iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** III **Month of publication:** March 2018

DOI: http://doi.org/10.22214/ijraset.2018.3132

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

Investigation of Severe risk by a Combined Fuzzy AHP and TOPSIS Approach – A Case Study

Subash Kumar Jaladhi[1], T.N.V Ashok Kumar[2], K. Bhargav[3], K. Daniel[4]
[1, 2, 3, 4,] Assistant Professor, Sasi Institute of Technology & Engineering, Tadepalligudem, Andhra Pradesh, India

Abstract: Every manufacturing industry must be giving more importance for safety. It is very impertinent to identify the most risk problems to take necessary action for safety. By knowing its risks severity, then they can make smart decisions about how to manage risk. In this work a combined Fuzzy AHP-TOPSIS approach is proposed to analysing of severity in risk, it is very useful tool in decision making criterion. This analysis discussed, a risk priority number (RPN) can find for each risk and failure modes, by three risk factors: severity (S), occurrence (O), and detect ability (D) are evaluated. In this paper a combined Fuzzy AHP – TOPSIS is used to find severity of risk for the equipment of MMSM department in steel making shop and suggested corrective actions for De-Scalar area, Oil cellars and Crane operations.

Keywords: Fuzzy AHP, Detect ability, Occurrence, Risk, Severity, TOPSIS

I. INTRODUCTION

This study was conducted for finding the severity of risk criteria constitute a reference for the evaluation of the need for risk measures and shall therefore be available prior to starting the risk analysis at Visakhapatnam Steel Plant, Visakhapatnam, and Andhra Pradesh. This report presents the findings from the hazard and operability to risk acceptance criteria study performed for some of the process units of Medium Merchant & Structural Mill. The study was conducted in Visakhapatnam Steel Plant, with help of operations representatives. Those are well experienced with the operations of the process. The purpose of this study is to identify possible risk problems or concerns. Once the potential risk and operability issues are identified, the severity of the consequences is determined and existing safeguards to prevent or mitigate the scenario are discussed. The scope of this study covered:

Charging Grids To De-Scalar Area – Heating of blooms to 1200˚C

Oil cellars – To supply hydraulic oil, lubrication to the system by Pumping, Collection, and Storage.

Crane Operation – Material Handling.

A. Process description

The Medium Merchant & Structural Mill is a single strand fully continuous mill having an annual capacity of 850,000 T of medium merchant, structural products and the universal beams both wide and parallel flange are rolled for the first time in India using four roll universal stands.

The MMSM products are mainly angles and channels constituting 75% of total tonnage. Rounds, squares, flats and T bars constitute about 8% and remaining 17% being universal beams both wide and narrow flange beams. The mills is also capable of rolling 80mm T-bars, equal angels 120mm and 130mm, Taper flange beams 116mm x 100mm, 125mm x 70mm and 150mm x 75mm and universal channels of 100mm to 180mm.

B. Sampling Equipment

Sampling equipment is located in front of right hand side cooling bed. A sample is separated from the end of the selected rolled product with the help of pendulum cut-off saw. It is cooled in water or air and checked.

C. Risk

The risk concept understands from the definition that risk aversion (i.e. where risk acceptance is concerned, in an evaluation of risk which places more importance on certain accidental consequences.) shall not be included in the expression of risk. Risk may be expressed qualitatively as well as quantitatively. Risk aversion in relation to assessment of risk and its tolerability is too admissible to consider on a certain qualitative basis.

©IJRASET (UGC Approved Journal): All Rights are Reserved

D. Safety objective

The safety objectives shall as far as possible be expressed in a way which allows verification of fulfillment through an evaluation. Long and short term safety objectives form the basis for further development of the safety level and the tightening of the risk acceptance criteria as an element of the management and also continuous improvement process.

E. Fuzzy –AHP

Saaty, 1980 is first proposed an Analytic Hierarchy Process for decision-making process in business management, it is a useful and flexible in decision-making process to managers and the they can set priorities and make a best decision for both qualitative and quantitative aspects of a decision needed problems.

Triangular fuzzy number is shown in Fig. 2.1. A triangular fuzzy number is denoted simply TFN and it is a set of l, m, n or set of m1, m2, m3. The parameters l, m and n respectively denote the smallest possible value, the most promising, and the largest possible value that describe a fuzzy event.

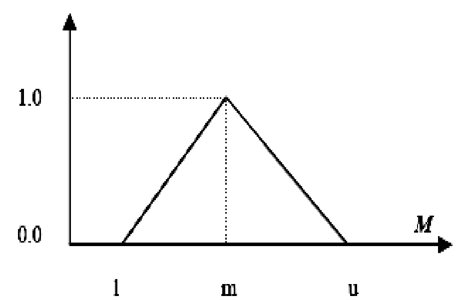


Fig. (2.1): A triangular fuzzy number

Either directly assigning or indirectly assigning pair-wise comparisons can be used find weight vector of risk factors. Here, it is suggested that the decision makers use the linguistic variables in Table 2.1 to evaluate the weight vector risk factors.

Table (1.1): Fuzzy evaluation scores for the weight vector

Linguistic terms	Fuzzy score
Absolutely strong (AS)	(2, 5/2, 3)
Very strong (VS)	(3/2, 2, 5/2)
Fairly strong (FS)	(1, 3/2, 2)
Slightly strong (SS)	(1, 1, 3/2)
Equal (E)	(1, 1, 1)
Slightly weak (SW)	(2/3, 1, 1)
Fairly weak (FW)	(1/2, 2/3, 1)
Very weak (VW)	(2/5, 1/2, 2/3)
Absolutely weak (AW)	(1/3, 2/5, 1/2)

II. FUZZY-AHP PROCESS

A. Step 1: The value of fuzzy synthetic extent with respect to the i^{th} object is defined as:

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]^{-1} \quad \ldots (2.1)$$

To obtain $\sum_{j=1}^{m} (M_{gi}^{j})$ perform the fuzzy addition operation of m extent analysis values for a particular matrix such that:

©IJRASET (UGC Approved Journal): All Rights are Reserved

$$\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j\right) \quad \dots (2.2)$$

And to obtain $\left(\sum_{i=1}^{n}\sum_{j=1}^{m}(M_{gi}^{j})\right)$ the fuzzy addition operation (j = 1, 2 . . . m) values are performed such as:

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i\right) \quad \dots (2.3)$$

And then the inverse of the above vector is computed in such as:

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right) \quad (2.4)$$

B. Step 2: As M1 and M2 are two triangular fuzzy numbers, the degree of possibility of$M_2 \le M_1$ is defined as:

$$V\left(\tilde{M}_2 \ge \tilde{M}_1\right) = hgt(\tilde{M}_1 \cap \tilde{M}_2) = \mu_{M_2}(d)$$

$$= \begin{cases} 1, & if \quad m_2 \ge m_1 \\ 0, & if \quad l_1 \ge u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & otherwise \end{cases} \quad \dots (2.5)$$

There are various operations on triangular fuzzy numbers. But here, three important operations used in this study are illustrated. If we define, two positive triangular fuzzy numbers (l1, m1, u1) and (l2, m2, u2) then:

$$(l_1, m_1, u_1) + (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2)$$

$$(l_1, m_1, u_1) \times (l_2, m_2, u_2) = (l_1 \times l_2, m_1 \times m_2, u_1 \times u_2)$$

$$(l_1, m_1, u_1)^{-1} = (1/u_1, 1/m_1, 1/l_1)$$

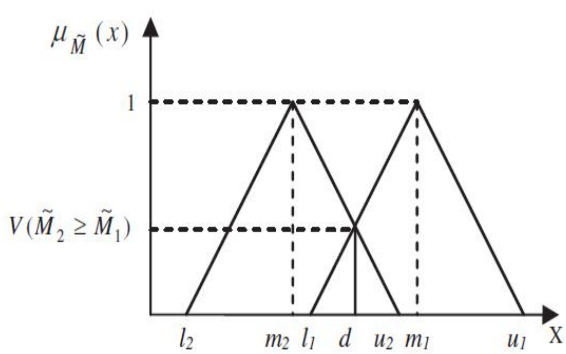


Fig. (2): The intersection between M1 and M2

Figure 3.2 illustrates Eq. (2.5) where d is the ordinate of the highest intersection point‘d’ between M1 and M2. To compare M1 and M2, we need both the values of

$$V(M_1 \ge M_2) \text{ and } V(M_2 \ge M_1)$$

©IJRASET (UGC Approved Journal): All Rights are Reserved

C. Step 3: The degree of possibility for a convex fuzzy number to be greater than k convex fuzzy numbers Mi can be defined by:

$$V(\tilde{M} \geqslant \tilde{M}_1, \tilde{M}_2, \ldots, \tilde{M}_k) = \min V(\tilde{M} \geqslant \tilde{M}_i),$$

where $i = 1, \ldots, k$.
Assume that

$$d'(A_i) = \min V(\tilde{S}_i \geqslant \tilde{S}_k).$$

For $k = 1, 2, \ldots; k \neq i$. Then the weight vector is given by

$$W' = (d'(A_1), d'(A_2), \ldots, d'(A_n))^T \quad \ldots (2.9)$$

where $A_i = (i = 1,2,\ldots n)$ are n elements.

D. Step 4: Via normalization, the normalized weight vectors are

$$W = (d(A_1), d(A_2), \ldots\ldots, d(A_n))^T \quad \ldots (2.10)$$

Where W is a non-fuzzy number.

III. TOPSIS PROCESS

The chosen Alternative should have the shortest distance from the ideal solution and the farthest from the negative-ideal solution. Each Attribute in the Decision Matrix takes either monotonically increasing or monotonically decreasing utility. Any Outcome which is expressed in a non-numerical way should be quantified through the appropriate scaling technique.

It is suggested that the decision makers use linguistic variables to evaluate the ratings of alternatives with respect to criteria. Table 2.2 gives the linguistic scale for evaluation of the alternatives. Assuming that a decision group has K people, the ratings of alternatives with respect to each criterion can be calculated as

$$\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij}).$$

Table (2.2): Fuzzy evaluation scores for alternatives:

Linguistic terms	Fuzzy score
Very poor (VP)	(0, 0, 1)
Poor (P)	(0, 1, 3)
Medium poor (MP)	(1, 3, 5)
Fair (F)	(3, 5, 7)
Medium good (MG)	(5, 7, 9)
Good (G)	(7, 9, 10)
Very good (VG)	(9, 10, 10)

Obtaining weights of the criteria and fuzzy ratings of alternatives with respect to each criterion, the fuzzy multi-criteria decision-making problem can be expressed in matrix format as:

$$D = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \vdots & \vdots & \cdots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix}, \quad \ldots (2.11)$$

$$W = [w_1, w_2, \ldots, W_n], j = 1, 2, \ldots, n, \quad \ldots (2.12)$$

Where x_{ij} is the rating of the alternative Ai with respect to criterion j (i.e. C_j) and w_j denotes the importance weight of C_j. These linguistic variables can be described by triangular fuzzy numbers: $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$.

1) Step (1): To avoid the complicated normalization formula used in classical TOPSIS, the linear scale transformation is used here to transform the various criteria scales into a comparable scale. Therefore, we can obtain the normalized fuzzy decision matrix denoted by 'r'. Decision matrix is normalized via Eq. (2.11):

$$r_{ij} = \frac{w_{ij}}{\sqrt{\sum_{j=1}^{J} w_{ij}^2}} \qquad j = 1,2,3,\dots,J \quad i = 1,2,3,\dots,n \qquad \dots (3.13)$$

2) Step (2): Calculate the weighted normalized decision matrix by multiplying the normalized decision matrix by its associated weights. The weighted normalized value (V_{ij}) is calculated as:

$$V_{ij} = W_j \times r_{ij} \qquad \dots(3.14)$$

3) Step (3): Positive ideal solution (PIS) and negative ideal solution (NIS) are determined:

$$v^{+} = \{\text{MAXIMUM value of } (V_{ij}) \text{ for every column}\} \text{ where } i = 1, 2\dots7 \text{ and } j = 1, 2, 3$$

$$v^{-} = \{\text{MINIMUM value of } (V_{ij}) \text{ for every column}\} \text{ where } i = 1, 2\dots7 \text{ and } j = 1, 2, 3$$

4) Step (4): Calculate the separation measures, using the m- dimensional Euclidean distance. The separation measure of each alternative from the PIS D_i^+ and NIS D_i^+ is given as:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2}, \quad i = 1,\dots,m \qquad \dots (2.15)$$

$$D_i^- = \sqrt{(V_{ij} - V_j^+)^2}, \quad i = 1, 2\dots, m \qquad \dots (2.16)$$

5) Step (5). Calculate the relative closeness to the idea solution and rank the alternative in descending order. The relative closeness of the alternative A_i with respect to PIS V^+ can be expressed as:

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-} \qquad \dots (3.17)$$

Obviously, an alternative Ai is closer to the (FPIS, A*) and farther from (FPIS & A*) as C_i approaches to 1. Therefore, according to the closeness coefficient, we can determine the ranking order of all alternatives and select the best one from among a set of feasible alternatives.

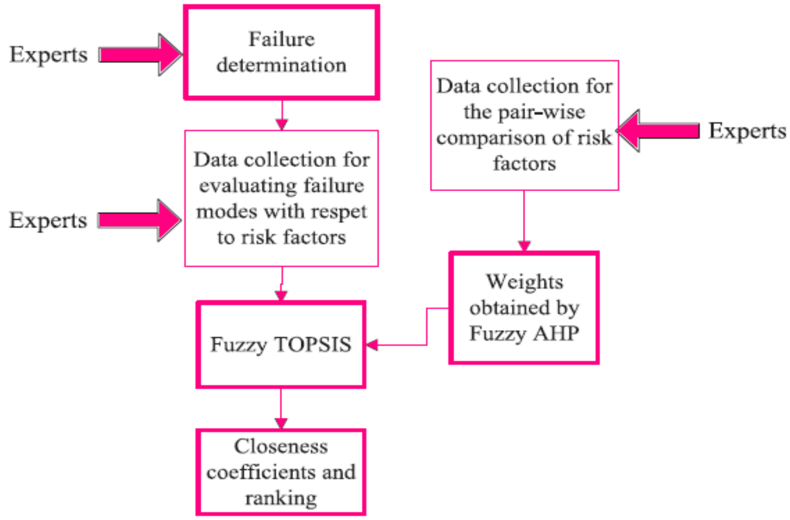
IV. PROPOSED METHODOLOGY

Fuzzy logic is the tool for transforming the vagueness of human feeling and recognition and its decision-making ability into a mathematical formula. It also provides meaningful representation of measurement for uncertainties and vague concepts expressed in natural language. So a fuzzy multi-criteria decision making methods is preferred instead of crisp decision making methods for overcoming the FMEA procedure. For determining the importance of failure modes a modified fuzzy approach proposed by Ekmekçioglu et al. (2010) is used in this section. Firstly, a group of decision-makers identifies the failure modes. Second, a pair-wise comparison matrix for risk factors is constructed, and Chang's fuzzy AHP is utilized to determine the weight vector of these risk factors. Later, experts' linguistic evaluations of each failure mode with respect to risk factors are aggregated to get a mean value. Then by using the linguistic scores of risk factors for each failure modes, fuzzy decision matrix is constructed for the implementation of TOPSIS. After that, by using the weight vector of risk factors and the fuzzy decision matrix weighted normalized fuzzy decision matrix is constructed. Subsequently, FPIS and FNIS and the distance of each failure mode from FPIS and FNIS are calculated, respectively. At last step of Chen's fuzzy TOPSIS closeness coefficients of processes are obtained. According to the closeness coefficients, the ranking order of all failure Modes are determined.

©IJRASET (UGC Approved Journal): All Rights are Reserved

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

To sum up the most important failure modes are determined through succeeding the following steps:



1) *Step 1):* A group of decision-makers identifies the failure modes
2) *Step 2):* Chang's fuzzy AHP approach is used to obtain the weights of the risk factors

Appropriate linguistic variables for risk factors of each failure mode are determined.

A pair-wise comparison matrix for severity, occurrence, and detectability is constructed, and experts' linguistic evaluations are aggregated to get a mean value for each pair-wise comparison.

Consistency of pair-wise comparison matrix for Severity (S), Occurrence (O), and Detect ability (D) is checked after the defuzzification of each value in the matrix according to graded mean integration approach.

3) *Step 3):* Chen's fuzzy TOPSIS is utilized to obtain the closeness coefficients of processes.

Experts' linguistic evaluations of each failure mode with respect to risk factors are aggregated to get a mean value.

Fuzzy decision matrix and the normalized fuzzy decision matrix are constructed for the implementation of TOPSIS.

Weighted normalized fuzzy decision matrix is constructed.

FPIS and FNIS are determined.

A. Case Study

The proposed methodology is applied to manufacturing facility of Medium merchant and structural mills (MMSM), Visakhapatnam steel plant industry. Major potential risk modes (PRMs) are identified by a group of experts in an operating process at the manufacturing facility as steel material. The purpose of this study is to identify possible risk problems or concerns. Once the potential risk and operability issues are identified, the severity of the consequences is determined and existing safeguards to prevent or mitigate the scenario are discussed. The scope of this study covered:

Charing Grids To De-Scalar Area – Heating of blooms to 1200˚C

Oil cellars – To supply hydraulic oil, lubrication to the system by Pumping, Collection, and Storage.

Crane Operation – Material Handling.

After the determination of the PFMs, by utilizing FAHP method, evaluations of three experts in linguistic variables are used to determine the importance of risk factors (S, O, and D) by pair-wise comparison as shown in Table (2.1). For instance, when comparing the risk factor severity and occurrence, the responses of three experts are fairly strong (FS), fairly strong (FS), and very strong (VS), respectively. As a result the weight vector for the risk factors is obtained as (0.2604, 0.3964, 0.3432) subsequently evaluations of the experts in linguistic variables for the risk factors with respect to each failure modes are obtained as expressed in Table (2.1).

The experts evaluated the potential failure mode non-conforming material as fair (F), fair (F), and medium poor (MP) respectively for severity (S), fair (F), medium good (MG), and medium good (MG) respectively for occurrence (O), and good (G), medium good (MG) and good (G) respectively for detection (D). In the next step, by using weight vector of the risk factors obtained through FAHP, and the fuzzy evaluations of each risk factor with respect to PFMs, fuzzy TOPSIS is utilized as illustrated in Table 2.2. The closeness coefficient values found in the method are used as scores. Finally, as shown in Table 6, the scores are ranked and results show that the most important failure mode is wrong process.

B. CASE-A: Charging Grids To De-Scalar Area – Heating Of Booms To 1200 ^{0}C:

In this case the probability of defined main safety functions being impaired (damaged) is calculated in order to ensure that the platform design does not imply unacceptably high risk, and to provide input to the definition of dimensioning accidental risk. This has often been done within the concept risk analysis.

The following factors causes to risk at Charging Grids to De-Scalar Area – Heating of blooms to 1200˚C:

1) A_1 – Closing of discharge valves
2) A_2 – Malfunctioning of damper
3) A_3 – Pipe line leak
4) A_4 – low air level
5) A_5 – Malfunctioning of valves
6) A_6 – no gas at the line
7) A_7 – Short supply

Table (4.1): Evaluations of experts in linguistic variables and weights of the risk factors:

	1	2	3	4
WEIGHTS	Severity (l_1, m_1, n_1)	Occurrence (l_2, m_2, n_2)	Detect ability (l_3, m_3, n_3)	W_j
Severity	(1, 1, 1)	(1, 1.5, 2)	(1, 1, 1.5)	0.2604
Occurrence	(0.5, 0.7, 1)	(1, 1, 1)	(1, 1, 1.5)	0.3964
Detect ability	(0.7, 1, 1)	(0.7, 1, 1)	(1, 1, 1)	0.3432

Table (4.2): Evaluations of experts in linguistic variables for risk factors with respect to each PFMs.

Weights →	S (0.2604)	O (0.3964)	D (0.3432)
A_1	(3, 5, 7)	(3, 5, 7)	(7, 9, 10)
A_2	(0, 1, 3)	(9, 10, 10)	(1, 3, 5)
A_3	(1, 3, 5)	(9, 10, 10)	(0, 0, 1)
A_4	(1, 3, 5)	(3, 5, 7)	(7, 9, 10)
A_5	(3, 5, 7)	(5, 7, 9)	(7, 9, 10)
A_6	(5, 7, 9)	(5, 7, 9)	(1, 3, 5)
A_7	(0, 1, 3)	(9, 10, 10)	(0, 0, 1)

©IJRASET (UGC Approved Journal): All Rights are Reserved

Table (4.3): Aggregated fuzzy score of table (4.2):

i ↓ / J →	S	O	D
A_1	5.964	5.964	7.953
A_2	1.988	9.941	2.982
A_3	3.976	9.941	2.485
A_4	3.976	5.964	6.959
A_5	5.964	7.953	7.953
A_6	7.953	7.953	5.964
A_7	1.988	9.941	1.491

Table (4.5): weighted normalized value matrix (V_{ij}):

V_{ij}	S	O	D
A_1	0.134	0.204	0.235
A_2	0.049	0.373	0.097
A_3	0.094	0.359	0.078
A_4	0.104	0.237	0.239
A_5	0.122	0.248	0.214
A_6	0.163	0.248	0.161
A_7	0.051	0.385	0.05

Table (4.6): distance measurement between two fuzzy numbers Positive ideal solution (PIS) and negative ideal solution (NIS):

Potential failure modes	PIS D_i^+	NIS D_i^-
A_1	0.183	0.204
A_2	0.182	0.175
A_3	0.177	0.163
A_4	0.159	0.200
A_5	0.145	0.185
A_6	0.158	0.165
A_7	0.22	0.181

Table (4.7): Ranking of failure modes:

Potential failure modes	A1	A_2	A_3	A_4	A_5	A_6	A_7
Scores	0.527	0.49	0.48	0.556	0.561	0.511	0.451

C. CASE–B: Oil cellars – To supply hydraulic oil, lubrication to the system by Pumping, Collection, and Storage:

In this case the probability of defined main safety functions being impaired (damaged) is calculated in order to ensure that the platform design does not imply unacceptably high risk, and to provide input to the definition of dimensioning accidental risk. This has often been done within the concept risk analysis.

The following factors causes to risk at Oil cellars – To supply hydraulic oil, lubrication to the system by Pumping, Collection, and Storage:

1) B_1 – Low ambient temperature
2) B_2 – Malfunctioning of pressure
3) B_3 – Error in manual filling
4) B_4 – Cooling system failure
5) B_5 – Wrong grade of oil
6) B_6 – Leakage in the system
7) B_7 – Leakage in oil cooling system

Table (4.8): Evaluations of experts in linguistic variables and weights of the risk factors:

	S	O	D	W
S	(1, 1, 1)	(1, 1.5, 2)	(1, 1, 1.5)	0.2465
O	(0.5, 0.7, 1)	(1, 1, 1)	(0.5, 0.7, 1)	0.4828
D	(0.7, 1, 1)	(1, 1.5, 2)	(1, 1, 1)	0.2706

Table (4.14): Ranking of failure modes:

Potential failure modes	B_1	B_2	B_3	B_4	B_5	B_6	B_7
Scores	0.418	0.612	0.59	0.418	0.389	0.57	0.611
Ranking	5	1	3	6	7	4	2

D. CASE-C: Crane Operation – Material Handling:

In this case the probability of defined main safety functions being impaired (damaged) is calculated in order to ensure that the platform design does not imply unacceptably high risk, and to provide input to the definition of dimensioning accidental risk. This has often been done within the concept risk analysis.

The following factors causes to risk at Crane Operation – Material Handling:

1) C_1 – Production demand
2) C_2 – No alarm system for heavy loads
3) C_3 – No supply from power grid
4) C_4 – Ageing of power contacts
5) C_5 – Over greasing of rails
6) C_6 – Electronic cards

7) C_7 – Overload

Table (4.15): Evaluations of experts in linguistic variables and weights of the risk factors:

	1	2	3	4
	Severity (l_1, m_1, n_1)	Occurrence (l_2, m_2, n_2)	Detect ability (l_3, m_3, n_3)	W_j
Severity	(1, 1, 1)	(0.5, 0.67, 1)	(0.5, 0.67, 1)	0.483
Occurrence	(1, 1.5, 2)	(1, 1, 1)	(1, 1, 1.5)	0.246
Detect	(1, 1.5, 2)	(0.67, 1, 1)	(1, 1, 1)	0.271

Table (4.21): Ranking of failure modes

Potential failure modes	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Scores	0.641	0.523	0.695	0.57	0.608	0.727	0.254
Ranking	3	6	2	5	4	1	7

V. RESULTS AND DISCUSSIONS

In this chapter discussed about results of the case study is done for the equipment of MMSM department detail methodology and calculation is illustrated.

After computing the normalized priority weights for each possible risk problems or concerns of the fuzzy AHP hierarchy, the next step is to synthesize the solution following the TOPSIS method for the risk analysis problem. The normalized local priority weights of criteria obtained from the fuzzy calculations are normalized to obtain the global priority weights. After calculating the global weights, they are rearranged in the descending order of priority, as shown in Tables 6.1, 6.2, 6.3.

Table 6.1. Ranking of main criteria for Charging Grids to De-Scalar Area – Heating of blooms to 1200˚C.

RANK	RISK FUNCTION	C_i
1	A_5 – Malfunctioning of valves	0.561
2	A_4 – low air level	0.556
3	A_1 – Closing of discharge valves	0.527
4	A_6 – no gas at the line	0.511
5	A_2 – Malfunctioning of damper	0.49
6	A_3 – Pipe line leak	0.48
7	A_7 – Short supply	0.451

©IJRASET (UGC Approved Journal): All Rights are Reserved

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

Table 6.2. Ranking of main criteria for Oil cellars – To supply hydraulic oil, lubrication to the system by Pumping, Collection, and Storage:

RANK	RISK FUNCTION	C_i
1	B_2 – Malfunctioning of pressure	0.6119
2	B_7 – Leakage in oil cooling system	0.61108
3	B_3 – Error in manual filling	0.59045
4	B_6 – Leakage in the system	0.5704
5	B_1 – Low ambient temperature	0.5
6	B_4 – Cooling system failure	0.41815
7	B_5 – Wrong grade of oil	0.41815

Table 6.3. Ranking of main criteria for Crane Operation – Material Handling:

RANK	RISK FUNCTION	C_i
1	C_6 – Electronic cards	0.727
2	C_3 – No supply from power grid	0.695
3	C_1 – Production demand	0.641
4	C_5 – Over greasing of rails	0.608
5	C_4 – Ageing of power contacts	0.57
6	C_2 – No alarm system for heavy loads	0.523
7	C_7 – Overload	0.254

When an analysis is carried out by external consultants, the operator or owner shall prepare his own assessment of the study's conclusions and recommendations. This document shall include plans for implementation of risk reducing measures, including emergency preparedness measures. Assumptions and premises stated in the overall risk analyses (those that are carried out in order to compare results against risk acceptance criteria, at an early stage of the design, shall be included as functional requirements for safety and emergency preparedness measures for later phases of the manufacturing. Documentation from risk and emergency preparedness analysis shall specify such functional requirements, in a way that makesthem suitable for being used as dimensioning requirements. Results of emergency preparedness analyses are primarily used for establishment of emergency preparedness, including emergency preparedness plans and training and exercise plans. In addition, the results of the risk and emergency preparedness analysis shall be used for:

1) Selecting optimum solutions between available alternatives.
2) Designing risk reducing measures, including emergency preparedness measures.
3) Documenting risk acceptability of the chosen solution.
4) Designing basis for preventive safety measures.
5) Carrying out cost benefit studies relating to improvement of safety and emergency preparedness
6) Preparing procedures for operations having critical importance for safety.

The format of the risk acceptance criteria will influence strongly the presentation of risk results. The presentation of result of a quantitative risk analysis shall further be comprehensive, allowing good insight into the mechanisms of risk causation.

©IJRASET (UGC Approved Journal): All Rights are Reserved

Table 6.4. Recommendations

NO.	NODE NAME	RECOMMENDATIONS
1.	Charging Grids To De-Scalar Area – Heating of blooms to 1200°C	1. Gas regulation should be maintained 2. Inspection & maintenance of valves to be done quarterly 3. Periodic review of shut down procedure with respect to any change in the process/ modification 4. Inspection & maintenance of flow control valve, flow indicator are to be done once a month 5. Stack monitoring is recommended to assess the pollution level, monthly 6. Eliminate ignition sources around gas pipe line and potential leakage point 7. Monthly inspection of explosion flap 8. Inspection, maintenance transmitters are to be done quarterly. 9. Safe operating procedure (SOP) is to be in place to handle possible deviation due to nitrogen pressure 10. Level control for water in the trough is to be maintained 11. Calibration of temperature probes by competent person and record is to be maintained
2.	Oil cellars – To supply hydraulic oil, lubrication to the system by Pumping, Collection, Storage	Ensure oil fire extinguishers (mechanical foam) are adequate and placed in identified locations
3.	Crane Operation – Material Handling	Present control systems are sufficient.

REFERENCES

[1] Bozdag E., Asan U., Soyer A. and Serdarasan S. 2015. Risk prioritization in Failure Mode and Effects Analysis using interval type-2 fuzzy sets, Expert Systems with Applications, 42: 4000–4015.

[2] Du Y., Chen S. and Deng Y. 2014. Risk Evaluation in Failure Mode and Effects Analysis Based on Dempster-Shafer Theory and Prospect Theory, Journal of Information & Computational Science, 11: 1153-1161.

[3] Franceschini F. and Galetto M. 2001. A new approach for evaluation of risk priorities of failure modes in FMEA. International Journal of Production Research, 39: 2991-3002.

[4] Zadeh, L.A. (1965) 'Fuzzy sets', Information and Control, Vol. 8, pp.338–353.

[5] Kai Meng Tay, Chian Haur Jong, Chee Peng Lim 2015. A clustering-based failure mode and effect analysis model and its application to the edible bird nest industry.

[6] MithatZeydan, CüneytÇolpan, CemalÇobanoğlu, 2011. A combined methodology for supplier selection and performance evaluation. Expert Systems with Applications 38 (2011) 2741–2751.

[7] Akman G. and Alkan A. 2006. Measurement of Supplier Performance at Supply Chain Management by Using Fuzzy AHP Method: A study at Automotive Subcontractor Industry, Stanbul Ticaret University Fen Bilimleri Dergisi, 5(9): 23-46.

[8] Ahmet CanKutlu, MehmetEkmekçioğlu, 2012. Fuzzy failure modes and effects analysis by using fuzzy TOPSIS-based fuzzy AHP. International Journal of Computational Intelligence Systems, Vol. 5, No. 4 (August, 2012), 611-626.

[9] Aya, zdemir, 2006. A fuzzy AHP approach to evaluating machine tool alternatives. Journal of Intelligent Manufacturing. v17. 179-190.

[10] Badri, 2001. A combined AHP-GP model for quality control systems. International Journal of Production Economics. v72. 27-40.

[11] Chan et al., 2007. Global supplier selection: a fuzzy-AHP approach. International Journal of Production Research.

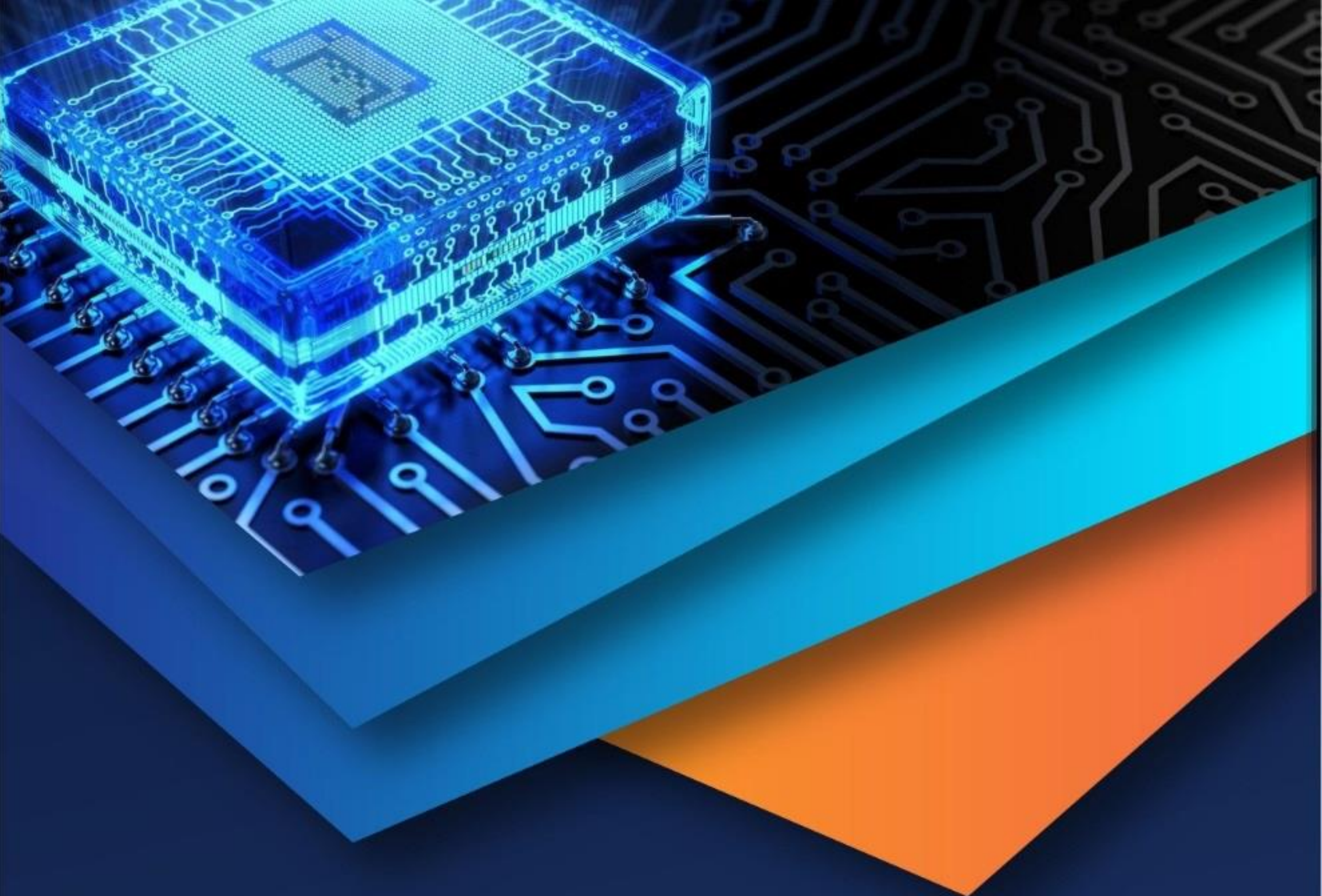
[12] Chu, 2002. Selecting plant location via a fuzzy TOPSIS approach. International Journal of Advanced Manufacturing Technology. v20. 859-864.

[13] Da deviren, 2008. Decision making in equipment selection: An integrated approach with AHP and PROMETHEE. Journal of Intelligent Manufacturing. v19. 397-406.

[14] Wang and Elhag, 2006. Fuzzy TOPSIS method based on alpha level sets with an application to bridge risk assessment. Expert Systems with Applications. v31. 309-319.

[15] Metin Dağdeviren, Serkan Yavuz, Nevzat Kılınç, 2009. Weapon selection using the AHP and TOPSIS methods under fuzzy environment, Expert Systems with Applications: An International Journal, Volume 36 Issue 4.

©IJRASET (UGC Approved Journal): All Rights are Reserved



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)