ISSN 2409-2665
Journal of Logistics, Informatics and Service Science
Vol. 5 (2018) No. 1, pp.1-16

A Case Study on Risk Management in Existing Construction Project in Bangladesh

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(Received on Jan. 2018, accepted on May 2018)

Abstract. Risks are involved in every construction projects like buildings, bridges or any types of the construction project. The project manager plays major roles to tackle the risk in a construction project. However, an effective and proper risk management approach requires an appropriate and systematic methodology, knowledge, and experience (Alfredo Federico Serpella, 2014).The aim of this paper is to identify and classify the risk, identify the methods to mitigate or reduce the risks and find out vital risks through Analytical Hierarchy Process analysis (AHP) in a construction project. The whole methodology is described through a case study of the collapse of Rana Plaza in Bangladesh. The major risk of Rana Plaza are foundation system, materials procurement, and structural design. Through AHP analysis, we find that the collapse of Rana Plaza is foundation system.

Keywords: Risk, Risk Management, Construction Project, AHP Analysis, Rana Plaza.

1. Introduction

1.1. Construction project risks

Risks is an uncertain event or condition if it occurs have a negative effect on the project objective. Risks can happen at any stage in construction project without warning. In the construction management domain, Perry and Hayes (1985) defined risk as an exposure to economic loss or gain arising from involvement in the construction project.

Before the project started some potential risks can be identified such as equipment defects or change in the technical requirements. But major risks in the project may not be identified before the project starts. So we used risk management process to avoid, control or reduce risks. However systematic risks management technique requires practical experience and properly trained to use of risk management techniques. According to the Anthony (1996),systematic risks management helps to identify, assess, and rank risks, making the risks explicit; focus on the major risks of the project; make informed decision on the provision for adversity, e.g. mitigation measures; minimize potential damages should the worst happen; control the uncertain aspect of construction projects; clarify and formalize the company's role and the roles of others in the risks management process; identify the opportunities to enhance project performance. Chavas and Paul (2003) express effective risk management is a critical component of any winning management strategy.

Project manager professional obviously needs to know the proper way to the balance of contingencies of risk with their specific financial, contractual, organizational and operational requirements. In order to achieve this balance is required to proper risk identification and proper contingency plan to tackle risk. However proper identification and proper contingency plan to mitigate the potential for loss.

In modern construction management, the best practices of the project manager are too successful risk management in a project delivery. This study focus is to identified, classified and mitigating risk in the construction project.

1.2. Risk management processes

Risks management in a construction project is very important as shown in figure 1(Larson & Gray, 2011).Possible risk for the subsequent project success can be identified in the planning phase and make a contingency plan to reduce risk.

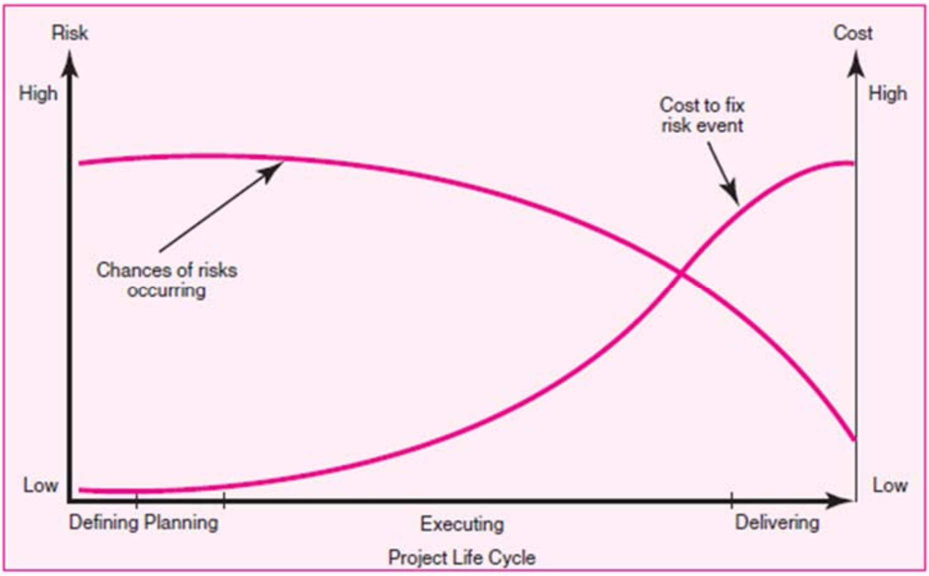


Figure 1. Risk Event Graph (Larson &Gray, 2011)

The major steps of risk management process are given below the figure 2(Larson &Gray, 2011).Each step will be examined in more details study.

Figure 2. Risk Management Process (Larson & Gray, 2011)

1.3. Know the risk in construction project

Generate a list of possible risks through brainstorming, problem identification, risk profiling. There are various types of risks at different stages of a construction project. From the literature review, the risks can be classified into 8 groups as shown in below-

- Construction Risk
- Design Risk
- Financial Risk
- Legal-contractual Risk
- Environmental Risk
- Physical Risk
- Political Risk
- Completion Risk

1.4. Construction risk in a project

During the construction phase of a project lifecycle, the construction risk will occur. The construction phase is one of the most important and critical phases. Any changes during the construction phase will affect to a great extent of time cost and quality. The time, cost and quality is the major factor of construction. When the project manager fails to meet the 3 factors in a project then a dispute will occur. Many causes of project delay such as site hazard, lack or unavailability of equipment, materials, labor, fuel, spares, poor inventory management, lack of supplier relationship, poor storage practices & weather condition, labor conflict etc.

Other than the Construction risk is errors or omission on plan and specifications and additions to a bill of quantities, insufficient time to prepare bid tender, poor communication, and inadequate contract document.

1.5. Design risk in construction project

A Design risk will occur when the project is being designed phase either in a conceptual, preliminary or detailed design process. Immediate assessment of design risk will increase the chances of reducing or mitigating possible risks. In many cases, errors or discrepancies in the documents do not become apparent until construction has started. This is known as latent ambiguity. Sometimes the errors or omission in the design document by the drafter.so this is the major impact on project time and cost.

1.6. Financial risk in construction project

Financial loss in a construction project is also known as the financial loss. Financial loss in project consists of inadequate payment, unavailability of funds, cash flow problem, dispute or slow payment problem, loss due to the default of suppliers, contractor or others. In long-term project inflation, increase the materials price, increase the government taxes is the major financial problem. In large projects can involve the highly complex financial problem.

1.7. Legal-contractual risk in construction project

During the bid, the contractor and owner bonded on a legal contractual relationship. There are several types of contract method such as-

- Direct Labor
- Admeasurements contracts, including
    - (i) Bill of quantities (BOQ) or
    - (ii) Schedule of rates (SOR)
- Lump-sum contracts/ Firm fixed price contract (FFPC)
- Cost/reimbursement contracts:
    - (i) Cost plus % fee, or
    - (ii) Cost plus fixed fee, or
    - (iii) Cost plus fluctuating fee
- Design and construct contracts /D&B contract
- All-in contracts ('package' or 'turnkey' contracts)

- An all-in contract is normally a lump-sum contract
- Management contract

In response to risk parameters, the location of risk of the different methods is different.

1.8. Environmental risk in construction project

In a constructional project, environmental risk is a serious risk in the construction industry. Although many construction firms cling to the belief that environmental exposures are associated only with environmental work, in fact, they exist in every facet of a construction firms practice Jayne (2003). To attain in the now-a-days debatable environment, onward looking contractor are organize sound environmental risk management practices thought out their business activities. Environmental risk can consist of pollution, public inquiry, ecological, geological, public inquiry, etc.

1.9. Physical risk in construction project

In a construction project, physical risk means the physical nature associated with the project Most of the risk fall under this category are an uncontrolled source of risk. This types of risk like as weather, storm, flood, landslip, heavy rain, fire etc.

1.10. Political risk in construction project

Political risk is a risk of losses resulting from loss or damages of assets caused by political violence such as terrorism, war, insurrection, civil unrest, sabotage etc. For political risk in a construction project, it might change the law of construction, unavailability of labor, material etc. suppose unexpected general strike in the country all the construction work should be stopped.

1.11. Completion risk in construction project

All types of risk are associated with time. Any types of risk may cause the project delay. The cost will increase when the project is a delay. If the project is commercial will be count in owner for the delay. This loss is directly going to the construction group.

2. Methodology

2.1. Analytical hierarchy process

A number of a systematic model has been proposed for analyzing risk management in the construction project. Kangary and Riggs (1989) classified these methods into two categories: classical model (i.e. probability analysis) and conceptual models (i.e. fuzzy set analysis).They noticed that probability set models suffered from two major limitations. Some models required circumstantial quantitative information, but which is not normally available in the initial or planning stage.so the analyzing of risk in this model is limited. So, therefore, need to a subjective approach to project risk assessment. Saaty (1980) was developed the analytical hierarchy process. It allows objective as well as subjective factors to be considered in project risk analysis.

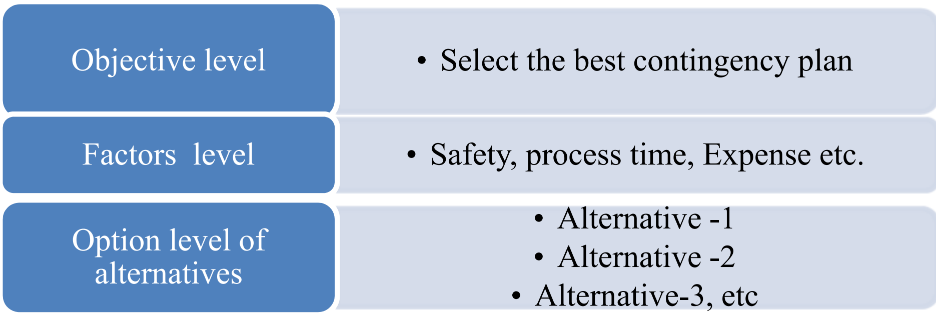
Formulating the reasoning problem in the form of the first step of a hierarchy structure. In a typical hierarchy, the top level shows the overall objective of the decision problem. The elements affecting judgment are the intermediate level. The decision option comprises the lowest level. Once the hierarchy is built, the decision makers systematically evaluate its various elements by comparing them to each other two at a time, with respect to their impact on an element above them in the hierarchy. In making the comparisons, the decision makers can use concrete data about the elements, but they typically use their judgments about the elements' relative meaning and importance. It is the essence of the AHP that human judgments, and not just the underlying information, can be used in performing the evaluations. When the comparison matrix have been prepared the process then the relative weights of the elements of each level with respect to an element in the adjacent of the upper level are calculated as the elements are normalized eigenvector connected with the largest Eigenvalue of the comparison matrix. Following a path at the lowest level of each alternative from the top of a hierarchy, and weights along each segment can be multiplied of the path do this.

2.2. Developing priorities and synthesizing hierarchy

Priorities are developed from judgment are synthesized down the hierarchy by the method of weighting and assemble to go from local priorities executed from multiplication by the priority of the criterion and overall priorities derived by assembling the global priorities of the same element. The consistency of AHP is known as consistency ratio (CR).This consistency ratio reflects that the consistency of the pairwise judgments.

Table 1. The AHP Scale (Satty, 1980)

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one activity over another
5	Strong importance	Experience and judgment slightly favor one activity over another
7	Very strong on demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
2,4,6,8	For compromise between the above values	Sometimes one needs to interpolate a compromise judgment numerically because there is no good word to describe it.
Reciprocals 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	A comparison mandated by choosing the smaller element as the unit to estimate the larger one as a multiple of that unit.
Rationales	Ratios arising from the scale	If consistency were to be forced by obtaining n numerical values to span the matrix



1.1-1.9	For tied activities	When elements are close and nearly indistinguishable; moderate is 1.3 and extreme are 1.9.

Figure 3. Typical AHP Tree

2.3. Calculation of priority vector and CR

Step-1: First we prepare standard matrix. The process of prepare standard matrix is, for any comparison matrix to add up the column and divide the each column value with column summation.

$$f(\lambda) = |A - \lambda I| = \begin{vmatrix} a_{11}-\lambda & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22}-\lambda & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n1} & a_{n1} & a_{nn}-\lambda \end{vmatrix} \qquad (1)$$

Equation (1) represents the formation of standard matrix.

Step-2: Then we calculated the average of the each row, this is known as priority vector. The eigenvectors of matrix A [from Equation (2)] are each column and non-zero vector Xi, for which the following equality occurs:

$$(\mathbf{A} - \lambda_i)X_i = 0 \qquad (2)$$

$$Aw = \lambda_{max} w \qquad (3)$$

Step-3: Then multiply the priority vector to the standard matrix and summation of all values of the column and take the average of this sum.

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n} \frac{(\mathbf{Aw})_i}{W_i} \qquad (4)$$

The maximum eigenvector λmax is calculated from equation (4). Here, n is the number of factors, w is the weight matrix.

Step-4: Then Consistency Index is calculated from the following formula

$$\text{Consistency Index (CI)} = (\lambda_{max}-1)/(n-1) \qquad (5)$$

Here in equation (5), n is the number of factors. CR=Consistency Index (CI) / Random Index (RI).

RI can be found from the table corresponding the value of n.

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	.58	.90	1.12	1.24	1.32	1.41	1.45	1.49

2.4. Case Study Using AHP Framework: Rana Plaza Collapse in Bangladesh

The collapse of Rana Plaza was a structural failure that occurred on 24 April 2013, Wednesday in the Savar Upazila of Dhaka, Bangladesh, This is an eight-story commercial building. The search for the dead ended on 13 May 2013 with a death total of 1,129. Approximately 2,500 injured people were rescued from the building alive direct causes for the building problems were:

- Building was built without authorization on a pond,
- Conversion from commercial use to industrial use,
- Addition of 4 floors above the original permit
- The use of low-quality construction material (which led to an overload of the building structure increased by vibrations due to the generators).

3. Results

Rana plaza is a horrific name for the Bangladeshi people for it cruelty in 2011. What is actually responsible for these thousands people deaths is trying to find out in this study. For finding the factor AHP analysis is conducted showing in Table 2 and Table 3 below.

Alternatives:

Alternative 1. Change the foundation system.

Alternative 2. Redesigning.

Alternative 3. Change the source of material procurement.

Criteria Level/ factors:

I. Safety

• User's safety.

• Workmen safety.

• Neighboring structures safety

II. Expenses

• Materials

• Workmanship

• Hazard

III. Process Time

• Redesigning time.

• Execution time.

• Time for material procurement

Table 2. AHP Model for Rana Plaza

Factors	**Safety**	**Expense**	**Process Time**	**Priority**
Safety	1	3	3	0.60
Expense	1/3	1	1	0.20
Process Time	1/3	1	1	0.20
Sum	1.67	5.00	5.00	1.00
			CR=	0
Safety	Users	Workman	Neighboring	Priority
Users	1	5	3	0.69
Workman	1/5	1	0.333	0.08
Neighboring	1/3	3	1	0.23
Sum	1.53	9.00	4.33	1.00
			CR=	0.033
Expense	Materials	Workman	Hazard	Priority
Materials	1	5	3	0.69
Workman	1/5	1	0.333	0.08
Hazard	1/3	3	1	0.23
Sum	1.53	9.00	4.33	1.00
			CR=	0.033

Process Time	Redesigning	Execution	Procurement	Priority
Redesigning	1	7	3	0.71
Execution	1/7	1	0.2	0.05
Procurement.	1/3	5	1	0.24
Sum	1.48	13.00	4.20	1.00
			CR=	0.056
Users Safety	A1	A2	A3	Priority
A1	1	6	4	0.76

A2	1/6	1	0.25	0.05
A3	1/4	4	1	0.19
Sum	1.42	11.00	5.25	1.00
			CR=	0.095
Workmen Safety	A1	A2	A3	Priority
A1	1	3	5	0.56
A2	1/3	1	3	0.33
A3	1/5	0.33	1	0.11
Sum	1.53	4.33	9.00	1.00
			CR=	0.033
Neighboring Safety	A1	A2	A3	Priority
A1	1	4	4	0.67
A2	1/4	1	1	0.17
A3	1/4	1	1	0.17
Sum	1.50	6.00	6.00	1.00
			CR=	0.000
Workman Expense	A1	A2	A3	Priority
A1	1	4	7	0.64
A2	1/4	1	3	0.27
A3	1/7	0.33	1	0.09
Sum	1.39	5.33	11.00	1.00
			CR=	0.028
Material Expense	A1	A2	A3	Priority
A1	1	3	7	0.64
A2	1/3	1	3	0.27
A3	1/7	0	1	0.09
Sum	1.48	4.33	11.00	1.00

			CR=	0.006
Hazardous Expense	A1	A2	A3	Priority
A1	1	4	6	0.55
A2	1/4	1	4	0.36
A3	1/6	0.25	1	0.09
Sum	1.42	5.25	11.00	1.00
			CR=	0.095

Redesigning Time	A1	A2	A3	Priority
A1	1	7	5	0.79
A2	1/7	1	0.33	0.05
A3	1/5	3	1	0.16
Sum	1.34	11.03	6.33	1.00
			CR=	0.058
Procurement Time	A1	A2	A3	Priority
A1	1	7	3	0.69
A2	1/7	1	0.33	0.08
A3	1/3	3	1	0.23
Sum	1.48	11.03	4.33	1.00
			CR=	0.007
Execution Time	A1	A2	A3	Priority
A1	1	1	3	0.43
A2	1	1	3	0.43
A3	1/3	0	1	0.14
Sum	2.33	2.33	7.00	1.00
			CR=	0.000

Table 3. Choosing the best alternative using AHP

			Likelihood	Alternative 1	Alternative 2	Alternative 1

Factors	1	Sub Factors	LP	GP	LP1	GP1	LP2	GP2		GP3
Safety	0.6	Users	0.69	0.414	0.76	0.315	0.05	0.021	0.19	0.079
		Workman	0.08	0.048	0.56	0.027	0.33	0.016	0.11	0.005
		Neighboring Structure	0.23	0.138	0.67	0.093	0.17	0.024	0.17	0.024
Expense	0.2	Material	0.69	0.138	0.64	0.088	0.27	0.037	0.09	0.012
		Workmanship	0.08	0.016	0.64	0.010	0.27	0.004	0.09	0.001
		Hazard	0.23	0.046	0.55	0.025	0.36	0.017	0.09	0.004
Process Time	0.2	Redesigning	0.71	0.142	0.79	0.112	0.05	0.007	0.16	0.023
		Execution	0.05	0.010	0.43	0.004	0.43	0.004	0.14	0.001
		Procurement	0.24	0.048	0.69	0.033	0.08	0.004	0.23	0.011
Overall Priority of the Alternative						0.71		0.13		0.16

Through the AHP analysis alternative 1 is the best the suited, Change the foundation system is the response to the building collapse.

4. Conclusion

A successful risk management requires to identify and manages risk in a project. The most common problem in a construction project such as delays in completing the project, low level of materials quality, over budget, environmental hazard and so on needs to be removed as far as possible. The only way to accomplish this is by managing risk throughout the production of a project.

The decision-making procedure described in this paper, analytical hierarchy process (AHP) is about breaking the problem down and then accumulating the solutions of all the sub problems into a conclusion. It simplifies decision making by organizing felling, decision, and memories into a framework that indicator the forces that influence a decision. In the easy and maximum common case, the forces are arranged from the more general and less controllable to the more specific and controllable.

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