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THE ANALYSIS OF RISK MANAGEMENT IMPLEMENTATION ON HOSPITAL CONSTRUCTION PROJECT

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ABSTRACT

In every construction job there must be a risk, the risk is a consequence of an uncertain condition. In a construction work the uncertainty is substantial because it can't be predicted exactly how much profit or loss will be obtained. Because of this, there is a need for risk management analysis from early of a construction project to reduce the risk and impact of possible risks. The results of this study by using the method of principal component analysis based on the method of likelihood are aspect difficult locations, the bureaucracy of the necessary permits, condition of the land acquisition is difficult, the weather conditions, health and safety, payment is not on time, delays in delivery of materials, location and site conditions are bad, demonstration/despoliation on location of the project, policy of government's political, interest rates on bank loans and the quality of materials that are less good; based on the impact are aspect of order changes, human error, weather conditions, natural disasters, lack of timely payment, health and safety, communication and coordination, equipment, material prices, equipment is not feasible and the culture and customs. While the research results using measurement scale AS / NZS according the likelihood of events resulted in three aspects of risk is very high, 5 aspects of high risk and 4 aspects of intermediate risk, and based on the impact occurs produces one aspect of risk is very high, four aspects of high risk 5 aspects medium risk and one low risk aspect.

Key word: Risk Analysis, Risk Aspects, Levels of Risk.

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1. INTRODUCTION

Construction work is a combination of various disciplines of science, both in terms of technical construction and in terms of non-technical and including the element of human resources (man power). In construction work is always concerned with the organization of construction work and the community of the organizers of the construction work itself. Where the implementation of this construction work must meet the provisions on engineering, Occupational Safety and Health, labor protection, and local environmental order to ensure the realization of orderly construction of construction work. In Indonesia there are more than 300 thousand work accidents, 5000 deaths, 500 permanent disability and compensation of more than 550 billion rupiah. This compensation is part of direct losses. It is estimated that indirect losses from all formal sectors are more than 2 trillion rupiah, which is largely a loss to the business world [1]. By looking at the losses incurred both material and non-material related to accidents and occupational diseases, it is necessary to do an attempt to prevent and control the risks posed by a construction work. One form of commitment that can be done by a company, in an effort to reduce the number of accidents and occupational diseases is to apply the risk management system, therefore the need for a special review to assess each risk faced construction work. With a special study to identify the conditions of uncertainty that pose risks or sources of risk faced, it is expected to know what are the main factors that are the source of risk and determine the classification of risk levels based on the sources of risk factors. This study is conducted to know the classification of risk level in construction work, to know the main factors what is the source of risk in construction work, to know how to determine assessment process and possible risk which is identified at construction job.

2. LITERATURE STUDY

Risk management is the process of measuring or assessing risks and developing management strategies. The strategy starts from identifying risks, measuring and determining the magnitude of risk, then finding ways to handle those risks [2]. After the source of risk is obtained and continued with risk analysis using AS / NZS 4360: 2004 measurement scale to obtain the risk level classification. The level of risk based on events, are high risk, consisting of price and cost aspects. Significant Risk, which consists of material and equipment aspects, education and finance aspects, aspects of planning, weather aspects, supervision aspects, medium risk, consists of management and production management aspects, human resource management and socio-cultural aspects, health and safety aspects. The level of risk based on the consequences are high risk is the aspect of supervision, significant risk is the aspect of location, human resources and quality, socio-cultural aspects and health and safety, aspects of planning, weather aspects, and price aspects, medium risk is the material, equipment and time aspect, cost budget aspect [3]. Qualitative risk analysis and management have two objectives: risk identification and preliminary risk assessment, where the objective is to establish the main sources of risk and to illustrate the level of frequent consequences, including the most likely impact on cost and time estimates [4]. Based on the activity, risks can be sourced from the political, environmental, planning, marketing, economic, financial, natural, project, technical, human, criminal and safety [5]. Risks can be recognized from the source event, and consequences of these risks. Sources of risk are conditions that may increase the likelihood of occurrence of risk, event is an event that cause influence, effects that can be harmful and profitable [6]. Risk identification through factor analysis and major component analysis based on the event resulted in ten aspects of risk sources are planning and finance aspects, equipment aspects, location and environmental aspects, natural aspects, government policy aspects, material aspects, human and energy aspects work, control aspects, aspects of health and safety, aspects of human error. Level of risk from the most influential is the high risk consisting of aspects of health and safety, aspects of human error, and aspects of nature; significant risk for aspects of government policy; medium risk consisting of planning and finance aspect, equipment aspect, location and environment aspect, material aspect and human resource aspect and worker aspect; low risk for controlling aspects [7]

3. METHODOLOGY

a. Location of study

This study was conducted on a hospital construction project in Bogor District, Indonesia

b. Principal Component Analysis (Factor Analysis)

In this study factor analysis used is the principal component analysis, which serves to transform the original set of variables into a set of smaller linear combinations based on most of the original variables. The expected output from the analysis by SPSS is a rotated component matrix, which is the matrix principal component of extraction results rotated with varimax and the number of components taken is the component having eigenvalue ≥ 1, where eigenvalue represents the value of information content obtained from certain factors of the variable in this research.

c. Risk Analysis Measurement Scale AS / NZS

The method of data analysis used in this risk assessment is the Australian semi-quantitative risk analysis method Standard / New Zealand Standard (AS / NZS 4360: 2004). Semi-quantitative analysis is used to see how much the level of likes and consequences by using a risk table, then multiplying those values to determine the level of risk.

$$\text{Risk Index} = \text{Risk Probability (Frequency)} \times \text{Risk Impact}$$

Table 3.1. Risk Level

Risk Level	Description
17 – 25	Extreme High Risk
10 – 16	High Risk
5 – 9	Medium Risk
1 – 4	Low Risk

4. RESULTS AND DISCUSSION

a. Principal Component Analysis (Factor Analysis)

In the result of the analysis with SPSS based on the probability of occurrence (table 4.1), the main component having eigenvalue ≥ 1 is formed up to the 12 component. It is concluded that 12 main components have been able to explain the data diversity as cumulative percentage is 85,790%.

Table 4.1 Eigenvalue Value Possible Occurrence

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.626	15.777	15.777	6.626	15.777	15.777
2	6.125	14.582	30.359	6.125	14.582	30.359
3	4.343	10.342	40.701	4.343	10.342	40.701
4	3.890	9.262	49.963	3.890	9.262	49.963
5	3.418	8.137	58.101	3.418	8.137	58.101
6	2.557	6.088	64.189	2.557	6.088	64.189
7	2.052	4.885	69.074	2.052	4.885	69.074
8	1.717	4.087	73.161	1.717	4.087	73.161
9	1.467	3.493	76.654	1.467	3.493	76.654
10	1.442	3.433	80.086	1.442	3.433	80.086
11	1.317	3.136	83.223	1.317	3.136	83.223
12	1.078	2.567	85.790	1.078	2.567	85.790
13	.973	2.317	88.107			
14	.891	2.121	90.229			
15	.845	2.013	92.242			
16	.677	1.613	93.855			
17	.602	1.434	95.289			
18	.480	1.144	96.433			
19	.368	.876	97.309			
20	.333	.792	98.100			
21	.248	.592	98.692			
22	.198	.472	99.164			
23	.118	.282	99.445			
24	.111	.265	99.711			
25	.062	.149	99.859			
26	.043	.102	99.961			
27	.016	.039	100.000			
28	9.039E-16	2.152E-15	100.000			
29	8.027E-16	1.911E-15	100.000			
30	7.695E-16	1.832E-15	100.000			
31	7.337E-16	1.747E-15	100.000			
32	3.785E-16	9.011E-16	100.000			
33	2.270E-16	5.406E-16	100.000			
34	7.294E-17	1.737E-16	100.000			
35	5.113E-17	1.217E-16	100.000			
36	-3.299E-17	-7.854E-17	100.000			
37	-1.097E-16	-2.613E-16	100.000			
38	-2.032E-16	-4.839E-16	100.000			
39	-3.283E-16	-7.817E-16	100.000			
40	-4.057E-16	-9.659E-16	100.000			
41	-5.748E-16	-1.369E-15	100.000			
42	-7.665E-16	-1.825E-15	100.000			

Extraction Method: Principal Component Analysis.

Then, the variables are grouped to form a factor, which is derived from the rotated component matrix, which is the matrix principal component of extraction which is rotated based on the varimax method and the number of components taken is the component having eigenvalue ≥ 1 (table 4.2).

Table 4.2 Rotated Component Matrix Possible Occurrence

Component Matrix[a]

	Component											
	1	2	3	4	5	6	7	8	9	10	11	12
X.19	.709	-.605	-.157	-.078	.037	-.052	.073	-.101	-.008	-.060	.021	.140
X.35	.676	-.576	-.080	-.041	.071	-.130	.045	-.142	.008	-.080	.094	.044
X.21	.655	-.425	-.091	-.120	.104	-.097	-.132	.198	.165	-.053	-.295	.109
X.22	.652	-.402	-.095	-.102	.023	.063	.139	-.407	-.006	.013	.078	.246
X.42	.602	.442	-.349	-.061	-.104	.169	-.272	.103	-.114	.074	.127	.100
X.14	.601	.569	-.132	.083	-.234	.127	.164	-.214	-.264	-.152	-.080	.070
X.2	.601	.569	-.132	.083	-.234	.127	.164	-.214	-.264	-.152	-.080	.070
X.20	.565	-.264	.001	.377	-.308	.044	.220	.005	.232	.077	.081	-.237
X.24	.542	-.179	.187	.302	.301	-.319	-.319	.198	-.226	-.146	-.187	-.033
X.33	.525	.169	-.099	-.295	-.279	-.240	-.071	.091	.071	.488	.030	-.191
X.16	.475	.403	-.384	-.166	-.125	-.002	.046	.223	.223	.397	.035	.156
X.3	.555	-.712	-.148	-.226	.145	-.065	.092	-.144	-.066	-.025	.000	.138
X.26	.536	.673	-.006	.110	-.218	.047	.102	-.213	-.139	-.038	-.131	.099
X.32	-.118	.646	-.187	-.202	.151	-.384	.184	.141	-.114	-.251	.264	.016
X.23	.219	.635	.275	.306	-.219	-.079	-.189	-.170	.074	.216	-.038	.117
X.17	.064	-.630	-.302	-.353	.102	.235	.223	.210	-.080	-.009	-.026	.095
X.31	-.006	.625	-.031	-.365	.273	-.221	-.064	.207	-.106	-.107	.363	.054
X.40	.241	.483	.359	-.029	.093	-.028	.208	-.293	.241	-.212	.005	-.286
X.37	.404	.029	.793	-.067	-.109	-.181	.058	.218	-.156	-.007	.134	.017
X.41	-.404	-.029	-.793	.067	.109	.181	-.058	-.218	.156	.007	-.134	-.017
X.36	.383	-.032	.741	-.087	-.128	-.362	-.108	.052	.120	.069	.039	.027
X.39	-.327	-.312	.595	-.191	.092	-.067	.357	-.205	-.072	.126	.097	.262
X.18	-.174	.001	.586	.403	.048	.098	-.116	-.043	.327	.060	.085	.191
X.11	.196	-.345	-.506	.265	-.103	-.098	.124	.226	.123	-.184	.313	-.019
X.38	-.299	-.390	.488	-.319	.171	.043	.143	-.205	-.114	.095	.281	.193
X.5	.105	-.083	.109	.716	-.039	.354	.290	.264	-.047	.160	-.058	-.072
X.2	.085	.120	.184	-.640	-.062	.356	-.337	.094	-.330	.238	.079	.027
X.7	-.229	-.204	.016	.638	.130	.354	.191	.201	-.418	.105	.142	.069
X.4	.099	-.241	.116	.633	-.391	.298	-.122	.210	-.131	.088	.274	.048
X.27	.322	.229	.069	.172	.863	-.006	.015	-.002	.001	-.072	-.045	.021
X.29	.026	.411	-.125	-.087	.735	.143	.173	.047	.046	.134	.076	-.020
X.25	.266	.253	-.001	.291	.709	.187	-.056	.033	.253	-.177	.032	.191
X.15	-.237	.033	-.179	.458	-.161	-.583	.412	-.232	.099	.129	-.034	.075
X.13	.160	-.031	.293	-.081	-.242	.494	-.285	-.348	.263	-.076	.019	.011
X.30	.277	-.234	.165	.464	.286	-.482	-.442	.124	-.030	.025	-.141	-.023
X.10	.395	.273	.337	.192	.254	.422	.158	-.030	.135	-.118	.224	-.157
X.34	-.345	.195	-.187	.306	-.081	.097	-.538	-.099	.058	-.098	.015	.504
X.14	-.186	.318	.150	.103	-.221	-.189	.434	.221	-.177	-.091	-.415	.342
X.12	.131	.286	.023	-.277	-.126	.117	.296	.467	.533	.076	.003	.321
X.28	.471	.088	-.171	.160	.484	.025	.106	-.132	-.135	.502	.066	-.018
X.35	.399	-.096	-.036	-.078	-.406	.048	-.009	.224	.034	-.490	.258	.009
X.6	.179	-.041	.409	-.342	.116	.486	.112	.239	-.009	-.106	-.512	-.104

Extraction Method: Principal Component Analysis.

a. 12 components extracted.

In the analysis with SPSS based on the impact (Table 4.9), the main components with eigenvalue ≥ 1 formed up to the 11th component are shown. It is concluded that 11 main components have been able to explain data diversity as cumulative percentage that is 88,282%.

Table 4.3 Eigenvalue Value of Impact

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.691	23.075	23.075	9.691	23.075	23.075
2	5.492	13.075	36.150	5.492	13.075	36.150
3	4.701	11.194	47.344	4.701	11.194	47.344
4	3.594	8.557	55.901	3.594	8.557	55.901
5	3.446	8.206	64.107	3.446	8.206	64.107
6	2.371	5.646	69.753	2.371	5.646	69.753
7	1.921	4.573	74.326	1.921	4.573	74.326
8	1.722	4.101	78.427	1.722	4.101	78.427
9	1.482	3.528	81.955	1.482	3.528	81.955
10	1.472	3.506	85.461	1.472	3.506	85.461
11	1.185	2.821	88.282	1.185	2.821	88.282
12	.957	2.280	90.561			
13	.727	1.730	92.292			
14	.571	1.360	93.652			
15	.536	1.276	94.929			
16	.511	1.216	96.145			
17	.375	.892	97.037			
18	.280	.666	97.703			
19	.230	.548	98.251			
20	.217	.516	98.767			
21	.159	.378	99.144			
22	.117	.278	99.422			
23	.099	.235	99.658			
24	.074	.177	99.835			
25	.049	.116	99.951			
26	.014	.034	99.985			
27	.006	.015	100.000			
28	6.533E-16	1.555E-15	100.000			
29	5.120E-16	1.219E-15	100.000			
30	3.755E-16	8.941E-16	100.000			
31	1.731E-16	4.122E-16	100.000			
32	1.064E-16	2.532E-16	100.000			
33	3.213E-17	7.651E-17	100.000			
34	2.301E-18	5.478E-18	100.000			
35	-1.542E-17	-3.672E-17	100.000			
36	-2.805E-17	-6.680E-17	100.000			
37	-5.298E-17	-1.261E-16	100.000			
38	-1.211E-16	-2.883E-16	100.000			
39	-3.959E-16	-9.425E-16	100.000			
40	-5.022E-16	-1.196E-15	100.000			
41	-6.759E-16	-1.609E-15	100.000			
42	-7.957E-16	-1.895E-15	100.000			

Extraction Method: Principal Component Analysis.

Then we get the clustered variables to form a factor, which is derived from the rotated component matrix, which is the matrix principal component of the extracted result that is rotated based on the varimax method and the number of components taken is the component having eigenvalue ≥ 1 (table 4.4).

Table 4.4 Rotated Component Matrix of Impact

Component Matrix[a]

	Component										
	1	2	3	4	5	6	7	8	9	10	11
Y.13	.727	-.140	-.247	.107	-.429	-.164	.008	.297	.042	.009	.114
Y.40	.685	-.207	-.132	.156	-.407	-.258	.079	.258	-.028	.170	.003
Y.22	.674	.461	.331	-.242	.117	-.212	-.016	.160	.033	-.020	-.140
Y.23	.671	.557	.148	-.026	-.053	.244	.218	.010	-.240	.031	-.009
Y.14	.668	.497	.292	-.183	.157	-.112	.176	.160	-.050	-.062	.004
Y.42	.668	.497	.292	-.183	.157	-.112	.176	.160	-.050	-.062	.004
Y.30	.662	.393	.208	-.383	.006	-.148	-.113	-.031	.131	-.012	-.279
Y.41	.661	-.100	-.574	-.128	.204	-.154	-.126	-.132	-.033	.130	-.089
Y.1	.656	.314	.184	-.405	.006	-.175	-.301	.010	.015	-.016	-.152
Y.8	.630	.369	.171	.194	.282	.049	.313	-.070	.172	-.292	.083
Y.26	.527	-.011	-.110	.446	.056	.367	.150	.306	.135	.313	.146
Y.6	.522	.283	-.041	.441	.085	.011	-.496	-.293	.081	-.173	.182
Y.2	.522	.283	-.041	.441	.085	.011	-.496	-.293	.081	-.173	.182
Y.4	.513	.364	.082	.173	.341	.072	-.325	.011	.335	-.074	.281
Y.27	.498	-.686	.292	-.102	.213	-.121	.109	-.089	.152	-.115	.051
Y.17	.417	-.675	.041	-.092	-.215	.218	-.069	-.270	-.015	-.145	-.235
Y.21	.589	-.660	.267	.073	-.080	.144	.059	-.023	-.160	-.188	-.091
Y.28	.589	-.660	.267	.073	-.080	.144	.059	-.023	-.160	-.188	-.091
Y.24	.397	-.579	.425	-.346	.071	-.035	-.009	-.151	.110	.040	.097
Y.35	.489	-.156	-.678	.014	.308	-.125	.162	-.187	-.106	.106	-.024
Y.37	.386	-.191	-.669	-.102	.325	-.093	.283	-.245	-.106	.028	.016
Y.36	.631	-.100	-.635	-.070	.234	-.065	.027	-.144	-.102	.100	.032
Y.34	.631	-.100	-.635	-.070	.234	-.065	.027	-.144	-.102	.100	.032
Y.39	-.135	.152	-.540	-.007	.090	.311	.292	.152	.495	.248	.007
Y.25	.342	-.410	.527	-.409	.152	.059	.177	-.110	.050	.023	.175
Y.20	.365	-.081	.514	-.053	.131	-.178	-.102	-.114	-.117	.404	.175
Y.16	.206	.394	-.410	-.196	.083	-.008	.361	.096	.077	-.309	-.181
Y.19	.220	-.386	.407	-.261	.295	-.016	.272	.116	.329	.081	.186
Y.9	.044	.064	-.334	-.670	-.283	.296	-.319	-.018	.032	.053	.105
Y.32	-.036	-.101	.355	.636	.240	-.262	.209	.047	-.158	.269	.108
Y.31	.445	-.166	.065	.570	.216	.222	-.083	.018	.175	.281	-.345
Y.33	-.242	.365	.147	.544	.056	-.531	.222	-.166	.136	-.108	-.043
Y.7	.406	-.378	.145	.450	.156	.280	-.217	.141	-.093	.183	-.243
Y.11	.294	.180	.203	.196	-.691	.230	.242	-.263	.049	-.011	.187
Y.18	.425	-.283	-.290	.048	-.629	-.242	-.156	.266	.216	-.094	-.044
Y.12	.365	.343	.148	.194	-.567	.295	.237	-.343	-.037	.128	-.036
Y.29	.481	-.208	-.179	.148	-.545	-.311	-.083	.433	.144	-.103	.058
Y.10	.403	.444	.042	.013	-.477	.446	.202	-.272	-.052	.013	-.093
Y.38	.118	-.165	-.210	-.064	.278	.619	-.012	.320	-.047	-.315	.418
Y.15	.066	.355	.246	-.258	.245	.401	-.259	.252	.007	.348	-.241
Y.3	.183	.149	-.019	.234	.203	.091	-.034	.388	-.681	-.236	.025
Y.5	.139	.205	-.028	-.318	-.325	-.220	-.043	-.068	-.308	.437	.411

Extraction Method: Principal Component Analysis.

a. 11 components extracted.

b. Risk Analysis Measurement Scale AS/NZS

The result of Risk Index Analysis based on probability of occurrence is as follows in table 4.5.

Table 4.5 Risk Index Based on Probability Occurrence

No.	Aspect	Risk Probability	Risk Impact	Rank	Remark
1	The project location is difficult reachable	5	5	25	Extreme High Risk
2	Bureaucracy of building permit management	5	5	25	Extreme High Risk
3	Difficulty of land acquisition	5	5	25	Extreme High Risk
4	Weather conditions	4	4	16	High Risk
5	Health and safety	4	4	16	High Risk
6	Not on time payment	4	4	16	High Risk
7	Delays of material delivery	2	2	4	Low Risk
8	Hard of project location	4	4	16	High Risk
9	Demonstration	4	4	16	High Risk
10	Government regulation	3	3	9	Medium Risk
11	Interest rates on bank loans	3	2	6	Medium Risk
12	Material quality not good	2	2	4	Low Risk

The results of Risk Index Analysis based on the current impact are as follows (table 4.6)

Table 4.6 Risk Index Analysis Based on Current Impact

No.	Aspect	Risk Probability	Risk Impact	Rank	Remark
1	Change orders	5	1	5	Medium Risk
2	Human errors	5	3	15	High Risk
3	Weather conditions	3	4	12	High Risk
4	Natural disaster	3	2	6	Medium Risk
5	Not on time payment	1	4	4	Low Risk
6	Health and safety	5	4	20	Extreme High Risk
7	Communications and coordination	3	3	9	Medium Risk
8	Equipment	3	2	6	Medium Risk
9	Material cost	4	3	12	High Risk
10	Improper equipment	4	2	8	Medium Risk
11	Regional culture	4	4	16	High Risk

5. CONCLUSIONS

Determining the classification of risk levels in the implementation of construction work based on the probability of occurrence using Principal Component Analysis resulted in aspects are:

- The project location is difficult reachable,
- Bureaucracy of building permit management,
- Difficulty of land acquisition,
- Weather conditions,
- Health and safety,
- Not on time payment,
- Delays of material delivery,
- Hard of project location,
- Demonstration,
- Government regulation,
- Interest rates on bank loans,
- Material quality not good.

The impact, based risks of using Principal Component Analysis result in aspects are:

- Change orders ,
- Human errors,
- Weather conditions,
- Natural disaster,
- Not on time payment,
- Health and safety,
- Communications and coordination,
- Equipment,
- Material cost,
- Improper equipment,
- Regional culture

The main factors that become the source of risk on the implementation of construction work can be classified as follows

Based on probability occurrence:

- Extreme High Risk :
  - The project location is difficult reachable,
  - Bureaucracy of building permit management,
  - Difficulty of land acquisition.
- High Risk :
  - Weather conditions,
  - Health and safety,
  - Not on time payment,
  - Hard of project location,
  - Demonstration.
- Medium Risk :
  - Government regulation,
  - Interest rates on bank loans.
- Low Risk :
  - Delays of material delivery,
  - Material quality not good.

Based on current impact:

- Extreme High Risk :
  - Health and safety
- High Risk :

    - Human errors,
    - Weather conditions,
    - Material cost,
    - Regional culture
- Medium Risk :
    - Change orders,
    - Natural disaster,
    - Communications and coordination,
    - Equipment,
    - Improper equipment.
- Low Risk :
    - Not on time payment.

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