RISK MANAGEMENT OF READY MIX CONCRETE PLANTS

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ABSRACT

Ready Mix Concrete (RMC) industry is rapidly growing in India. With the increase in infrastructure projects the use of concrete increases exponentially and so the RMC industry. All public and government projects are going for the use of RMC rather than traditional concrete manufacturing techniques. At present, nearly 6 million cubic meters RMC per month (72 million cubic meters per year) is produced by commercial plants in India. RMC industries are subjected to many risks like other industries. If risk and optimization in RMC plants are effectively managed then RMC industry will achieve higher profit margins. As per the ICI Journal August 2016 issue, improving the efficiency by 10% in concrete production at RMC could save approximately $350m (Rs.2400crores) per year. This paper proposes an overall improvement of RMC industry by effectively managing risks that arise in the plants with the help of Fuzzy Logic in MATLAB.

Keywords:Ready mix concrete, risk, risk management,Fuzzy Logic, MATLAB

I.INTRODUCTION

As per Indian Standard code of practice (IS 4926 - 2003) Ready Mixed Concrete (RMC) is defined as "concrete mixed in a stationary mixer in a central batching and mixing plant or in a truck-mixer and supplied in the fresh condition to the purchaser either at the site or into the purchaser's vehicles" (Indian Standard 4926:2003). According to ISO 31000-2009 "risk is the effect of uncertainty on objectives"(Indian Standard 31000:2009). Where the effect is a deviation from the expected result and objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product and process). Risk analysis generally can be carried out using qualitative or quantitative analysis depending on the information available and the level of detail required. Qualitative risk analysis develops prioritized lists of risks by assessing the impact and probability of occurrence of the identified risks for further analysis or direct mitigation. In quantitative risk analysis, to quantify the frequency of risks and the magnitude of their severity different techniques such as Monte Carlo simulation (MCS), decision tree analysis, fault tree analysis (FTA), Failure mode and effect analysis (FMEA) and fuzzy logic are used. In this paper, an attempt is made to identify risk using qualitative risk analysis and then to prioritized using fuzzy logic. This approach resolves some of the problems in traditional methods of evaluation.

II.LITERATURE REVIEW

Trivedi and Iyunni (2015) identified the major mode of failure in production of RMC of different grades (M20, M25 and M30) using FMEA technique. The risk priority number (RPN) indicated the important factor to be monitored for the quality control process. Azambuja and Chen (2014) had done management of risk of just-in-time supply chain using failure mode, effects and criticality analysis (FMECA) tool and simulation modeling approach. Interviews with RMC plant managers, current demand, production, and delivery performance data served as input for analysis in his study. Prabhakaran and Babu (2014) found the most critical risk in RMC plants by developing a risk assessment model using FMEA technique. The risk prioritization was done using Analytical Network Process (ANP) with the help of Super decisions software for risk with equal value. Bowles and Pelaez (1995) gave a detailed introduction to fuzzy logic and used the severity, frequency of occurrence and detectability as membership function in the fuzzy tool, combined by matching them against rules in a rule base, evaluated with min-max inferencing, and then de-fuzzified to assess the riskiness of the failure.

III.METHODOLOGY OF WORK

In this paper, based on literature review and interviews with RMC experts, plant managers, transit mixer drivers, plant operators and quality control officers, risks that arise in RMC plants were identified. Total 56 risk factors relating to financial, environmental, operational, political, safety, quality, procurement, and storage aspects were identified. From the identified risk factors, 5 points Likert scale questionnaire was prepared for impact and probability of occurrence. The Impact was classified into 5 categories like very less, less, moderate, high, very high for ratings of 1, 2, 3, 4 and 5 respectively. Similarly, the probability of occurrence was classified into rare, unlikely, possible, likely, sure for ratings 0.1, 0.2, 0.3, 0.4 and 0.5 respectively. A total 40 respondents from 20 RMC plants in Pune rated this questionnaire based on their knowledge and experience.

Thereafter, impact and probability of occurrence of every risk factor are multiplied to get RPN. A risk matrix as shown in figure.1 was made for impact vs. probability of occurrence. Based on RPN value the risk factors are classified into four categories:- 1) low impact and low probability of occurrence, 2) low impact and high probability of occurrence, 3) high impact and low probability of occurrence and 4) high impact and high probability of occurrence. The factors like traffic problems, equipment breakdown, and breakdown of transit mixer, no periodical check-up of plant and machinery and delay during transportation have the high impact and high probability of occurrence. So, these factors should be attended properly to avoid risk and achieve higher profit margins. Solutions to plants were also suggested to either avoid or mitigate the risk factors.

The Risk is classified into five categories in the fuzzy tool, according to impact and probability of occurrence of the risk factor as shown in Table1. Impact and probability ofoccurrence are converted to membership set with trapezoidal distributions and risk with triangulardistribution as shown in Fig 2, 3 & 4.

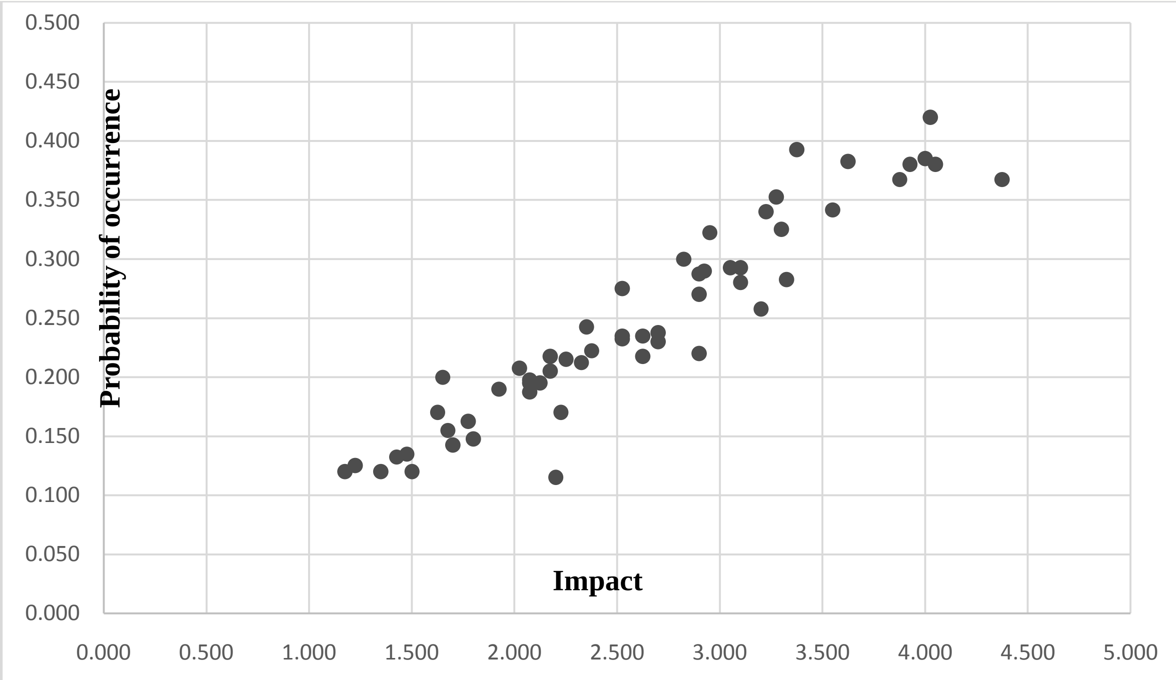

Figure 1: Risk matrix

Table 1 Classification of Risk

Classification of risk	Rating	Probability of occurrence and impact values
Minor	0.100	probability of occurrence=0.00 to 0.100 ; impact= 0.000 to 1.000
Low	0.400	probability of occurrence=0.100 to 0.200; impact= 1.000 to 2.000
Moderate	0.900	probability of occurrence=0.200 to 0.300; impact= 2.000 to 3.000
Important	1.600	probability of occurrence=0.300 to 0.400; impact= 3.000 to 4.000
Very important	2.500	probability of occurrence=0.400 to 0.500; impact=4.000 to 5.000

After assigning membership functionto input and output variables,the resulting fuzzy inputs are evaluated using a linguistic rule base and fuzzy logic operations to yield a classification of the 'riskiness' of the failure. Rules for impact, the probability of occurrence and risk is shown in Table 2. After rules are assigned to membership function, the fuzzy outputs are de-fuzzified. The formula to calculate the crisp value of output is given as follows:

Value of Output Component=∑ (Input Degree of membership * Output Set value)

The Surface graph in Figure 5 proves that the membership function and rules assigned to input and output variables are accurate.

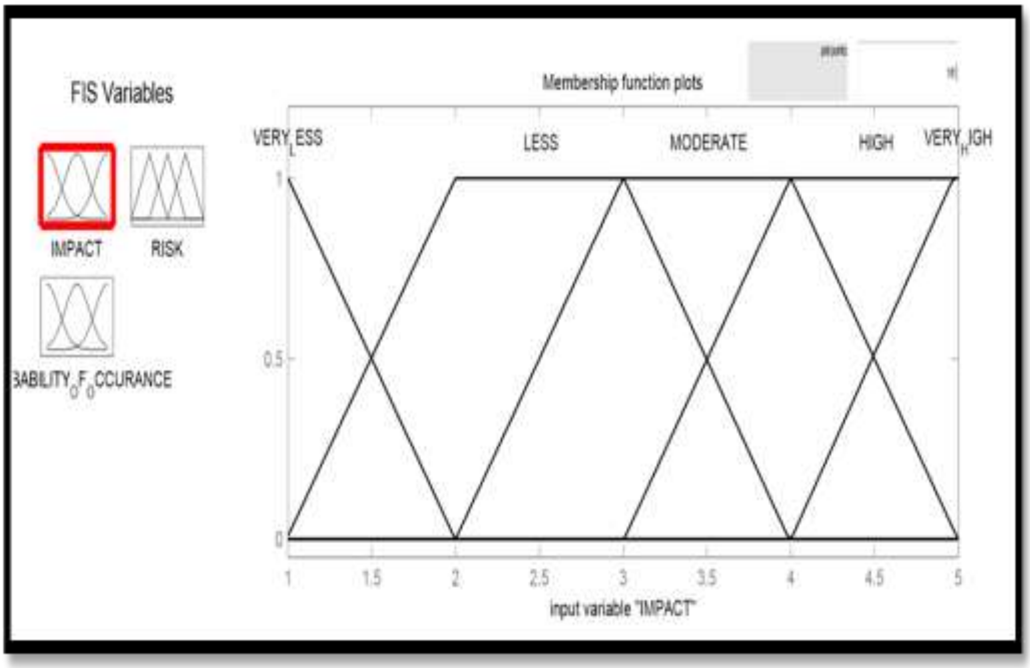

Figure 2:- Membership function for impact in MATLAB

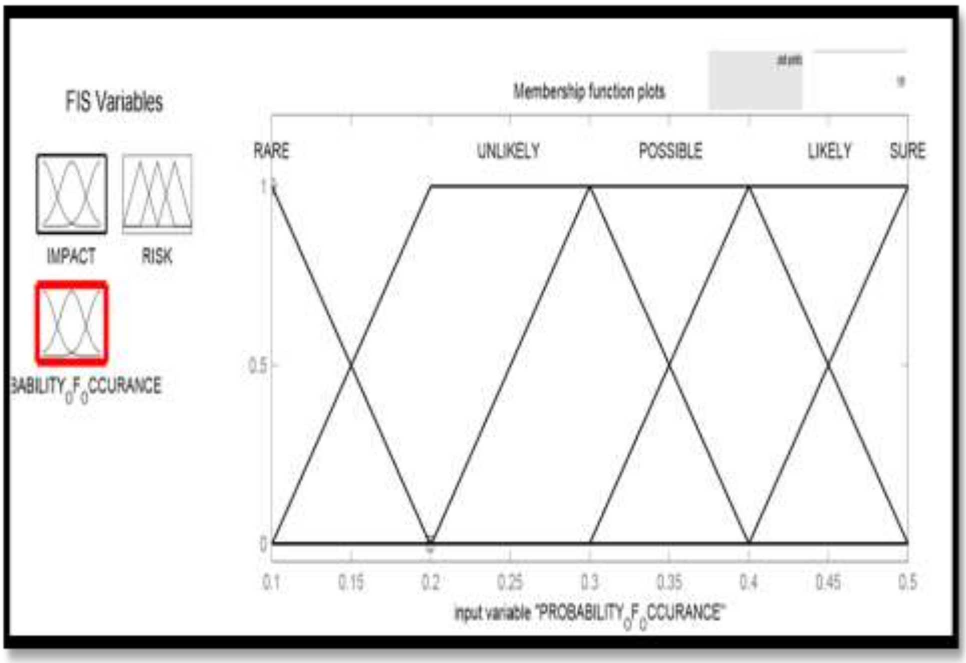

Figure 3:- Membership function for probability of occurrence in MATLAB

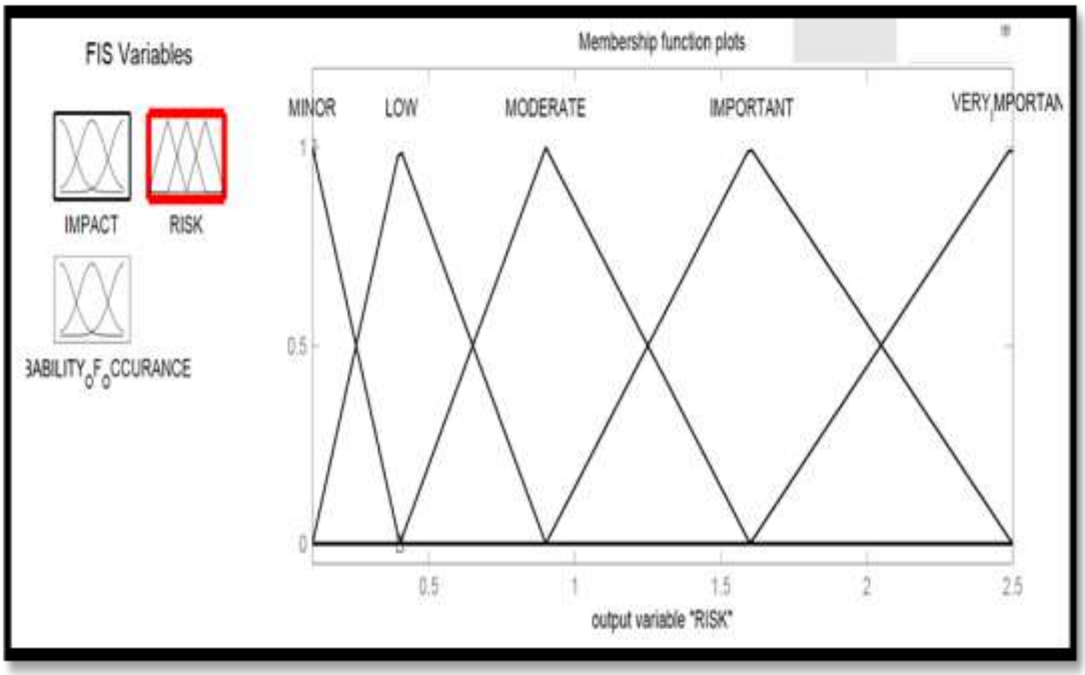

Figure 4:- Membership function for risk in MATLAB

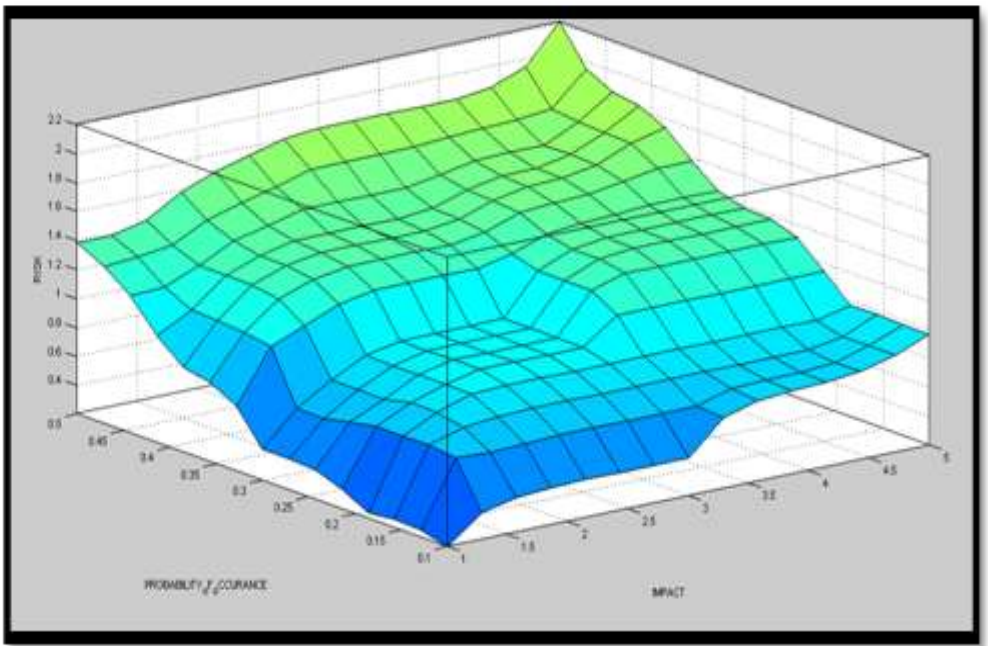

Figure 5:- Surface graph for impact, probability of occurrence and risk in MATLAB

Table 2 Rules for impact, probability of occurrence and risk

Sr no.	Impact	Probability of occurrence	Risk
1	Very less	Rare	Minor
2		Unlikely	Minor
3		Probable	Low
4		Likely	Low
5		Sure	Moderate
6	Less	Rare	Minor
7		Unlikely	Low
8		Probable	Low
9		Likely	Moderate
10		Sure	Moderate
11	Moderate	Rare	Low
12		Unlikely	Low
13		Probable	Moderate
14		Likely	Important
15		Sure	Important
16	High	Rare	Low
17		Unlikely	Moderate
18		Probable	Important
19		Likely	Important
20		Sure	Very important
21	Very high	Rare	Low
22		Unlikely	Moderate
23		Probable	Important
24		Likely	Very important
25		Sure	Very important

IV. CONCLUSION

In this study, a successful attempt is made to combine qualitative analysis of risk and the fuzzy logic tool to identify the risk factors that arise in RMC plants and to prioritize the identified risk. From the RPN the most critical risk that affects the RMC plant production, quality and profit is the traffic problem. The quality of RMC material gets affected due to traffic congestions. Sometimes the concrete gets hardened within mixer itself which leads to the huge loss for RMC owner. Thus, it is the most critical risk. This risk can be avoided or mitigated. Following solutions were suggested to RMC plants in Pune to avoid risk arising due to road traffic: -

1) delivering concrete at night time or early morning time when traffic is less, 2) using GPS and maps to choose the less traffic route, 3) proper training to transit mixer driver to take steps when there is failure to deliver concrete within 120 minutes, 4) checking of transit mixer before loading with concrete.

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