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SUPPLIER CHOICE PROCESS IN THE STEEL INDUSTRY USING AHP AND MATLAB

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ABSTRACT
Supplier's choice is one among the foremost essential activities of supply chain management. Supplier's choice could be an advanced activity involving qualitative and quantitative multi-criteria. A trade-off between these tangible and intangible factors is essential in choosing the most effective Supplier. This paper utilizes AHP in selecting the most effective suppliers. A problem involving the supplier selection out of 4 Suppliers A, B, C, and D is formulated. AHP method with the help of Matlab Software is utilized to calculate the weights of criterions, sub criterions and sub sub criterions for the 4 suppliers. The global weights are then calculated and compared. The results are tabulated and the best supplier out of the 4 suppliers is selected and the detailed process involving the complex Matlab calculations is depicted. Based on the given data it was found that out of the four suppliers the supplier A is the best supplier.

KEYWORDS: Analytic Hierarchy method (AHP), Supplier choice, Total worth of Purchasing (TVP)

INTRODUCTION

AHP (Analytic Hierachy Process)

The issues of Supplier's choice have attracted the interest of researchers since 1960s, and plenty of researches during this space have evolved .Analytic Hierarchy Process is one of Multi Criteria decision making method which was developed by Prof. Thomas L. Saaty [1]. It is a method to derive ratio scales from paired type comparisons. The inputs can be obtained from the actual measurement such as price, weight etc., or from the subjective opinion such as satisfaction feelings or preference. AHP allows some small inconsistency in judgment because of fact that human is not always consistent. The ratio scales are derived from principal Eigen vectors and consistency index is derived from the principal Eigen Value.

Having a comparison matrix, at your expanse, now we would like to compute the priority vector, which is the normalized Eigen vector of matrix. We will use Matlab to compute the Eigen values and the normalized Eigen Vector. After this the sensitivity analysis can be performed.

Sensitivity analysis identifies the impact of changes within the priority of criteria on the suppliers' performance and order quantities. Once getting the initial resolution with the given weights of the attributes, sensitivity analyses were performed to explore the response of the general utility of alternatives and to changes within the relative importance (weight) of every attribute or criterion. The sensitivity analyses are necessary as a result of the importance of attributes or criteria, which needs different levels of trust, quality, cost, delivery, management and organization, financial and sourcing opportunities for the alternatives. A series of sensitivity analyses should be conducted.

METHODOLOGY

Model Development

The objective of this work is to develop AHP technique for Supplier choice. The methodology of this work has been adopted from Yahya and Kingsman (1999), Tam and Tummala (2001) and Yu and Jing (2004) [2],[3]. So as to suits collecting quantitative and qualitative knowledge for AHP Supplier choice model that could be applied by the steel producing company ,a six steps approach was performed to insure thriving implementation as follows:

Step one: Outline criteria for supplier choice
Step Two: Outline sub criteria and sub sub-criteria for Supplier choice
Step three: Structure the class-conscious model
Step four: Place the order of criteria or sub criteria
Step five: Live Supplier performance.
Step six: Determine Supplier priority and choice

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Sensitivity analysis of result

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Case Study of the Indian Steel Industry

- Four Hydraulic Cylinder suppliers A, B, C, D were rated by the manager over various criterions, sub criterions and Sub Sub Criterions. The procedure enlisted below is used for it.
- Based on the interview conducted with the three managers R(1), R(2) and R(3) the ratings out of the 10 is taken for criterion like Quality, Delivery etc and average rating is taken as the score for it.
- The criterions are Cost, Quality, Delivery and Faith. The main criterion along with sub criterion and sub sub criterion are shown in the Table:
- The ratings of the pair wise criterions are done on the basis of the Information Shown below:

The ratings of the pair wise criterions are done on the basis of the Information Shown below:

Verbal judgment or preference	Numerical rating
Extremely preferred	9
Very strongly preferred	7
Strongly preferred	5
Moderately preferred	3
Equally preferred	1
Intermediate values between two adjacent judgments (when compromise is needed)	2, 4, 6, and 8

Sr.No.	Criterions	Sub Criterions	Sub Sub Criterions
1	Cost	Direct Cost	NET Price
2			Delivery Cost
3		Indirect Cost	Ordering Cost
4			Capital Investments
5	Quality	Quality of Product	Customer Rejector
6			Warranty
7			ISO 9000
8			Package
9		Quality of Manufacturing	Customer Focus
10			Top management
11	Delivery	Due Time Compliance	Percentage Late Delivery
12			Delivery Lead Time

13		Quality Compliance	Location
14	Faith	Inter Personal Faith	Faith Between key men
15		Inter Firm Faith	Rewin Percentage
16			Inter Firm Cooperation Length

The same criterion and sub criterions are used for all the suppliers. The detailed Matrixes with their priority vector calculations is shown below:

Supplier A

Level 1

	C	Q	D	F
Cost	1	2	3	4
Quality	1/2"	1	5	3
Delivery	1/3"	1/5"	1	2
Faith	1/4"	1/3"	1/2"	1

f = CR =7.67 percent

0.4422 0.3450 0.1233 0.0896

Level 2

Cost

	DC	IC
DC	1	4
IC	1/4"	1

Direct Cost 0.8
Indirect Cost 0.2

Quality

	QP	QM
QP	1	2
QM	1/2"	1

Quality of Product 0.66
Quality of Manufacturing 0.33

Delivery

	DC	QC
DC	1	5
QC	1/5"	1

0.83
Due Time Compliance 0.16
Quantity Compliance

Faith

	IPF	IFF
IPF	1	3
IFF	1/3"	1

Inter Personal Faith 0.75
Inter Firm Faith 0.25

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Level3

Direct Cost — Net Price — Delivery Cost

	NP	DC	
NP	1	3	0.75
DC	1/3"	1	0.25

Indirect Cost — Ordering Cost — Capital Investment

	OC	CI	
OC	1	6	0.85
CI	1/6"	1	0.15

Quality of Product — Customer Rejector — Warranty — ISO 9000 — Package

	CR	W	ISO	P
CR	1	4	3	4
W	1/4"	1	7	3
ISO	1/3"	1/7"	1	5
P	1/4"	1/3"	1/5"	1
	0.4862	0.3161	0.1336	0.0642

Quality of Manufacturing — Customer Focus — Top Management

	CF	TM	
CF	1	8	0.89
TM	1/8"	1	0.11

Due Time Compliance — Percentage Late Delivery — Delivery Lead Time

	PLD	DLT	
PLD	1	5	0.83
DLT	1/5"	1	0.16

Quantity Compliance — Location — 1

Inter Personal Faith — Faith Between Key Men — 1

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Inter Firm Faith

Re Win percentage

Inter Firm Cooperation Length

	RWP	IFC	
RWP	1	8	0.89
IFC	1/8"	1	0.11

The Local Weights and Global weights based on the above calculations are shown below:

Sr.No.	Criterions	Sub Criterions	Sub Sub Criterions	LW I	LWII	LWIII	GW
1	Cost	Direct Cost	NET Price	0.44	0.8	0.75	0.264
2			Delivery Cost			0.25	0.088
3		Indirect Cost	Ordering Cost		0.2	0.85	0.0748
4			Capital Investments			0.15	0.0132
5	Quality	Quality of Product	Customer Rejector	0.34	0.66	0.48	0.107712
6			Warranty			0.31	0.069564
7			ISO 9000			0.13	0.029172
8			Package			0.06	0.013464
9		Quality of Manufacturing	Customer Focus		0.33	0.89	0.099858
10			Top management			0.11	0.012342
11	Delivery	Due Time Compliance	Percentage Late Delivery	0.12	0.83	0.83	0.082668
12			Delivery Lead Time			0.16	0.015936
13		Quality Compliance	Location		0.16	1	0.0192
14	Faith	Inter Personal Faith	Faith Between key men	0.08	0.75	1	0.06
15		Inter Firm Faith	Rewin Percentage		0.25	0.89	0.0178
16			Inter Firm Cooperation Length			0.11	0.0022

0.969916

Similar analysis was performed for supplier B, C and D. The results summarizing the complete local weights and Global weights are given below: Supplier B

Sr.No.	Criterions	Sub Criterions	Sub Sub Criterions	LW I	LWII	LWIII	GW
1	Cost	Direct Cost	NET Price	0.54	0.75	0.66	0.2673
2			Delivery Cost			0.33	0.13365
3		Indirect Cost	Ordering Cost		0.25	0.83	0.11205
4			Capital Investments			0.16	0.0216
5	Quality	Quality of Product	Customer Rejector	0.28	0.83	0.48	0.111552
6			Warranty			0.31	0.072044
7			ISO 9000			0.13	0.030212
8			Package			0.06	0.013944

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9		Quality of Manufacturing	Customer Focus		0.16	0.89	0.039872
10			Top management			0.11	0.004928
11	Delivery	Due Time Compliance	Percentage Late Delivery	0.08	0.83	0.83	0.055112
12			Delivery Lead Time			0.16	0.010624
13		Quality Compliance	Location		0.16	1	0.0128
14	Faith	Inter Personal Faith	Faith Between key men	0.07	0.8	1	0.056
15		Inter Firm Faith	Rewin Percentage		0.2	0.75	0.0105
16			Inter Firm Cooperation Length			0.25	0.0035

0.955688

SupplierC

Sr.No.	Criterions	Sub Criterions	Sub Sub Criterions	LWI	LWII	LWIII	GW
1	Cost	Direct Cost	NET Price	0.49	0.66	0.89	0.287826
2			Delivery Cost			0.11	0.035574
3		Indirect Cost	Ordering Cost		0.33	0.75	0.121275
4			Capital Investments			0.25	0.040425
5	Quality	Quality of Product	Customer Rejector	0.28	0.83	0.48	0.111552
6			Warranty			0.31	0.072044
7			ISO 9000			0.1	0.02324
8			Package			0.09	0.020916
9		Quality of Manufacturing	Customer Focus		0.16	0.75	0.0336
10			Top management			0.25	0.0112
11	Delivery	Due Time Compliance	Percentage Late Delivery	0.15	0.83	0.83	0.103335
12			Delivery Lead Time			0.16	0.01992
13		Quality Compliance	Location		0.16	1	0.024
14	Faith	Inter Personal Faith	Faith Between key men	0.06	0.66	1	0.0396
15		Inter Firm Faith	Rewin Percentage		0.33	0.89	0.017622
16			Inter Firm Cooperation Length			0.11	0.002178

0.964307

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SupplierD

Sr.No.	Criterions	Sub Criterions	Sub Sub Criterions	LW I	LWII	LWIII	GW
1	Cost	Direct Cost	NET Price	0.44	0.83	0.75	0.2739
2			Delivery Cost			0.25	0.0913
3		Indirect Cost	Ordering Cost		0.16	0.66	0.046464
4			Capital Investments			0.33	0.023232
5	Quality	Quality of Product	Customer Rejector	0.34	0.66	0.51	0.114444
6			Warranty			0.28	0.062832
7			ISO 9000			0.13	0.029172
8			Package			0.06	0.013464
9		Quality of Manufacturing	Customer Focus		0.33	0.89	0.099858
10			Top management			0.11	0.012342
11	Delivery	Due Time Compliance	Percentage Late Delivery	0.12	0.75	0.75	0.0675
12			Delivery Lead Time			0.25	0.0225
13		Quality Compliance	Location		0.25	1	0.03
14	Faith	Inter Personal Faith	Faith Between key men	0.08	0.75	1	0.06
15		Inter Firm Faith	Rewin Percentage		0.25	0.66	0.0132
16			Inter Firm Cooperation Length			0.33	0.0066

0.966808

The Sum of the Global Weight in the case of 4 suppliers are as follows

SUPPLIER A: 0.969916
SUPPLIER B: 0.955688
SUPPLIER C: 0.964307
SUPPLIER D: 0.966808
The sum of the global weights is highest in case of Supplier A and thus it is the best supplier.

CONCLUSION

The issues of Supplier's choice have attracted the interest of researchers since 1960s, and plenty of researches during this space have evolved. Continuing the previous works in Supplier choice space, the work has got success in achieving its objectives.

The contribution was a development of a multi-criteria model for analysis and choice which is employed for Supplier choice in JSW Steel Limited. The use of AHP process is critical in the Supplier Choice process and the latest Software Packages like MATLAB are used to solve for the weights and decide the relative importance of the criterion.

The AHP Technique was applied on all the four suppliers A, B, C and D and weights (Local and Global) are calculated. Based on the above analysis described the supplier A was concluded to be best supplier having t he highest sum of global weights.

It was concluded that the AHP Process is very useful in Supplier selection and Tools like Matlab can help in the complex calculations involved.

Future Work

The AHP technique is used for supplier selection in the present paper. In the future work many other advanced techniques can be used for supplier selection. The use of genetic algorithm along with neural networks can be done to give better and accurate results. Also the number of criterions and sub criterions can be increased and the solution of the problem can be performed in completely simulated environment. The supplier selection process using AHP can be extended for other industries rather than only steel industries can be executed.

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