	:	0.03	=	5.09
Sum										**26.21**

(Source; The results of data processing, 2016)

Table 12. Calculation Looking for λmaks for Impact Level.

Average Matrix (A)	Initial Scale Matrix (B)					Matrix (A)*(B)		Average Matrix (A)		Result
0.50	1	3	5	7	9	2.74	:	0.50	=	5.46
0.26	0,333	1	3	5	7	1.41	:	0.26	=	5.43
0.13	0,200	0,333	1	3	5	0.70	:	0.13	=	5.20
0.07	0,143	0,200	0,333	1	3	0.34	:	0.07	=	5.03
0.03	0,111	0,143	0,200	0,333	1	0.18	:	0.03	=	5.09
Sum										**26.21**

(Source; The results of data processing, 2016)

The number of elements in the matrix (n) is 5, then λmax = 26.21 / 5, to obtain λmax of 5.24, thus because the λmax value approximates the number of elements (n) in the matrix ie 5 and the remaining eigen value is 0.24 which means close to zero, The matrix is consistent.

To test the consistency of the hierarchy and the degree of accuracy, the number of elements in the matrix (n) is 5, the magnitude of CRI for n = 5 according to Table 4 is 1.11, then:

$$CCI = \frac{5.24 - 5}{5 - 1} = 0.061$$

$$CRH = \frac{0.061}{1.11} = 0.05$$

The value of CRH obtained is quite small or below 10% means a consistent hierarchy and a high degree of accuracy.

4.2. Local Value, Final Value, Ranking and Risk Level Analysis

Based on the consistency test, the calculation of the local value of the frequency and impact of risk can be done, by inserting the weight of each element in accordance with the calculation of the weight of the elements above.

The final grade to rank or rank the AHP, calculated based on the combination of multiplication. The following is the rank or ranking of the final results that are being updated by multiplying the global data with the impact of multiplying by the local value. The weight used in this research is 0.5 for the impact and incidence for convergence in the same portion. The final value of the risk factor is obtained by summing the global frequency and impact that has been multiplied by the weight value.

The risk level analysis is then performed with risk level indexes that are grouped into four classes: L (Low), M (Medium), H (High), and E (Extreme). Class ranges are known from the highest weights are reduced by the lowest weights and the results are divided by the number of classes.

The main project risks are variables with risk levels of the Extreme and High categories. Below is a project risk rating under AHP and risk level analysis. The results of project risk identification can be seen in Table 13.

Table 23. Risk Analysis.

No.	Variable Risk Factors	Local Value		Global Values		Final Value	Ranking	Risk Level
		Frequences (%)	Impact (%)	Frequences (%) 0.5	Impact (%) 0.5			
1	Lack of Awareness of Safety and Work Safety	39.62	30.54	19.81	15.27	35,08	1	E
2	Environmental Problems	39.42	27.60	19.71	13.80	33,51	2	E
3	Owner's Payback	32.62	32.02	16.31	16.01	32,32	3	E
4	Flood	11.85	42.75	5.93	21.38	27,30	4	H
5	Earthquake	8.22	45.20	4.11	22.60	26,71	5	H
6	Tools Age Not Eligible	20.04	30.50	10.02	15.25	25,27	6	H
7	Crane Amblas / Overturned	9.54	40.87	4.77	20.44	25,21	7	H
8	Broken Pile at the Rapture	14.10	34.76	7.05	17.38	24,43	8	H
9	Rain	25.95	22.38	12.97	11.19	24,16	9	H
10	Late of License Agreement	21.06	25.16	10.53	12.58	23,11	10	H
11	Design Information Delay	17.17	28.79	8.58	14.39	22,98	11	H
12	Material Delivery Delays	22.65	21.99	11.32	10.99	22,32	12	M
13	Material Order Delays	21.06	21.99	10.53	10.99	21,52	13	M
14	Subcontractor Less Qualified	15.48	26.01	7.74	13.01	20,75	14	M
15	Inaccurate Estimates	20.07	20.47	10.04	10.23	20,27	15	M
16	Request Change	16.84	23.37	8.42	11.69	20,10	16	M
17	Material Quality Not Match Specification	15.09	23.54	7.54	11.77	19,31	17	M
18	Low Productivity Tools	15.75	22.05	7.87	11.03	18,90	18	M
19	Design Change	17.00	20.07	8.50	10.04	18,54	19	M
20	Workers Fall from Above	19.31	16.14	9.66	8.07	17,73	20	M

21	Error On Binding of Piling Sling	13.54	20.01	6.77	10.00	16,77	21	M
22	Inaccurate Land Data	12.12	20.80	6.06	10.40	16,46	22	M
23	Wire Rope / Cable Sling Disconnect	9.21	22.22	4.61	11.11	15,71	23	L
24	Tool Order Delays	14.36	16.11	7.18	8.06	15,24	24	L
25	Labor Productivity is Not Appropriate Estimated	14.86	15.09	7.43	7.54	14,97	25	L
26	No Time Control Information To Monitor And Analyze Mistakes Of Schedule Estimates Affecting Project Performance	13.44	16.41	6.72	8.20	14,92	26	L
27	Situation and Condition Changes	8.88	20.34	4.44	10.17	14,61	27	L
28	The Added Job Adds Not Recognized Billing	12.84	16.08	6.42	8.04	14,46	28	L
29	Lack of Ability / Experience	12.51	15.81	6.26	7.91	14,16	29	L
30	Lack of Equipment Security	14.10	13.44	7.05	6.72	13,77	30	L
31	Sloping piles	10.53	16.84	5.27	8.42	13,68	31	L
32	Weak Time Control System	11.52	14.82	5.76	7.41	13,17	32	L
33	Weak Cost Control System	11.19	14.16	5.60	7.08	12,68	33	L
34	Lack of Availability of Experts	9.54	15.52	4.77	7.76	12,53	34	L
35	Sample Test Material Not Subject to Defined Quality Standards	11.79	12.18	5.89	6.09	11,98	35	L
36	Communication Errors Between Individuals And Teams	10.20	13.44	5.10	6.72	11,82	36	L
37	Procedures Not Supporting	10.86	11.85	5.43	5.93	11,36	37	L
38	Diesel Hammer / Vibro Hammer Bounce	7.23	14.49	3.62	7.25	10,86	38	L
39	Personnel Limitations	8.88	11.52	4.44	5.76	10,20	39	L
40	Lack of Protective Equipment	10.53	9.21	5.27	4.61	9,87	40	L
Amount						748,66		
Average						18,72		
Max Value						35,08		
Min Value						9,87		
Class Range						6,30		

	Upper limit	Lower limit
Extreme	35,08	28,77
High	28,77	22,47
Medium	22,47	16,17
Low	16,17	9,87

(Source; The results of data processing, 2016)

4.3. Delphi Method

The next stage of re-validation of these risk factors to the expert in order to obtain recommendations for response to risk factors risk research results. Some natural risk variables caused by nature are summarized into one variable that is weather, because the out-of-control events are included in the variable force majeur. For risk with intolerable level, a response must be taken that can minimize the risk level until the risk is acceptable at least to As Low As Reasonable Practicable (ALARP) level, while at ALARP level needs to be responded or mitigated to reduce the level to acceptable, The cost of mitigation criteria should be less than the benefits it earns.

In undertaking a response to high risk, before determining what response is used have agreed to determine the order of priority of the risk response are as follows: (1) mitigation ie making efforts to reduce the impact or decrease the probability or both (2) Moving the risks (transference), if the mitigation measures undertaken are still left a large impact and high probability it is necessary to do the risk transfer step (3) Accept the Risk (acceptance), if steps 1 and 2 are perceived still leaves a potential risk it is necessary Is made to accept risks by preparing the necessary reserves, including the cost, time and other resources for those risks, (4) Avoidance of risk, if steps 1, 2 and 3 are perceived as not reducing the impact or probability, or cost Issued to decrease impact and probability beyond from potential loss then the last step is to avoid risk

The final result of the discussion is shown in table 14 below:

Table 14. Rekommended Response.

No	Sources of Risk	Recommended Response: Type Response A. Mitigation B. Transfer C. Accepted Risk D. Avoid	Recommended Response: *Action Plan/Step*
1	Lack of Awareness of Safety and Work Safety	a. *Mitigation*	1. Hold a briefing before work, 2. Give warning and warning
2	Environmental Problems	a. *Mitigation*	1. Conducting socialization to the community in the local environment, 2. Submit Additional Time
3	Owner's Payback	b. *Transfer*	Professionalism, Claim
4	Weather: 1). Earthquake	a. *Mitigation*	1. Requesting mapping data of earthquake prone areas, making evacuation routes and signs, preparing emergency response in case of earthquake,
	2). Flood		2. Make drainage disekitaar
	3). Rain		3. Request weather forecast data in Local BMKG
5	Tools Age Not Eligible	d. *Avoid*	1. Inspect the equipment to be used 2. Replacing tools that are not feasible to use with a new one
6	Crane Amblas / Overturned	a. Mitigation	Provide mat plate for footing for heavy equipment
7	Broken Pile at the Rapture	a. *Mitigation*	1. Make SOP and apply it 2. Perform material

			checks
8	LaLate of License Agreement	b. *Transfer*	1. Permit is done first
			2. Submit additional time
9	Design Information Delay	b. *Transfer*	1. Conduct regular communication between owner, consultant, and contractor
			2. Submit additional time

(Source; The results of data processing, 2016)

5. Conclusions

At the end of this research, it can be concluded that is the output of the stages of the previous data processing. The conclusions are as follows:

a) There are risks that have an impact on the time targets on the construction of the bottom structure pile foundation of the construction project. The dominant project risks are as follows:
   - Lack of awareness of occupational safety and security
   - Environmental issues
   - Weather (Earthquake, Flood, Rain)
   - Age of unsuitable tool
   - Crane collapsed / Overturned
   - The pile is broken during appointment
   - Late in Licensing Approval
   - Design Information Delay

b) Based on the dominant risk at point a and discussion on the previous CHAPTER, the technical internal factors (methods, technology, and complexity), non-technical internals (management, schedule, cost, cash flow), predictable external (inflation, environment, weather), And unpredictable external (natural disasters) affect the level of risk.

c) The responses to these dominant risks by reducing risks (mitigation) and risk transfer to risks that are difficult to mitigate or risk still have great potential impacts despite mitigation as described in Table.

6. References

[1]. PMBOK. (2008). *A Guide to the Project Management Body of Knowledge* (Vol. 53).

[2]. Akintoye and MacLeod, M.J. (1997), "*Risk analysis and Management in Construction", International Journal of Project Management*, Vol. 15.

[3]. Kartam, NA and Kartam, SA (2001) "*Risk and its Management in the Kuwait Construction Industry : A Contractor Perspective*", *International Journal of Project Management*, Vol. 19.

[4]. Iskandar, Rudy. (2002). Perencanaan pondasi dan permasalahannya

[5]. Lin, Michael Chew Yit. (2006). *Construction technology for tall buildings*(2nd ed.). Singapore: Singapore University Press.

[6]. Foster, S. J. (1994). *Structure and fabric*.Longman

[7]. Asiyanto.(2009). Manajemen risiko untuk kontraktor. Jakarta: Pradnya paramita.

[8]. Soeharto, Iman. (1995). Manajemen Proyek (dari konseptual sampai operasional) (2th ed.). Jakarta: Erlangga.

[9]. ICE and FIA (1998), *RAMP : Risk Analysis and Management for Project*, Thomas Telford, London

[10]. Subiyanto, Eddy. (2010). *Slide kuliah manajemen risiko*. Depok: Universitas Indonesia.

[11]. APM (1997), *Project Risk Analysis and Management*, APM Group Limited, Norwich Norfolk

[12]. AS/NZS (1999b), *Guidelines for Managing Risk : In the Australian and New Zealand Public Sector,* Standards Association of Australia.

[13]. Kerzner, Harold. (1995). *Project management: a system approach to planning, scheduling, and controlling*. New York: Van Nostrand Reinhold.

[14]. Nazir, Moh. (1983). *Metode penelitian*. Jakarta: Yudhitira

[15]. Santoso, Singgih. (2010). *Panduan lengkap menguasai statistik dengan SPSS 17*. Jakarta: Elex Media Komputindo.

[16]. Saaty, Thomas L. (2008). *Relative measurement and its generalization in decision making why pairwise are central in mathematics for the measurement of intangible factors the analytical hierarchu process.* Ciencias, Spain: Statistic and operation research, RACSAM.

[17]. Latief, Yusuf. (2010, December). Slide kuliah metode delphi. Depok: Jurusan Sipil FTUI.