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SWOT THROUGH ANALYTICAL HIERARCHIC PROCESS IN SRRMS

[1]Jacob P. George, [2]Pramod V.R

[1]HOD, Mechanical Engineering Department, Jawaharlal College of Engineering & Tech. Mangalam P.O, Palakkad, Kerala

[2]Associate Professor, N.S.S College of Engineering, Palakkad 8, Kerala

Abstract: **Strength S, Weakness W, Opportunities O and Threats T in a SWOT analysis is one of the widely used techniques to extract information of both internal and external variables in the formation of planning strategies of an organization. AHP is a multi-criterion decision making method. In this paper an analysis is done to obtain the effects of SWOT on integration with AHP technique. SWOTAHP in a Steel Re Rolling Mill (SRRM) analyses through a decision process and obtaining the global and local priorities. Advantages of both techniques are visible here.**

Keywords: **AHP, Eigen values of matrix, local and global priorities, multi criterion decision making, Steel re rolling mills (SRRMs), SWOT, SWOT AHP.**

1. INTRODUCTION

In a Steel Re Rolling MILLs (SRRM), the SWOT analysis had been done by different viewpoints (Jacob and Pramod, 2014). The variables are gathered and distributed into four categories namely „S" which is associated with factors in which the SRRM shows strength. These variables indicate the growth and development of the organization. W: contains variables linked with factors in which the SRRM show the weakness. These variables, unless be corrected or improved could inhibit or make the growth and developments. O: Variables are related with opportunities that the organization could take advantage of its development and growth. Variables T represent threat to the growth and development of the organization. Variables effects indicate whether they are advisable to prevent or counteract (Panagiotou, 2003). The variables strength and opportunities are taken in to positive strategies and weakness and threats are of the negative approaches of the SRRMs.

SWOT structure provides the basic outline in which performance analysis of decision making situations. SWOT is enhanced with the techniques of Multi Criterion Decision Making (MCDM) called AHP. AHP approach achieves pairwise comparisons among factors or criteria in order to prioritize them at each level of the hierarchy using the eigenvalue value calculation. The main purpose of this is to explain how to use the AHP method for prioritize of SWOT factors of SRRMs and compare them. The problems in SRRMs are the different criterions which are complex by nature with multiple decision makers and multiple criteria. Therefore, these problems are quite suited to the use of MCDM. Decision making means chose the best among different alternatives. A good alternative might be to apply more than one method, either in combination to make use of the strengths of both of these methods, or in parallel to get a broader decision basis for the decision maker (Badri and Abdulla, 2004).

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2. SWOT AHP

AHP is one of MCDM that was originally developed by Prof. Thomas L. Saaty. This method is to develop ratio scales from paired comparisons. The input is obtained from actual assessment of strength, weakness, opportunities, threats or from subjective opinion such as satisfaction feelings and inclination. AHP allows some inconsistency in judgment because human beings are not always consistent. The ratio scales are derived from the principal Eigen vectors and the consistency index is derived from the principal Eigen value. (Görener, 2012).

2.1 SWOT/AHP integration:

In SRRMs, it is to obtain a structured hierarchy for the strategic planning process based on a SWOT study, and to use a quantitative technique to estimate a global value for each one of the proposed strategies. In order to use AHP to perform these evaluations, number of previous similar situations were studied (Kangas et al., 2001). From the study the integration of both techniques, and illustrate it with a real case were sorted out. Here, combinations, though using a different procedure for the final evaluation of the strategies which are used for the SRRM industries were identified. This difference could turn out to be important if some strategy fails in results, in which case the pair comparison would give a misleading answer by not identifying the weakness of the strategy. While comparing strategies with respect to factors the important thing is not the relative value of a factor within the strategy, but how well a strategy achieves the objective implied by the factor, independently of how well it behaves for other factors.

The hierarchy for the problem has been intended in four levels. First level, is the goal to be achieved by the decision making; the second level is recognized by the four SWOT groups of factors. Third level is created by the factors included in each one of the four groups of the previous level. Final level is constituted by the strategies that should be evaluated and compared (Helms and Judy, 2010). A graphical representation of the hierarchy is presented in Figure 5 and 6.

3. CALCULATION OF SWOT- AHP

The developments of SRRMs industry depends on the upgradation of the industry in future. How these categories are prioritized? How preference may be chosen? Answers will be clear when the analysis are sorted out through the AHP tool. AHP is well proven technique to identify the priority in making decisions in an industry like SRRM. It is given by a mathematical base in which several studies were conducted.

3.1 Steps of integration of SWOT with AHP:

The following steps are used to integrate SWOT with AHP;

Step 1- Conduct SWOT analysis in SRRMs,

Step 2- SWOT analysis is combined with AHP,

Step 3- Pair-wise comparisons are conducted with respect to objectives of the SWOT groups in SRRMs,

Step 4- The results obtained is employed in the evaluation process.

The major idea of using SWOT analysis is to evaluate SWOT‟s criteria or factors and proportionate their strength and opportunities systematically. AHP method offers quantitative measures of significance of each factor on decision making (Kurttila et al., 2001). The structure of conducting these integration methods is addressed in the four steps given above (Wickramasinghe and Takano, 2009). SWOT analysis method has been widely used as a tool for analysing and planning the tactical actions over the past two decades. Not only this method is used in identifying environmental relationships but also enable an industry to relate to its environment and help to grow industrial strategies. SWOT analysis is originally explained as a means tool for tackling large and complex tactical issues by decreasing the quantity of information to boost decision making in industries (Wheelan and Huger, 1998). SWOT analysis is to determine gaps and matches between resources and the business situations in their popular business policy and strategy. (Subramoniam et al., 2010) initiated that SWOT analysis is one of the best method used in strategic planning in the SRRM companies. Furthermore, the SWOT analysis method can also be used to evaluate the proposed framework against best practice frameworks in developing countries (Terrados et al., 2007).

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Table 1 SWOT analysis criteria

Strength	**Weakness**
S1- Maintenance Quality Function Deployment (MQFD) techniques can be implemented in SRRMs. **S2-** Steel bars are inevitable for re inforced concretes. **S3**-Steel bars are available as per the demand and requirement. **S4**-Quality and strength of bars can be assured by the producer. **S5**-Profit making business if the production process and maintenance of machinery is properly maintained.	**W1**-Different SRRM produces steelbars with different strength and quality. **W2**- Social impacts if pollution and waste disposal are no properly controlled. **W3** -Chance of accident and health hazards due to heavy and high power machineries and chemical process. **W4**- Lack of labourers in severe situations. **W5**- Stringent rules and regulations of central and state governments.
Opportunities	**Threats**
O1-MQFD implementation solves many problems in SRRMs. **O2**-High demand for quality product due to nation"s development. **O3**-Raw material can be imported are cheaper rate. **O4**-Ministry if Iron and steel's help and advice at any time. **O5**-Benefits of tax exemptions and other fringe benefits from the state and central ministry.	**T1**-High competition in the market due to more number of units. **T2**-Fluctuation of power tariff, cost of fuels and labour cost. **T3**-High maintenance and replacement costs of machineries. **T4**-Huge investment for flexibility and expansion of SRRMs. **T5**-Swallowing of small SRRM units by big units.

At the outset, major points were identified. They are shown in Table 1. From the chart it was noticed that there are five each points for strength, weakness, opportunities and threats. Though there are many points, the most decisive points are noted here for the AHP analysis integration. The solution of SWOT with the integration of AHP consists of different steps as explained earlier.

Now the steps for AHP analysis it is observed through the following programs. Initially, the aim/ goal of the problem are to be defined. Then, identify the objective followed by factors have to be assessed from the strength, weakness, opportunities and threats.

4. AIMS AND OBJECTIVES OF SWOTAHP OF SRRMs

AHP initiates by decomposing an intricate problem into a multilevel hierarchical structure of objective, criteria and alternatives (Srivastava et al., 2005). The aim of the problem statement is "To provide cost effective re-inforced steel bar with high quality and reasonable price which are available at the nearest point and its wastage may be minimized. The life span of the construction may be good enough and the chance of failures may be minimized".

From the aim given above the objectives are identified for the SRRMs. They are;

Objective1. The SRRM industry follows the QFD system and may have latest facility in production technology with hazardous free atmosphere. The industry is trying to implement MQFD and other cost effective techniques.

Objective2. The SRRM have transparency and accountability to society. Regular maintenance is going on in the industry.

Objective 3 The product may be available in the market and have good properties and the company may not create harmful effects in society. It must have flexibility in production process.

There are three levels of AHP structure (Hierarchy) of decision issues. The first level is the aim then the objectives and finally the comparison or alternatives level. The comparison levels are elements. For three elements there are three or four alternatives are there.

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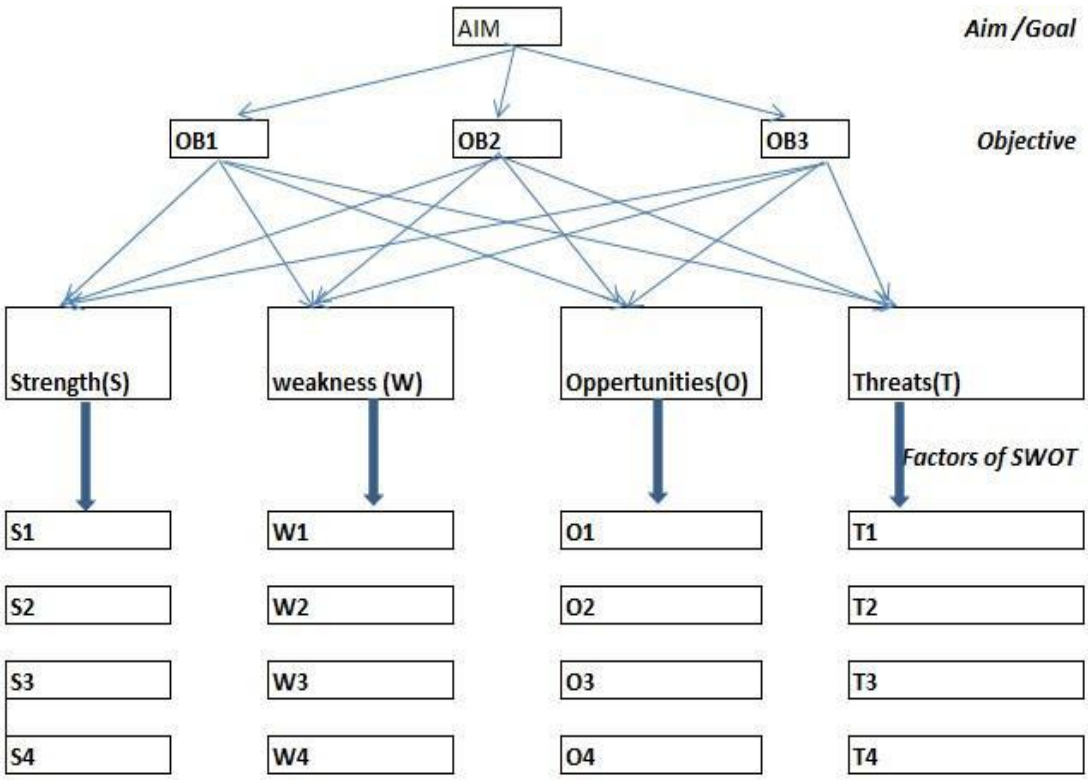

Figure 1 Hierarchical structure of SWOT combined with AHP of SRRMs

5. MATHEMATICAL CALULATION OF SWOTAHP IN SRRMs

Following steps are required for the evaluation for SWOTAHP. Initially we have to develop rating for each decision alternative for each criterion by

1. Developing a pair-wise comparison matrix for each criterion,

2. Normalize the resulting matrix by totaling the column. Each entry in the column is then divided by the column sum to yield its normalized score. Thus the sum of each column is 1.

3. Obtain the average values in each row to get the corresponding rating

4. Obtain the consistency ratio(CR)

5. Calculate the weighted average rating for each decision alternative. Choose the one with the highest score.

The consistency analysis is done to arrive consistency ratio through the following steps.

a). Calculate the consistency measure.

b).Calculate the consistency index CI= (λmax-n)/ (n-1).

c).Calculate the consistency ratio (CI/RI where RI is a random index).

d).Obtain CR = CI / RI for each matrix.

To find out the relative selection for n elements of the hierarchy matrix, the Saaty"s fundamental scale of value from 1-9 is used to consider the intensity priority between two elements and, using the verbal scale associated with the 1–9 scale. (Saaty, 2008)

To calculate relative weights of elements in each pair-wise comparison matrix, the Eigen value method may be used. To calculate Eigen vector or priority vector, initially totalise each column of the matrix which is then divide each element of the matrix with the sum of its column and normalise relative weight.

To normalise Eigen vector, row elements will be summed up and then divided by number of elements in the same row, which is finding the average value. The Eigen vector validates relative weights amongst the objects that we compare.

The Eigen value λmax may be obtained by summing of products between each element of Eigen vector multiplied by the total of columns of the reciprocal matrix. Every Eigen value is scaled to total up to one to get the priorities. Then sum of all elements in Eigen value (priority value) is one. Inconsistency may occur when λmax moved away from n this is because of the inconsistency responses in pair-wise comparisons. Saaty, proved that the biggest Eigen value is equal to the number of comparisons λmax which is equal to n . Thus the matrix should be examined for consistency by using consistency index CI.

CI= (λmax -n)/ (n-1) …….. (1)

One of the critical steps of SWOT AHP method is to generate the comparison matrixes. When the number of alternatives increases, more comparisons between alternatives are required. This might easily source the excess of the consistency of the model. Therefore, a consistency check is essential for the pair-wise comparison matrix (Saaty, 1992). The CI is to check whether the judgment of decision makers is consistent with respect to a comparison matrix. CI is important for the decision maker to assure him that the judgments were consistent and that the final decision is made well. Then calculate consistency ratio CR from equation (2):

CR = CI/RI…… (2)

Saaty proposed that CI used to compare with the appropriate consistency index which is called Random consistency index (RI). In order to check the CI if it is about 0.1 or 10% or less CI values are computed. The random CI is illustrated in Table 4 onwards.

The matrix will be consistence and acceptable if consistency ratio is less than 0.1 (CR < 0.1), if not it has to revise the subjective judgement. In order to obtain the overall rating for the alternatives as depicted in the above equation. (Vahindina et al., 2008).

Table 2 Random Consistency index/ Saaty scale (Saaty & Forman, 1993)

n	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	9	10
	0	**0**	**0.58**	**0.9**	**1.12**	**1.24**	**1.32**	**1.41**	**1.45**	**1.49**

6. SWOT- AHP EVALUATION METHOD

SWOT analysis method has been ideally used in various aspects for evaluation as explained in section 3. In this section the author analyses the proposed model based on strengths, weaknesses, opportunities and threats, and then evaluates the model using AHP. The idea of using SWOT analysis is to evaluate systematically SWOT"s criteria or factors and proportionate their strength. This method scans both demand and supply side. Regardless of these advantages of SWOT, the use of traditional SWOT analysis has no mean of forming the significance of each SWOT factor (Shinno et. al., 2006). It will be hard to evaluate the most impacting factors in decision making process. Hence, with SWOT analysis method alone cannot perform accurate decision. In this paper, AHP and their Eigen value calculation is integrated with SWOT analysis. AHP method offers a quantitative measure of significance of each factor on decision making. (Kurttila et al., 2001). The structure of conducting these integration methods is addressed in the following four steps (Wickramasinghe and Takano, 2009)

6.1 Step 1: SWOT analysis is conducted:

The summary of the proposed SRRM model is shown in Figure 6.3 and more details can be found (Kahraman et al., 2008). In this section the SWOT analysis method of the provider and demand side of the proposed SRRM model will be addressed for the sake of the evaluation procedure. This method includes systematic thoughts and inclusive identification of factors relating to a new technology, management or planning and products (Kahraman, et al., 2003).

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6.2 STEP 2. AHP method is combined with SWOT analysis:

The hierarchical structure of the evaluation process achieved at this step which is illustrated in Figure 4. Upper level represents the aim (A) which is the evaluation of the proposed SRRM model. The level below the top level (second level) represents the significant objectives (OB) of the proposed model such as; (OB1) Cost effective establishment of SRRMs, (OB2) Transparency and accountability to reduce wastage and provide quality product of the entire consumers and (OB3) MQFD deployment in SRRMs. The third level represents the SWOT factors assigned to each SWOT group.

It is useful to consider many factors; the number of pair-wise comparisons in AHP raises exponentially a number of factors. Hence, the current process leads to four factors of strengths, four weaknesses, eight opportunities, and five threats, but in this case only four factors of each SWOT group will be used from Figure 3. It is essential to note that according to (Saaty, 1986) the number of factors in the analysis categories should not exceed 10 factors under each SWOT group and this is the main shortage of the AHP. However, this made the user to avoid overlapping and carelessness when building the SWOT matrix. In level one there will be one comparison matrix communicates to pair-wise comparisons between significant objectives with respect to aim of the evaluation (Boroushaki and Malczewski, 2008).

The comparison matrix of the first has the size of 3 by 3, to identify the most significant objective, and use its values as a scaling factor. The second level pair wise comparisons between SWOT factors performed within each individual SWOT group with respect to the objectives, and identifies scaling factors for the coming level. Making the comparisons based on the Saaty‟s scale is to consider the intensity priority between two elements and, using the verbal scale associated with the 1–9 scale as illustrated in Table 3. In addition, it has the ability to cover qualitative as well as quantitative information as required by the pair-wise comparison form of the AHP. With these comparisons as the input, the local priorities of the factors are computed by Eigen value method as explained in section (2). These priorities imitate the decision makers‟ view point of the relevant importance of the factors. The third level‟s pair wise comparisons conducted to obtain the highest value factor within the group. Consequently, the comparison matrix of the first and second levels comprises on the sizes of 3 by 3 and 4 by 4 respectively.

Regarding the first level, the pair-wise comparison consists of a matrix with size of 3 by 3, (Table 3) and then calculates the factors by dividing each element of row by the sum of each column of the objectives (Table 4). Then, normalises the Eigen vectors by averaging the value of the factors across the new rows, adds each new row and divided by number of factors which is three in this case. (Table 5). Pair-wise comparison matrix for objectives with respect to the aim is shown in Table 3.

6.3 Step 3 Pair-wise comparisons conducted with respect to three objectives and four SWOT groups:

The three objectives (SO1, SO2, and SO3) were subjected to pair wise comparison at the second level will be calculated. The SWOT group were rated using objectives criteria with respect to five intensity ratings which is shown in Table 3, equal important, moderately important, strongly important, very strongly important and extremely important. The SWOT factors with respect to each objective have been calculated. Figures 9, 10, and 11 shows the calculation of SWOT factors with respect to all three significant objectives.

Table 3Overall Priority of SWOT (OB1, OB2 and OB3)

Strength	0.343
Weakness	0.092
Opportunities	0.149
Threats	0.06

Strength	0.114
Weakness	0.022
Opportunities	0.105
Threats	0.043

Strength	0.036
Weakness	0.009
Opportunities	0.003
Threats	0.005

Table 4 Local priority over SWOT(OB1, OB2, OB3)

Strength	0.534	0.491	0.401
Weakness	0.143	0.128	0.077
Opportunities	0.231	0.308	0.37
Threats	0.093	0.073	0.153

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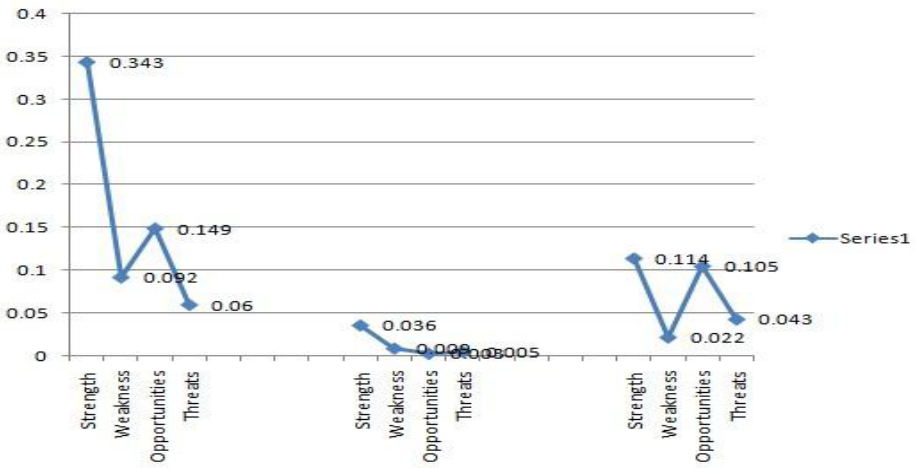

Figure 2. Interpretation of the output of pair wise comparison of SWOT factors with respect to the objectives (OB1, OB2 and OB3).

Table 5 Global priority over SWOT

Strength	0.461
Weakness	0.068
Opportunities	0.325
Threats	0.167

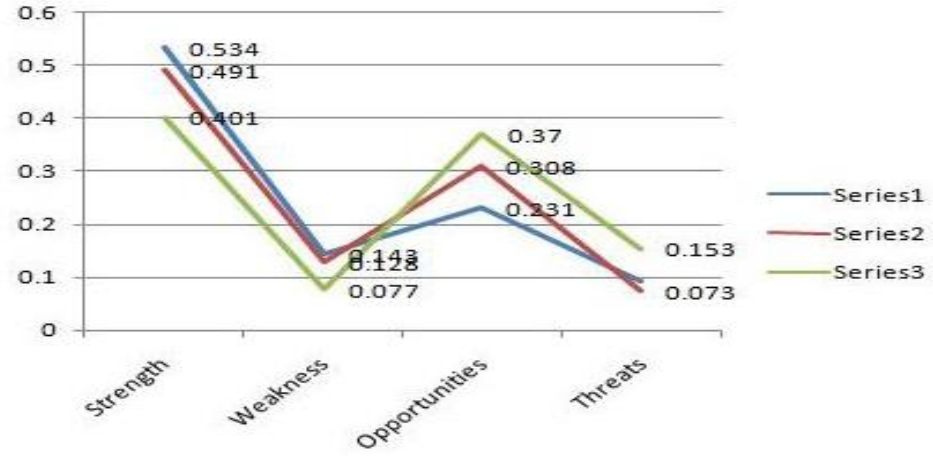

Figure 3 Interpretation of Local priorities over SWOT (OB1, OB2, OB3)

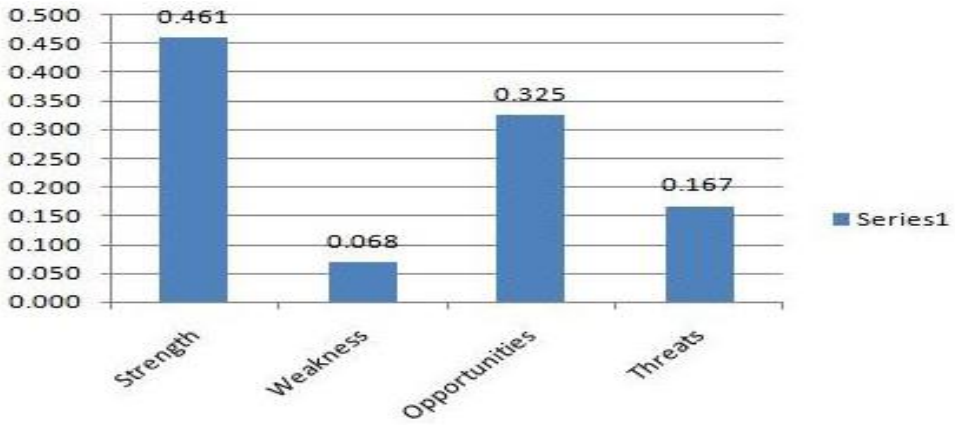

Figure 4 Interpretation of SWOT with Global Priority

7. RESULT AND INFERENCES OF SWOTAHP IN SRRMs.

From the analytical and mathematical calculations it is observed that SWOTAHP has great effects and impacts on decision making in SRRMs. From the evaluation it was clear that the issues and problems of SRRM identified for the MQFD is really worth and meaningful. Since competitions are there in the market, the SRRM industry must survive. Thus the objectives were clearly assessed. From the objectives once again it is assured that good quality products of SRRM must only come to the market and the profit of the industry has to come from the efficient MQFD implementations.

The present situation of productions of steel bars and the customer voice have not been taken care of. QFD techniques from SRRM industries, it has been observed that quality of the products such as strength, yield strength, chemical analysis, brand name, international specifications etc. are to be well taken care of.

From the above tabular column following information are observed.

1. From Table 7 the CR is found to be only 8.34% (less than 10%)

2. From Table 9 CR was found to be 8.79 % (Less than 10%)

3. From Table 11 CR was found to be 7.71 % (Less than 10%)

4. From Table 13 CR was found to be 4.69 % (Less than 10%)

5. From Table 15 CR was found to be 3.15 % (Less than 10%)

6. From Table 17 CR was found to be 6.57 % (Less than 10%)

7. From Table 19 CR was found to be 2.53 % (Less than 10%)

8. From OB1, OB2, and OB3, CR are 3.5%, 8.8% and 7.7% respectively.

9. From SWOT factors CR are found to be3.2%, 4.7%, 6.7%and 2.5%, less than 10%).

In practice, a CR of 0.1 or below is considered acceptable. Any higher value at any level indicates that the judgments warrant reflects the consistency of one‟s judgment and need re-examination. The results are excellent and no re-examination is needed. (Sharma et al., 2008)

8. CONCLUSIONS

Significant strategic factors to SRRMs are determined which are assessed from the SRRM by merging SWOT with AHP techniques. The results show the following ranking of each SWOT group priority: Strengths (group weight 46.1%), Opportunities (32.5%), Weaknesses (6.8%) and Threats (16.7%). The main aim considered was to provide cost effective reinforced steel bar with high quality and reasonable price which were available at the nearest point and its wastage might be minimized. The life span of the construction may be good enough and the chance of failure may be minimized.

From the aim given the objectives are identified for the SRRMs. For the objective of the implementation of Maintenance Quality Function Deployment (MQFD) in SRRM, obtained the highest global priority as 0.343 with a priority/ scaling factor 0.643 (64.3%) and for others it was only 7.3% and 28.3% only.

Table 6, pair-wise comparison of objective criteria

Criteria/factors	OB1	OB2	OB3
OB1	1	7	3
OB2	1/7	1	1/5
OB3	1/3	5	1
Total	1.47619	13.00000	4.20000

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Table7, pair wise comparison of the three objectives criteria with scaling factor

Criteria/factors	OB1	OB2	OB3	Scaling factor
OB1	1.000	7.000	3.000	0.643
OB2	0.143	1.000	0.200	0.074
OB3	0.333	5.000	1.000	0.283
Total	1.476	13.000	4.200	1.000
λmax=		3.0967		
CI=(λmax-n)/(n-1)=		0.0484	CR=CI/RI	
RI =		0.5800		
CR=		0.0834		

Table 8, Pair wise comparison of the SWOT group with respect to OB2

Criteria/Factors	S	W	O	T
S	1	7	3	3
W	1/7	1	1/5	5
O	1/3	5	1	7
T	1/3	1/5	1/7	1
Total	1 4/5	13 1/5	4 1/3	16

Table 9, Priorities within the group(scaling factor)

Criteria/Factors	S	W	O	T	Priorities within the group(Scaling factor)
S	1	7	3	3	0.4903
W	1/7	1	1/5	5	0.1283
O	1/3	5	1	7	0.3077
T	1/3	1/5	1/7	1	0.0737
Total	1 4/5	13 1/5	4 1/3	16	1.00

λmax=	4.2372	
CI=(λmax-n)/(n-1)=	0.0791	
RI=	0.9000	CR=CI/RI
CR=	0.0879	

Table 12, Pair wise comparison of the SWOT group with in SWOT group

Criteria/Factors	S1	S2	S3	S4
S1	1	1/7	1/3	1/7
S2	7	1	1/5	1/3
S3	3	5	1	5
S4	7	3	1/5	1
Total	18	9 1/7	1 ¾	6 1/2

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Table 13, Priorities within the group(scaling factor)

Criteria/Factors	S1	S2	S3	S4	Priorities within the group(local weight)
W1	1	1/7	1/3	1/7	0.0714
W2	7	1	1/5	1/3	0.1663
W3	3	5	1	5	0.5156
W4	7	3	1/5	1	0.2467
Total	18	9 1/7	1 ¾	6 1/2	1.00

λmax=	4.1266	
CI=(λmax-n)/(n-1)=	0.0422	
CR=CI/RI, RI=	0.9000	(CI)
CR=	0.0469	

Table 14, priority factor or local weight of the Weaknesses in SWOT group

W1	1	3	3	7
W2	1/3	1	3	3
W3	1/3	1/3	1	7
W4	1/7	1/3	1/7	1
Total	1 4/5	4 2/3	7 1/7	18

Table 15, Priorities within the group(scaling factor)

Criteria/Factors	W1	W2	W3	W4	Priorities within the group(local weight)
S1	1	3	5	3	0.5155
S2	1/3	1	3	3	0.2463
S3	1/3	1/3	1	9	0.2239
S4	1/7	1/3	1/7	1	0.0565
Total	1 4/5	4 2/3	7 1/7	18	1.04
λmax=			4.0850		
CI=(λmax-n)/(n-1)=			0.0283		
CR=CI/RI, RI=		0.9000		(CI)	
CR=			0.0315		

Table 16, priority factor or local weight of the Opportunities in SWOT group

Criteria/Factors	O1	O2	O3	O4
O1	1	7	5	5
O2	1/7	1	1/7	1/3
O3	1/5	7	1	3
O4	1/5	3	1/3	1
Total	1 ½	18	6 ½	9 1/3
Total	1.00	1.00	1.00	1.00

Table 17, Priorities within the group(scaling factor)

Criteria/Factors	O1	O2	O3	O4	Priorities within the group(local weight)
O1	1	7	5	5	0.5862
O2	1/7	1	1/7	1/3	0.0515
O3	1/5	7	1	3	0.2486
O4	1/5	3	1/3	1	0.1137
Total	1 ½	18	6 ½	9 1/3	1.00
λmax=			4.1775		
CI=(λmax-n)/(n-1)=			0.0592		
CR=CI/RI, RI=		0.9000		(CI)	
CR=			0.065		

Table 18, Priority factor or local weight of the Threats in SWOT group

Criteria/Factors	T1	T2	T3	T4
T1	1	5	7	9
T2	1/5	1	1/3	3
T3	1/7	3	1	3
T4	1/9	1/3	1/3	1
Total	1 4/9	9 1/3	8 2/3	16

Table 19, Priorities with in the SWOT group/ local weight for Threats

Criteria/Factors	T1	T2	T3	T4	Priorities within the group(local weight)
T1	1	5	7	9	0.6484
T2	1/5	1	1/3	3	0.1177
T3	1/7	3	1	3	0.1806
T4	1/9	1/3	1/3	1	0.0533
Total	1 4/9	9 1/3	8 2/3	16	1.00
λmax=		4.0683			
CI=(λmax-n)/(n-1)=		0.0228			
CR=CI/RI, RI=		0.9000		(CI)	
CR=		0.0253			

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