International Journal of Engineering Research
Volume No.5, Issue Special 1 pp : 274-276

ISSN:2319-6890(online),2347-5013(print)
8 & 9 Jan 2016

Risk Analysis of Construction Projects using Fuzzy Logic

Katti Rhushikesh Siddhappa, B. A. Konnur, Amarsinh B. Landage
Department of Civil Engineering, Government College of Engineering, Karad
Email: rhushi42@gmail.com, bakonnur@gmail.com, amarlandage@yahoo.co.in

Abstract:This paper reports the methodology to solve risk analysis problems related to Construction industry with the purpose of determining the project's attractiveness. The literature presented in this paper is related with use of fuzzy logic risk analysis of construction projects. This logic is perfect to deal with the uncertainty risk plays in a projects development. This methodology provides a quick and efficient tool for project managers in their use of project evaluation, by allowing the project manager to scrap useless projects without putting the least amount of effort into an analysis. This methodology can also be generalized and therefore have the capability of being used in the project evaluation in many different kinds of industries not only the construction industry.
Keywords: Fuzzy Logic, Fuzzy Risk Analysis, Project Attractiveness, Project Evaluation

I. Introduction

The phenomenon of risk is a subject of investigation for many both practitioners and theorists. However, only a few of them take these problems and try to formulate the problem within the framework of a procedure. PMBOK Guide defines risk as a measure of the probability and consequence of not achieving a defined project goal. Compared with many other industries Construction industry deals with most of the uncertainty due to its unique features for each project. Risk analysis can be conducted by using the theory of probability which estimates the likelihood and consequence of any given risk. Due to some unknown and vague factors which affects project, probability theory cannot deal with important aspects of project uncertainty and cannot explain some important aspects of observed project management practice. . Risk has two primary components for a given event:

- A probability of occurrence of that event
- Impact (consequence) of the event occurring

Consequently the risk for each event can be defined as a function of probability and consequence (impact); that is: (PMBOK Guide) Probability theory cannot deal with important aspects of project uncertainty and cannot explain some important aspects of observed project management practice. The ability of a fuzzy system to explain its reasoning process is shown to have definite applicability within the field of risk analysis. Also fuzzy set theory (FST) is highly subjective and related to inexact and vague information which we deal in construction projects. As per classification aspect Shen (1997) identified eight major risks accounting for project delay and ranked them based on a questionnaire survey with industry practitioners. Abdou (1996) classified construction risks into three groups, i.e. construction finance, construction time and construction design.

II. Methodology

Construction of Fuzzy Risk Analysis Model

The method for fuzzy risk analysis model consists of five stages (E.W.T Ngai, F.K.T Wat, 2005) as:

1. Risk classification
2. Natural language representation
3. Fuzzy assessment aggregation
4. Fuzzy weighted average computation
5. Linguistic approximation

- Risk classification

The first step is to conduct risk identification and compile a list of the most significant uncertainty factors and their descriptions. As mentioned earlier, in this study we use Hierarchical Risk Breakdown Structure (HRBS*)* based on Tah *et al*. (1993) approach.

In HRBS the project risks are categorized to internal and external risks. External risks are those which are relatively uncontrollable and due to their nature there is a need for continual scanning and forecasting of these risks as like as economic risks, political risks, etc. internal risks are relatively more controllable and vary between projects. Internal risks are divided to local and global risks. The hierarchical risk breakdown structure is shown in figure 1.

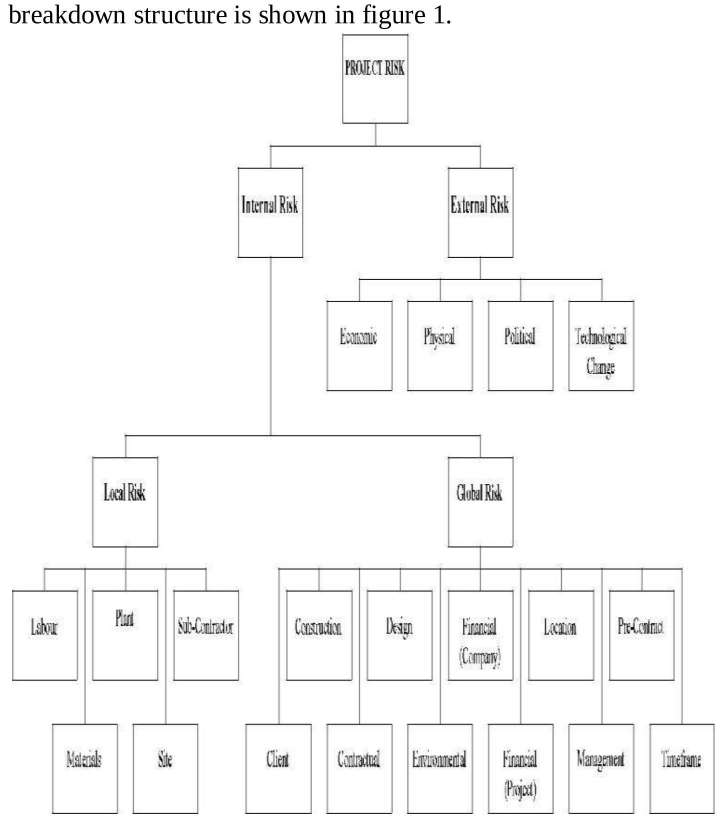

Figure 1 Hierarchical Risk Breakdown Structure (HRBS)

2. Natural language representation

The risk assessment process requires an assessment of the probability or likelihood of the risk and impact. The assessment of the level of risk is a complex subject shrouded in uncertainty and vagueness. Risk severity should be considered in terms that are as close as possible to the corporate objectives at the time of assessment. A simple approach that is advocated by some risk experts is to multiply the severity of the consequence by the likelihood of their occurrence, as the likelihood of the occurrence automatically includes the exposure (A.Waring, A.I. Glendon, 1998). Consequently the key attributes of risks and risk factors are likelihood and severity (J.H.M Tah and V.Carr, 2000). Table 1 shows a customizable standard terms for quantifying likelihood and table 2 shows a customizable standard term for severity quantification. In Fuzzy Weighted Average (FWA) we can assign

'likelihood" as the rating factor (*Ri*) and "severity" as the weighting factor (*W i*) that corresponds to the rating factor.

Table 1: Customizable standard terms for quantifying likelihood

Likelihood	Description
Very very likely	Expected to occur with absolute certainty
Very likely	Expected to occur
Likely	Very likely to occur
Medium	Likely to occur
Unlikely	Unlikely to occur
Very unlikely	Very unlikely to occur
Very very unlikely	Almost no possibility of occuring

Table 2: Customizable standard terms for severity quantification

Severity	Time	Cost	Quality	Safety
Critical	>20% above target	>20% above target	Very poor	Injury
High	10%<target<20%	10%<target<20%	Poor	Safety hazard
Moderate	5%<target<10 %	5%<target<10 %	Average	Average
Low	1%<target<5 %	1%<target<5 %	Above average	Above average
Minimal	1%<target	1%<target	OK	OK

3. Membership Functions

The difference between traditional set and fuzzy set theory lies in the degree of membership which elements may possess in a set. Traditional set theory dictates that an element is either a member of a set or it is not; its membership values are defined as 1 or 0.

In fuzzy set theory this membership value can take any real value from 0 to 1 and this value defines the degree of membership of a given set.

A membership function is a curve that defines how each point in the input space is mapped to a membership value (or degree of membership) between 0 and 1. The only condition a membership function must really satisfy is that it must very between 0 and 1. There are so many membership functions which can e used. Some of them are Triangular, Trapezoidal, Gaussian, Generalized Bell, Z Curves, etc.

In this study, the membership functions of the linguistic terms are characterized by Triangular fuzzy numbers. Triangular fuzzy numbers are very often use in applications such as fuzzy controllers, managerial decision making, business and finance, social science, etc. (G.Bojadziev, M.Bojadziev, 1997).

4. Fuzzy Assessment Aggregation

Expert judgment techniques have the potential for bias in risk identification and risk analysis, as well as in selecting risk response strategies. These biases vary on a case-by-case basis and can affect the probability of occurrence and consequence of occurrence estimates differently. Cognitive factors that can introduce a bias and/or noise term include, but are not limited to:

- Adjustments from an initial value
- Anchoring (biased toward the initial value)
- Availability of post events
- Fit ambiguous evidence into predispositions
- Insensitivity to the problem or risk
- Motivation
- Overconfidence in the reliability of the analysis
- Overconfidence in one`s ability

5.Fuzzy Weighted Average Computation; EFWA Algorithm

After computing the likelihood and severity of each risk,Fuzzy Weighted Average can be Computed through EFWA Algorithm.

6.Linguistic Approximation

The objective of this part is to find an appropriate natural language expression for the estimated fuzzy set. There are basically three techniques: Euclidean distance; Successive approximation; and Piecewise decomposition.

III. Conclusion

Construction projects take place in a complex and challenging environment. High levels of risk are associated with this industry. A reliable way to analyze the associated risks is vital to make success. In this research it is tried to propose a fuzzy risk analysis for construction projects. Although the computations involved in the model of the fuzzy risk analysis are tedious if performed manually, it is an easy task and the time for risk analysis can be significantly reduced. Construction project managers can predict the overall risk of the project before start the implementation. An overall risk index can be used as early indicators of project problems or potential difficulties. The proposed fuzzy risk analysis provides an effective, systematic and more natural way to analyze the associated risks. Evaluators can just simply use the risk evaluation checklist and use the linguistic terms to evaluate construction projects risk level. There are some limitations in this research. For example the membership functions were distributed by triangular fuzzy numbers. Various membership functions need to be estimated to be as realistic as possible.

Acknowledgement

We are thankful to Dept. of Civil Engineering Government College of Engineering Karad for their valuable guidance and necessary support to provide such platform for putting this work in this conference. Also would like to thankful to all these researchers for their valuable work in the field of Fuzzy Logic.

References

i. *Roozbeh Kangari, Leland S.Riggs, (1989),"Construction Risk Assessment by Linguistics", IEEE transactions on engineering management, 36(2), pp 126-131.*

ii. *T.J. Liou, M.J.J. Wang, (1992), "Fuzzy wighted average: an improved algorithm", Fuzzy sets and Systems, 49, pp 307-315*

iii. *D.H.Lee, D.Park, (1997), "An efficient algorithm for fuzzy weighted average", Fuzzy sets and Systems, 87, pp 39-45.*

iv. *A.Nieto-Morote, F. Ruz-Vila(2010), "Fuzzy approach to construction project risk assessment" International Journal of Project Management,Volume 29,Issue 2,Page No.220-231*

v. *Abdelgawad M.A.(2010) "Risk Management in the Construction Industry using Combined FMEA and Fuzzy AHP" ASCE Journal of Construction Engineering and Management, Vol No. 136, Issue 9, Page No. 1028-1036.*

vi. *Pejman Rezakhani(2011) "Fuzzy Risk Analysis Model for Construction Projects",international Journal of Civil and Structural Engineering. Volume* 2 *Issue* 2, Page No.79-94

vii. *Olubukola Tokede and Sam Wamuziri(2012) "Perceptions Of Fuzzy Set Theory In Construction Risk Analysis"Journal of Construction Engineering and Management,Volume 4, Issue 1,Page No. 124-152.*

viii. *P. Rezakhani(2012) "Review of Fuzzy Risk Assessment Models For Construction Projects."Journal of Construction Engineering and Management,Volume 20, Issue 3 , Page No. 258-272.*

ix. *Sina Khanmohammadi and Javad Jassbi(2012) "A Fuzzy Approach for Risk Analysis with Application in Project Management"Journal of Intelligent and Robotic Systems, Volume 17, Issue 3, Page No. 42-62.*

x. *NABI IBADOV, JANUSZ KULEJEWSKI(2014) "The Assessment Of Construction Project Risks With The Use of Fuzzy Sets Theory" Technical Transactions Civil Engineering 1-B/2014,Page No. 176-182.*