Available online at www.sciencedirect.com
SciVerse ScienceDirect
Procedia Engineering 38 (2012) 2312 – 2328
Procedia Engineering
www.elsevier.com/locate/procedia

International Conference on Modeling Optimization and Computing (ICMOC-2012)

A Multi Criteria Decision Making Approach for Suppliers Selection

Dr. P. Parthiban[a]*, H. Abdul Zubar[b], Chintamani P. Garge[c]

[a]* Assitant Professor, Department of Production Engineering, National Institute of Technology Tiruchirappalli, Tamil Nadu – 620015, India.
[b]Research Scholar, Department of Production Engineering, National Institute of Technology Tiruchirappalli, Tamil Nadu – 620015, India.
[c]Post Graduate student, Department of Production Engineering, National Institute of Technology Tiruchirappalli, Tamil Nadu – 620015, India.

Abstract

The study deals with the factors affecting the supplier selection process, to study the interaction between them and thus empirically assess which factors are most influencing one in supply chain operations which must be given careful attention. For studying the interaction between the factors and prioritizing the factors, we have used ISM (Interpretive Structural Modeling) technique, by which we got the weights for the performance factors which are examined and ranked. AHP (Analytical Hierarchy Process) is used to rank the supplier and found out the best supplier from the group of supplier. This method is applied to an automotive component manufacturing industry in the southern part of India. Qualification and final selection of the supplier are done based on the method proposed. We have collected the data from the mentioned industry and the results are implemented by the industry.

Keywords: Supplier Selection; Supplier Ranking; Analytical Hierarchy Process(AHP)

1. INTRODUCTION

1.1 Suppliers

Anyone who supplies products into the market is part of the supply chain, including manufacturers, importers, wholesalers, retailers and hire companies. Few products or services exist that so not require some supply chain management. The more suppliers that are involved, the supply chain management becomes more complex. There have been a number of philosophies about how to deal with the supply chain management. Backward integration, develop as many suppliers as possible to make

1877-7058 © 2012 Published by Elsevier Ltd.
doi:10.1016/j.proeng.2012.06.277

the supply item a commodity, competitive bidding, single source, supplier partnerships to name a few. In general, the closer a product or service is to a commodity item by definition the more potential suppliers are available. This can make the supply chain management extremely complex. Maintaining traceability becomes much more burdensome.

While selecting the suppliers, a company should concentrate on capabilities and competences not resources. When evaluating suppliers, clients tend to focus on the supplier's resources because these are highly visible on site tours, balance sheets and resumes. But they should be more interested in the supplier's ability to turn these resources – its physical and human assets such as physical facilities, technologies, tools and workforce – into capabilities that, in turn, can be combined to create high level customer facing competencies.

Need of selecting the best supplier is because it is unwise to pay too much, but it is unwise to pay too little. When you pay too much, you lose a little money that is all. When you pay too little, you sometimes lose everything, because the thing you bought was incapable of doing the thing you bought it to do.

Today, organizations that wish to carry on the sustainable growing need a robust strategic performance measurement and evaluation system because of changing demands of consumers, reduced product life cycle, competitive and globalised markets.

Best practice for supply chain dictates that managers should look to form closer, longer term relationships that deliver long term value to both parties. Strong relationships help drive collaboration, trust and value throughout your supply chain. Top level organisations recognise the importance of developing and maintaining world class supply chains that give them competitive advantages from others in their market. Transparency and performance have always been important for organisations looking to be a market leader. Therefore, many of them are starting to recognise the value in SPM for nurturing supplier relationships through a performance culture.

The concept of Interpretive Structural Modelling (ISM) was primary introduced by J. Warfield (1973). Warfield proposed ISM due to evaluate the complex socioeconomic systems. He stated that ISM approach facilitates to compel classification and direction on the complex relationships among components of a complexity of relationships among elements of a socioeconomic system. ISM is interpretive as based on a group's judgment and decision whether and how the system's elements are linked. It is structural as constructed on the relationship's foundation and final structure is exploited from the complex set of system's variables. It is also a modelling, as the final relationship is illustrated in a directed graphical model.

The Analytic Hierarchy Process (AHP) has been developed by T. Saaty (1977, 1980, 1988 and 1995) and is one of the best known and most widely used MCA approaches. It allows users to assess the relative weight of multiple criteria or multiple options against given criteria in an intuitive manner. In case, quantitative ratings are not available, policy makers or assessors can still recognize whether one criterion is more important than another. Therefore, pair wise comparisons are appealing to users. Saaty established a consistent way of converting such pair wise comparisons (X is more important than Y) into a set of numbers representing the relative priority of each of the criteria.

The AHP, as a compensatory method, assumes complete aggregation among criteria and develops a linear additive model. The weights and scores are achieved basically by pair wise comparisons between all options with each other.

In decision making the weights assigned to the decision criteria attempt to represent the genuine importance of the criteria. When criteria cannot be expressed in quantitative terms, then it is difficult to accurately represent the importance of these criteria. In a situation like this, the decision making process can be improved considerably by identifying the critical criteria and then can be re-evaluated more accurately the weights of these criteria. The intuitive believe is that the criterion with the highest weight is the most critical one. This may not always be true and in some instances, the criterion with the lowest weight may be the most critical one.

2. LITERATURE REVIEW

Supplier selection attained the state of highest significance for companies in the current scenario because of increasing competition. Improper selection of suppliers will have an poor impact on the overall performance of the manufacturer. The new approach proposed by Mithat Zeydan, Cüneyt Çolpan, Cemal Çobanoglu (2010) consider both qualitative and quantitative variables in evaluating performance for selection of suppliers based on efficiency and effectiveness in one of the biggest car manufacturing factory in Turkey. This new methodology is realized in two steps. In the first stage, qualitative performance evaluation is performed by using fuzzy AHP in finding criteria weights and then fuzzy TOPSIS is utilized in finding the ranking of suppliers. A weighted max–min fuzzy model is developed to handle the vagueness of input data effectively and different weights of criteria in the paper submitted by A. Amid a,n, S.H.Ghodsypour b, C.O'Brien (May 2010). They have used the AHP to determine the weights of the criteria. Saroj Kaul & Rakesh Varma proposes a dynamic model with uncertainty based on Fuzzy AHP for long-term strategic vendor selection problems.

An attempt has been made by M. Punniyamoorthy, P. Mathiyalagan, P. Parthiban (2011) to develop a new composite model using structural equation modeling and fuzzy analytic hierarchy process technique, based on the results of a survey of 151 respondents. The paper by Desheng Dash Wua, Yidong Zhang, Dexiang Wud, David L. Olson (February 2009) proposes a fuzzy multi-objective programming model to decide on supplier selection taking risk factors into consideration. Huan-Jyh Shyura,1, Hsu-Shih Shihb, (April 2005) Proposed a hybrid model for supporting the vendor selection process in the new task situations. The paper submitted by Samuel H. Huang, Harshal Keskar (July 2006) presented an integration mechanism in terms of a set of comprehensive and configurable metrics arranged hierarchically that takes into account product type, supplier type, and OEM/supplier integration level. The study by Ashutosh Sarkar, Pratap K.J. Mohapatra (2006) assume two important dimensions of suppliers—performance and capability.

Jiann Liang Yang, Huan Neng Chiu, Gwo-Hshiung Tzeng, Ruey Huei Yeh (June 2009) proposed integrated fuzzy multiple criteria decision making (MCDM) method addresses this issue within the context of the vendor selection problem. They used interpretive structural modelling (ISM) to map out the relationships among the sub-criteria. Then they have used the fuzzy analytical hierarchy process (AHP) method to compute the relative weights for each criterion. Understanding and quantifying the interrelationships between individual risk elements is a significantly important but complex challenge. If we view all the risks in a firm as an integrated system, we can apply a computer-assisted learning process called Interpretive Structural Modeling (ISM) to construct a structural graph and illustrate those risk interrelationships. Rick Gorvett, FCAS, MAAA, FRM, ARM, Ph.D. Ningwei Liu, Ph.D. (2006) has used ISM concepts and techniques to understand a company's overall risk profile in a better way. The supplier decision-making problem is complicated by several criteria and sub-criteria. The criteria and sub-criteria used may vary across different product categories and situations. The aim of the paper submitted by G. Kannan and A. Noorul Haq (February 2006) is to analyse the interaction of criteria and sub-criteria. These criteria are used to select the supplier for the built-in-order supply chain environment in the original equipment manufacturing company.

Alfonso Sánchez & Evangelos Triantaphyllou presents a methodology for performing a sensitivity analysis on the weights of the decision criteria and the performance values of the alternatives expressed in terms of the decision criteria. The study by Che-Wei Chang, Cheng-Ru Wu, Chin-Tsai Lin, Huang-Chu Chen discusses and develops a manufacturing quality yield model for forecasting 12 in silicon wafer slicing based on the Analytic Hierarchy Process (AHP) framework. Finally, sensitivity analysis is performed to test the stability of the priority ranking. In the paper by Alessio Ishizaka, Ashraf Labib, the authors review the developments of the analytic hierarchy process (AHP) since its inception. In particular, they discuss problem modelling, pair-wise comparisons, judgement scales, derivation methods, consistency indices, incomplete matrix, synthesis of the weights, sensitivity analysis and group decisions. All have been important areas of research in AHP.

3. PROBLEM DESCRIPTION

3.1 Problem Definition

Among the questions that arise are: what are the criteria that influences the performance of suppliers from the company perspective, what interactions are there between the criteria that have been identified, which are the criteria mostly influencing the supplier selection decision, choosing the best suppliers from the bunch of suppliers, identifying the weak suppliers and proposing performance improvement methods to raise the quality. We have to choose the criteria by conducting the survey. Then we have to find the interaction between the criteria and develop a data sheet with the linguistic variables. Data has been collected from the company.

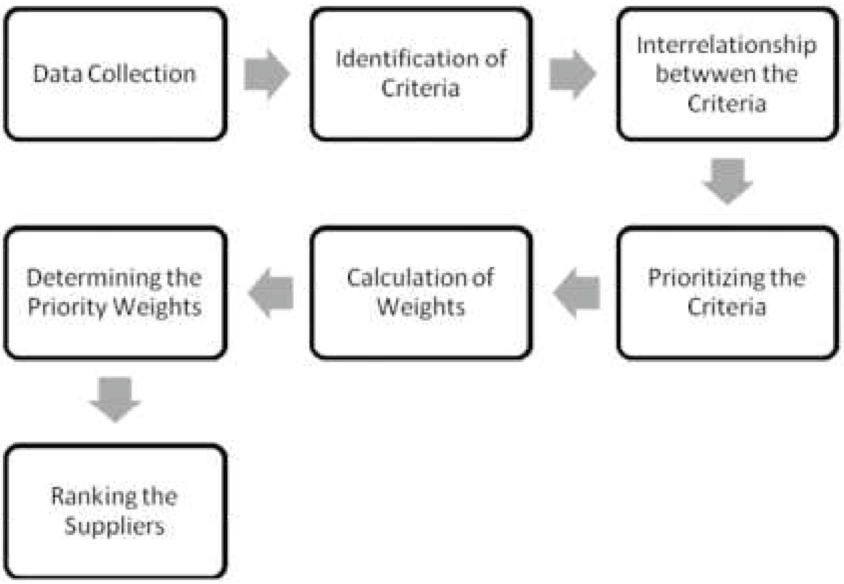

Fig. 3.1 Problem Description

3.2 Model formulation

Following steps have been followed to solve the problem and flow chart of the problem description is as shown in Fig. 3.1,

- identifying the criteria and respective weights of linguistic variables of the criteria by taking opinions from industry expert,

- developing the interrelationship between the criteria,
- prioritizing the criteria and ranking them,
- calculation of the weights for the criteria,
- determining the priority weights of the criteria for no of suppliers and ranking the suppliers,
- identifying the group of best suppliers,
- performing the sensitivity analysis to study the effect criterion and alternative on the performance of the suppliers.

Methodology we are going to use for the above purpose is as following and the model is shown in Fig. 3.2,

- We have used MISM (Modified Interpretive Structural Modelling) technique, for studying the interaction between the criteria and prioritizing the criteria. We got the weights for the performance criteria and established a contextual relationship between elements with respect to which pairs of elements, which are examined and ranked.
- AHP (Analytical Hierarchy Process) is used to rank the supplier and found out the best supplier from the bunch of supplier.

4. METHODOLOGY

4.1 Identification Of The Performance Criterion

The performance criteria which are relevant from the supplier's point of view are identified by taking opinions from the industry experts and the literature reviewed. After discussing with the industry expert the factors which are finalized for the study are as follows,

- Quality (Q),
- Delivery (D),
- Productivity (P),
- Costs (C),
- Application of conceptual Manufacturing (A),
- Technological Capabilities (T),
- Environmental Management (E),
- Human Resource Management (H),
- Manufacturing Challenge (M),
- Service (S).

To meet standard requirement and continuous improvement in business, companies need to monitor their supplier performance. Delivery and quality are two of the most important indicators of supplier evaluation.

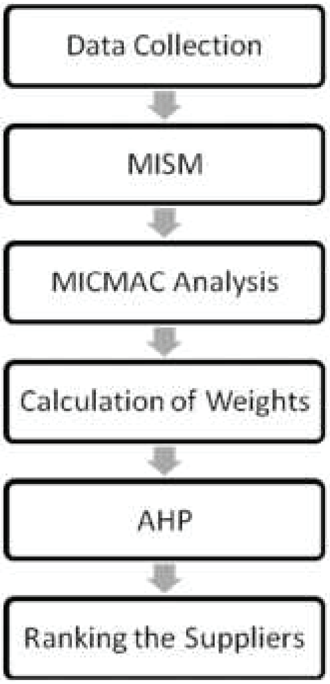

Fig. 3.2 Model Formulation

4.2 Modified Structural Self-Interaction Matrix

We have modified the technique by adding two more constraints in the Structural Self Interaction Matrix which will clearly discriminate among the factors, which will give a clearer idea about which factors are the driving factors and which are the depended factors. Thus we can prioritize them as well as rank them effectively. This will also help us to give weights to the criteria which in turn will help to rank the suppliers effectively.

For analyzing the performance criteria in developing SSIM, the following six symbols have been used to denote the direction of relationship between factors (i and j):

V - Factor i will affect factor j majorly;

A - Factor j will affect factor j majorly;

O- Factors i and j will help to achieve each other;

X – Factors i and j are unrelated;

E - Factor i will affect factor j;

U – Factor j will affect factor i.

4.3 Reachability Matrix

The SSIM has been converted into a matrix, called the initial reachability matrix by substituting V, A, O, X, E and U by 4, 3, 2, 1 and 0 as per given case.

- if the (i, j) entry in the SSIM is V, then the (i, j) entry in the reachability matrix becomes 4 and the (j, i) entry becomes 0;
- if the (i, j) entry in the SSIM is A, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 4;
- if the (i, j) entry in the SSIM is O, then the (i, j) entry in the reachability matrix becomes 2 and the (j, i) entry also becomes 2;
- if the (i, j) entry in the SSIM is X, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry also becomes 0;
- if the (i, j) entry in the SSIM is E, then the (i, j) entry in the reachability matrix becomes 3 and the (j, i) entry also becomes 1;
- if the (i, j) entry in the SSIM is U, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry also becomes 3.

4.4 Level Partition

The reachability and antecedent set (Warfield 1974) for each factor is found from the reachability matrix. The reachability set for a particular variable consists of the variable itself and the other variables, which it may help to achieve. The antecedent set consists of the variable itself and the other variables, which may help in achieving them. Subsequently, the intersection of these sets is derived for all variables. The variable for which the reachability and the intersection sets are the same is given the top-level variable in the ISM hierarchy, which would not help achieve any other variable above their own level. After the identification of the top-level factors, it is discarded from the other remaining variables. This iteration is continued until the levels of each variable are found out. The identified levels aids in building the digraph and the final model of ISM.

4.5 MICMAC Analysis

The objective of the MICMAC analysis is to analyse the driver power and the dependence power of the variables. The variables are classified into four clusters as shown in figure 2. The first cluster consists of the autonomous criteria that have weak driver power and weak dependence. These criteria are relatively disconnected from the system, with which they have only few links, which may be strong. Second cluster consists of the dependent criteria that have weak driver power but strong dependence. The third cluster has the linkage criteria that have strong driving power also strong dependence. These criteria are unstable in the fact that any action on these criteria will have an effect on others also a feedback on themselves. The fourth cluster includes the independent criteria having strong driving power but weak dependence. It is observed that a variable with a very strong driving power called the key variables falls into the category of independent or linkage criteria.

4.6 Analytical Hierarchy Process

Then Analytical Hierarchy Process is used to for evaluating the suppliers. We have used the linguistic variable scale consisting of 5 ratings to rate the different suppliers. Then normalized weights for each supplier with respect to the various factors have been calculated. The priority weights of suppliers with respect to the each factor are given by adding the weights per supplier multiplied by weights of the corresponding performance factor.

5. APPLICATION OF MODEL TO CASE ILLUSTRATION

The objective of this section is to find interaction between the performance criteria, to find the criteria weights and to discriminate the best suppliers from the other, also to validate the model by carrying out the sensitivity analysis. The model has been applied to the automotive component manufacturing company in the southern part of India. The required data have been collected from the same industry and model has been worked out for the industry.

In this research for identifying the contextual relationship among the performance factors for the supplier selection, cross functional team from the industry were consulted for the above work.

5.1 Weights for the Performance Criteria

The hierarchy levels obtained from the Modified ISM method are used to obtain the weights for each factor. The Modified Structural Self Interaction Matrix (MSIM) is shown in table 5.1; the Reachability Matrix is calculated and shown in table 5.2. The overall Level partition is shown in table 5.3. The number of levels in the ISM process for the criteria is 5. So the maximum rating of the criteria, i.e. 4 is divided by 5 to obtain the weight of the lowest level (i,e, 4/5 = 0.8). The multiples of this value are used for assigning the weights to the higher values. The normalized weights of the performance factors are calculated in table 5.4. The factors with the highest level are given a weight of 4. The criteria that have the same level are assigned same values. Modified ISM based hierarchy model for the criterion is shown in fig 5.1.

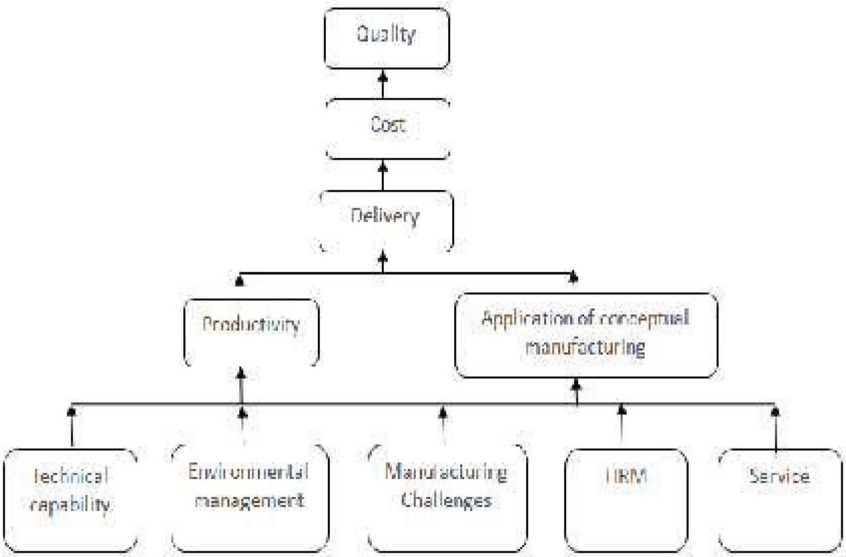

Fig. 5.1 Modified ISM based hierarchy model for the criterion

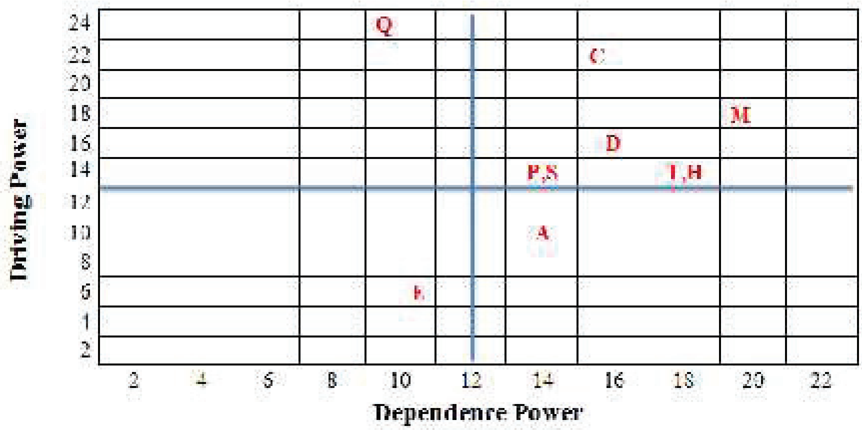

Fig. 5.2 driving power and dependence diagram for criterion from Modified ISM

We have also used ISM technique to identify the interrelationship between the performance measures. The results of the ISM are as shown below in fig. 5.3 with the digraph showing hierarchy levels of the performance factors. From the digraph below service is at the highest level followed by quality, cost, and productivity and so on. The MICMAC analysis fig. 5.4 also shows most of the criteria are concentrated in third cluster which shows linkage criteria.

We have used Modified ISM technique to get the clearer idea about which factors are driving factors which are dependent and to prioritize them more effectively into the four groups in MICMAC analysis and also to get the proper hierarchy structure by adding two more constraints. Through Modified

Interpretive Structural Modelling we got more practical results. ISM technique is used to verify the Modified ISM technique. After comparing the ISM & Modified ISM and consulting the cross functional team from industry, we found out that MISM is giving better results satisfying the industry requirement.

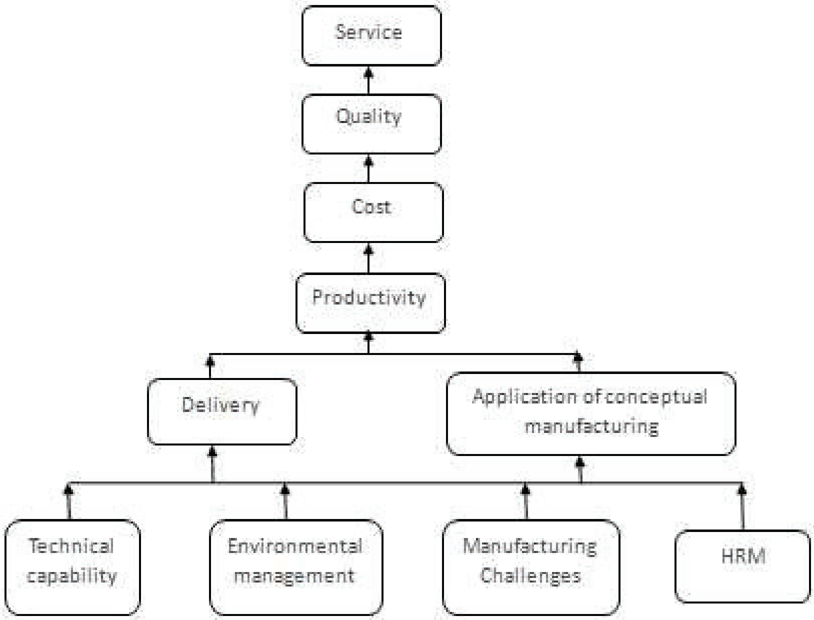

Fig. 5.3 ISM based hierarchy model for the criterion

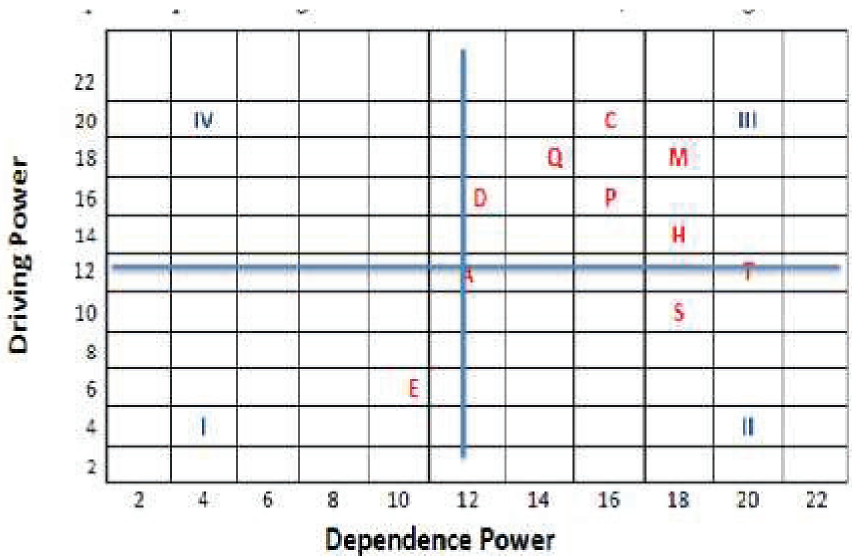

Fig. 5.4 driving power and dependence diagram for criterion from ISM

Table 5.1 Modified Structural Self Interaction Matrix (MSIM) showing linguistic variables for the performance criterion

Factors Description	Quality	Delivery	Productivity	Costs	Application of Conceptual manufacturing	Technological Capability	Environment Management	HRM	Manufacturing Challenges	Service
Quality	O	X	O	V	E	V	X	E	U	V
Delivery	-	O	O	E	X	U	V	E	X	U
Productivity	-	-	O	A	V	O	X	O	O	X
Costs	-	-	-	O	E	O	X	O	E	O
Application of Conceptual Manufacturing	-	-	-	-	O	O	X	X	V	X
Technological Capability	-	-	-	-	-	O	X	X	O	U
Environmental Management	-	-	-	-	-	-	O	U	O	X
HRM	-	-	-	-	-	-	-	O	U	O
Manufacturing Challenges	-	-	-	-	-	-	-	-	O	O
Services	-	-	-	-	-	-	-	-	-	O

Table 5.2 Reachability Matrix showing driving powers and dependence power for each criterion

Factors Description	Quality	Delivery	Productivity	Costs	Application of Conceptual manufacturing	Technological Capability	Environment Management	HRM	Manufacturing Challenges	Service	Driving Power
Quality	2	0	2	4	3	4	0	3	1	4	**23**
Delivery	0	2	2	1	0	1	4	3	0	1	**14**
Productivity	2	2	2	0	4	2	0	2	2	0	**16**
Costs	0	3	4	2	3	2	0	2	3	2	**21**
Application of Conceptual Manufacturing	1	0	0	1	2	2	0	0	4	0	**10**
Technological Capability	0	3	2	2	2	2	0	0	2	1	**14**
Environmental Management	0	0	0	0	0	0	2	1	2	0	**5**
HRM	1	1	2	2	0	0	3	2	1	2	**14**
Manufacturing Challenges	3	0	2	1	0	2	2	3	2	2	**17**
Services	0	3	0	2	0	3	0	2	2	2	**14**
Dependence Power	**9**	**14**	**16**	**15**	**14**	**18**	**11**	**18**	**19**	**14**	

Table 5.3 Overall Level partition of factors

Factors	Reachability Set	Antecedent Set	Intersection	Level
Q	Q,P,C,A,T,H,M	Q,P,A,H,M,S	Q,P,A,H,M	Level 5
P	D,P,C,T,E,H,S	D,P,C,T,H,S	D,P,C,T,H,S	Level 2
D	Q,D,P,A,T,H,M	Q,D,P,C,T,H,M	Q,D,P,T,H,M	Level 3
C	D,P,C,A,T,H,M,S	Q,D,C,A,T,H,M,S	D,C,A,T,H,M,S	Level 4
A	Q,C,A,T,M	Q,P,C,A,T	Q,C,A,T	Level 2
T	D,P,C,A,T,M,S	Q,D,P,C,A,T,M,S	D,P,C,A,T,M,S	Level 1
E	E,H,M	D,E,H,M	E,H,M	Level 1
H	Q,D,P,C,E,H,M,S	Q,D,P,C,E,H,M,S	Q,D,P,C,E,H,M,S	Level 1
M	Q,P,C,T,E,H,M,S	Q,P,C,A,T,E,H,M,S	Q,P,C,T,E,H,M,S	Level 1
S	Q,D,C,T,H,M,S	D,C,T,H,M,S	D,C,T,H,M,S	Level 1

Table 5.4 Normalized weights of the performance criterion

Performance criteria i	Levels p	Weights w_i	Normalized Weights nw_i
Quality	Level 5	4.0	0.2381
Productivity	Level 2	1.6	0.0952
Delivery	Level 3	2.4	0.1429
Costs	Level 4	3.2	0.1905
Application of Conceptual Manufacturing	Level 2	1.6	0.0952
Technological Capability	Level 1	0.8	0.0476
Environmental Management	Level 1	0.8	0.0476
HRM	Level 1	0.8	0.0476
Manufacturing Challenges	Level 1	0.8	0.0476
Services	Level 1	0.8	0.0476

Then normalized weights for each supplier with respect to the various factors have been calculated. The priority weights of suppliers with respect to the each factor are given by adding the weights per supplier multiplied by weights of the corresponding performance factor. Finally the priority weights of each supplier can be calculated by weights per supplier multiplied by weights of the corresponding criterion. The highest score of the supplier gives the idea about the best global supplier for supply of the parts.

While using AHP we have to check the consistency of the matrix, but we are using hybrid technique using MISM and AHP in which we are not using the pair wise comparison of the criteria elements to calculate the priority weights. Instead we are using the MISM technique so we need not have to check the consistency of the matrix.

Table 5.5 Summary combination of the priority weights: performance criteria of the overall objective with the alternatives (i.e. 20 Suppliers)

	Quality	Delivery	Productivity	Costs	Application of Conceptual manufacturin	Technological Capability	Environment Management	HRM	Manufacturin g Challenges	Service	**Alternative priority weights**
Weights	0.23	0.09	0.14	0.19	0.09	0.04	0.04	0.04	0.04	0.04	
Suppliers											
s1	0.05	0.05	0.04	0.04	0.02	0.05	0.04	0.04	0.05	0.04	**0.047**
s2	0.05	0.04	0.05	0.05	0.02	0.05	0.03	0.05	0.04	0.05	**0.050**
s3	0.04	0.05	0.04	0.05	0.05	0.06	0.06	0.05	0.04	0.05	**0.051**
s4	0.04	0.04	0.04	0.05	0.07	0.04	0.04	0.04	0.05	0.05	**0.050**
s5	0.05	0.05	0.04	0.04	0.07	0.04	0.03	0.05	0.04	0.05	**0.051**
s6	0.05	0.05	0.04	0.04	0.02	0.05	0.04	0.05	0.04	0.04	**0.047**
s7	0.05	0.05	0.04	0.04	0.07	0.04	0.06	0.05	0.04	0.04	**0.052**
s8	0.04	0.0	0.04	0.04	0.02	0.04	0.03	0.05	0.05	0.05	**0.043**
s9	0.05	0.04	0.04	0.05	0.05	0.05	0.06	0.04	0.04	0.04	**0.051**
s10	0.05	0.05	0.05	0.04	0.05	0.04	0.06	0.05	0.05	0.05	**0.052**
s11	0.04	0.05	0.04	0.05	0.02	0.04	0.04	0.04	0.04	0.05	**0.046**
s12	0.04	0.05	0.05	0.04	0.07	0.06	0.04	0.05	0.04	0.04	**0.052**
s13	0.04	0.05	0.05	0.04	0.02	0.05	0.03	0.04	0.05	0.05	**0.046**
s14	0.04	0.05	0.04	0.05	0.05	0.06	0.06	0.05	0.04	0.04	**0.050**
s15	0.04	0.04	0.04	0.04	0.05	0.04	0.06	0.04	0.04	0.04	**0.045**
s16	0.05	0.05	0.04	0.04	0.05	0.04	0.04	0.05	0.05	0.05	**0.050**
s17	0.05	0.04	0.04	0.05	0.07	0.06	0.03	0.04	0.04	0.05	**0.053**
s18	0.05	0.05	0.04	0.04	0.02	0.05	0.06	0.05	0.05	0.04	**0.048**
s19	0.05	0.04	0.05	0.05	0.05	0.04	0.03	0.05	0.04	0.05	**0.051**
s20	0.05	0.04	0.05	0.04	0.07	0.04	0.06	0.04	0.05	0.05	**0.053**
									Total		**1.00**

Now, from the above table 5.5 and bar graph in figure 5.5 we can clearly find that Suppliers 17, 20, 10, 7, 12 are the best suppliers for the mentioned scenario.

Fig. 5.5 Suppliers rating

We have taken the four most important criteria from the supplier selection point of view which we got from the MISM technique and the five best suppliers which we got from the AHP to carry the sensitivity analysis to find out the most critical criteria and the most critical alternative i.e. supplier. The four criteria are Quality, Delivery, Cost and Productivity and the suppliers are S17, S20, S10, S7 and S12.

6. RESULTS AND DISCUSSION

In the current scenario of global operating conditions and competitive environment, it has become highly necessary for organizations to select the best supplier. Any inaccurate selection of supplier will lead to numerous problems which affect the company's overall performance. This shows that supplier selection procedure is a highly essential concern for companies. The selection of the right supplier from the growing number of alternatives in the market is complicated. A lot of supplier selection models are available in the literature, in this study, as discussed in the earlier chapters; this project is an attempt to arrive at an integrated method for supplier selection using MISM and AHP method. We have modified the original ISM technique by adding two more constraints in the Structural Self Interaction Matrix which will clearly discriminate among the factors and their interactions, which will give clearer idea about which factors are the driving factors and which are the depended factors. Thus we can prioritize them as well as rank them effectively. And will help us to give weights to the criteria which in turn will help to rank the suppliers effectively. This study focuses on the performance factors that influence supplier selection and the model has been built based on those factors and then Sensitivity Analysis is done to find out how sensitive these factors and the suppliers are to the change in other factors.

This method is applied to an automotive components manufacturing industry, and a particular component has 20 suppliers. Qualification and final selection of the supplier is done based on the criteria decided by the experts. Modified ISM technique is used to find the interrelationship between the criteria and weights for the each criterion. With the help of the supplier weights which we have collected from the industry and criteria weights from MISM. AHP is used for obtaining the weights for the each supplier for the each performance measure and obtaining 5 optimal solutions from 20 suppliers namely, S17, S20, S10, S7, S12.

7. CONCLUSION

The hybrid technique of Modified Interpretive Structural Modelling and Analytical Hierarchy Process with Sensitivity Analysis gives the more practical results than the traditional techniques. The interaction with the industry experts makes this model more feasible and practical. Also the modified ISM technique gives more practical results and clearer idea about the interrelationship of the performance factors. The model has been worked out for the automotive industry in southern part of India and results were implemented in the industry.

8. REFERENCES

[1] A. Amid, S.H.Ghodsypour, C.O'Brien. (2011) A weighted max–min model for fuzzy multi-objective supplier selection in a supply chain. Int. J. Production Economics 131 (2011) 139–145.

[2] Alessio Ishizaka, Ashraf Labib. (2011) Review of the main developments in the analytic hierarchy process. Expert Systems with Applications 38 (2011) 14336–14345.

[3] Anjali Awasthi, SatyaveerS.Chauhan, S.K.Goyal. (2010) A fuzzy multicriteria approach for evaluating environmental performance of suppliers. Int. J. Production Economics 126 (2010) 370–378.

[4] Ashutosh Sarkar, Pratap K.J. Mohapatra. (2006) Evaluation of supplier capability and performance: A method for supply base reduction. Journal of Purchasing & Supply Management 12 (2006) 148–163.

[5] Carol Prahinski, W.C. Benton. (2004) Supplier evaluations: communication strategies to improve supplier performance. Journal of Operations Management 22 (2004) 39–62.

[6] Chen, Y., J. Yu, K. Shahbaz and E. Xevi. (2009) A GIS-Based Sensitivity Analysis of Multi-Criteria Weights. 18th World IMACS / MODSIM Congress, Cairns, Australia 13-17 July 2009.

[7] Che-Wei Chang a,*, Cheng-Ru Wu b, Chin-Tsai Lin c, Huang-Chu Chen. (2007). An application of AHP and sensitivity analysis for selecting the best slicing machine. Computers & Industrial Engineering 52 (2007) 296–307.

[8] Desheng Dash Wu, Yidong Zhang, Dexiang Wu, David L. Olson. (2010) Fuzzy multi-objective programming for supplier selection and risk modeling: A possibility approach. European Journal of Operational Research 200 (2010) 774–787.

[9] Evangelos Triantaphyllou, Alfonso Sánchez. A sensitivity analysis approach for some deterministic multi-criteria decision making methods. Decision Sciences, Vol. 28, No. 1, pp. 151-194, Winter 1997.

[10] Felix T.S. Chan, Niraj Kumar. (2007) Global supplier development considering risk factors using fuzzy extended AHP-based approach. Omega 35 (2007) 417 – 431.

[11] G. Kannan And A. Noorul Haq. (2006) Analysis of interactions of criteria and sub-criteria for the selection of supplier in the built-in-order supply chain environment. International Journal of Production Research, Vol. 45, No. 17, 1 September 2007, 3831–3852.

[12] Hadi Shirouyehzad, Hamidreza Panjehfouladgaran, Reza Dabestani, Mostafa Badakhshian. (2011) Vendor Performance Measurement Using Fuzzy Logic Controller. The Journal of Mathematics and Computer Science Vol .2 No.2 (2011) 311-318.

[13] Huan-Jyh Shyura, Hsu-Shih Shih. (2005) A hybrid MCDM model for strategic vendor selection. Mathematical and Computer Modelling 44 (2006) 749–761.

[14] Jiann Liang Yang, Huan Neng Chiu, Gwo-Hshiung Tzeng, Ruey Huei Yeh (2008) Vendor selection by integrated fuzzy MCDM techniques with independent and interdependent. Information Sciences 178 (2008) 4166–4183.

[15] M. D. Singh, R. Kant. (2008) Knowledge management barriers: An interpretive structural modelling approach. International Journal of Management Science and Engineering Management Vol. 3 (2008) No. 2, pp. 141-150

[16] M. Punniyamoorthy, P. Mathiyalagan, P. Parthiban. (2011) A strategic model using structural equation modeling and fuzzy logic in supplier selection. Expert Systems with Applications 38 (2011) 458–474.

[17] Rajat Bhagwat, Milind Kumar Sharma. (2007) Performance measurement of supply chain management: A balanced scorecard approach. Computers & Industrial Engineering 53 (2007) 43–62.

[18] Rick Gorvett, FCAS, MAAA, FRM, ARM, Ph.D., Ningwei Liu, Ph.D. (2006) Interpretive Structural Modeling of Interactive Risks. Enterprise Risk Management Symposium, Chicago, IL.

[19] Sachin B. Modi, Vincent A. Mabert. (2007) Supplier development: Improving supplier performance through knowledge transfer. Journal of Operations Management 25 (2007) 42–64.

[20] Samuel H. Huang, Harshal Keskar. (2006) Comprehensive and configurable metrics for supplier selection. Int. J. Production Economics 105 (2007) 510–523.