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Combined AHP-TOPSIS Based Approach for the Evaluation of Knowledge Sharing Capabilities of Supply Chain Partners

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Abstract

A supply chain (SC) consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves. Supplier selection is one of the basic activities of Supply Chain Management (SCM). A best supplier for the firm is one who has implemented the concept of knowledge management successfully in his firm. Therefore the evaluation of knowledge sharing capability of suppliers becomes a task of prime importance. Such a case may be treated as a case of multi criteria decision making problem, which may be solved by using various Multi Criteria Decision Making (MCDM) techniques. In present paper the use of AHP and TOPSIS is shown with an example. Firstly, the weights of criteria are calculated by using Analytical Hierarchy Process (AHP), and then by implementing TOPSIS algorithm, assessment of knowledge sharing capabilities has been done.

Key words: Supply chain management (SCM); Multi criteria decision making (MCDM); Analytical hierarchy process (AHP); TOPSIS technique; Supplier; Supplier selection; Criteria; Weight; Firm; Knowledge sharing capabilities; Knowledge management; Supply chain; Customers; Task; Evaluation

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INTRODUCTION

Supply Chain Management (SCM) is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses and stores, so that merchandise is produced and distributed at the right quantities, to the right locations and at the right time in order to minimize system-wide costs while satisfying service level requirements (Simchi-Levi, Kaminsky, & Simchi-Levi, 2000). A supply chain is a business process that links suppliers, manufacturers, retailers and customers and are interrelated (Mishra, Lal, & Das, 2002). In the field of supply chain research, collaboration and information technology are regard as two essential parameters in the integration and coordination of the network. (Leee & Whang, 2000; Handfield & Jr Nichols, 1999). A variety of criteria appropriate for vendor selection have been developed in the past decades, but the information sharing capability of the supply chain partners was rare mentioned. It is especially important dimension since information technology is necessary to horizontally integrate geographically dispersed operations. Evaluation of the information sharing capability of potential supply chain partners can be considered as a multiple-attribute decision-making problem (Yang & Tu, 2009). Analytical Hierarchy Process (AHP), a commonly used quantitative research method, is the widely used evaluation indicator solution. AHP can quantify qualitative issues, which is effective to optimize the multi-level and multi-objective large-scale systems. Abroad, AHP is widely used in energy, resource allocation, program evaluation process, environmental prediction, evaluation, environmental protection norms, etc (GE, 2009). The technique for order preference by similarity to ideal solution (TOPSIS) is one of the well known classic MCDM methods. TOPSIS is a widely accepted multi-attribute decision-making technique due to its sound logic, simultaneous consideration of the ideal and the anti-ideal solutions, and easily programmable computation procedure (Lu & Zhao, 2008). The paper is organized in four sections. First, a review of knowledge sharing and knowledge sharing capability is presented. The methodology of the study is explained next followed by an illustrative application of combined AHP and TOPSIS. Finally, a number of issues and future directions are summarized in the final sections of the paper.

1. LITERATURE REVIEW

Many researchers have provided taxonomies and frameworks to help practitioners and academicians to understand the concept of supply chain management. Over years, researchers have focused on the role of suppliers in supply chain management. A number of criteria appropriate for supplier selection have been developed in the past decades. Dickson firstly performed an extensive study to determine, identify and analyze what criteria were used in the selection of a firm as a supplier. Dickson's study was based on a questionnaire sent to 273 purchasing agents and managers selected from the membership list of the National Association of Purchasing Managers. His research work was based on 23 selection criteria (Dickson, 1966). Ellram described the factors that influenced firm choice of a supplier: financial, performance, technology, organizational culture and strategy, and other factors such as safety record, business references, and suppliers' customer base (Ellram, 1990). In the review of Weber, the most mentioned criteria were price, delivery, quality, facilities and capacity, geographic location, and technical capability (Weber, Current, & Benton, 1991). Another study by Tullous and Munson discovered that quality, price, technical service, delivery, reliability, and lead time were among the most important selection factor (Tullous & Munson, 1991). Proceeding in the same direction, the review performed by Bross and Zhao concluded that the most valuable supplier selection criteria were cost, quality, service, relationship and organization. Simultaneously, many studies were conducted to identify the influence of the knowledge sharing capability of supply chain partners. Simultaneously, many studies were conducted to identity influences on knowledge management level of supply chain partners in terms of knowledge sharing capabilities (Bross & Zhao, 2004). In 2004, M. Huysman and D. de Wit investigate Social Networks as an important criterion for knowledge sharing. In the year of 2007, Lin identified determinants of knowledge sharing attitudes and intentions. He classified them as extrinsic and intrinsic. In 2008, M. D Singh and R. Kant identified 9 barriers in the successful implementation of knowledge management. These are Lack of Top Management Commitment, Lack of Technological Infrastructure, Lack of Methodology, Lack of Organizational Structure, Lack of Organizational Culture, Lack of Motivation and Reward, Staff Retirement, Lack of Ownership Problem and Staff Deflection. In their research work they also developed the relationship between the barriers. In 2009, Zhong Hua Yang and Jing Tu proposed three criteria for knowledge sharing as corporate culture, Leadership and Information Technology. They sub classified these criteria in 13 different sub criteria.

1.1 Criteria for the Evaluation of Information Sharing Capability of Suppliers

In this research, the evaluation criterion has been developed on the basis of literature review and a series of informal discussions with the academicians and industry personnel. The details of the criteria for the evaluation of knowledge sharing capabilities are given as follows:

Table 1
Evaluation Criteria for Suppliers

S. No	Criteria classification	References
1	Top Management Support, Commitment & Encouragement	ZhongHua Yang and Tu Jing, 2009.and M.D Singh and R.Kant, 2008
2	Technological Infrastructure	M.D Singh and R.Kant, 2008
3	Staff Retirement and Deflection	M.D Singh and R.Kant, 2008
4	Motivation & Reward	M.D Singh and R.Kant, 2008
5	Social Networks	Yang ZhongHua and Tu Jing.2009 and M. Huysman and D. Ke Wit, 2004.
6	Organization Structure	M.D Singh and R.Kant,2008
7	Organization Culture	M.D Singh and R.Kant,2008
8/	Vision and Goals	Yang ZhongHua and Tu Jing.2009
9	Interpersonal Trust	Yang ZhongHua and Tu Jing.2009
10	Open Leadership Climate	Yang ZhongHua and Tu Jing.2009
11	Methodology	M.D Singh and R.Kant,2008
12	Sharing Culture	Yang ZhongHua and Tu Jing.2009
13	Data Management Capability	Yang ZhongHua and Tu Jing.2009
14	Learning Orientation	Yang ZhongHua and Tu Jing.2009

2. METHODOLOGY

2.1 Analytical Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a structured technique for helping people deal with complex decisions. Rather than prescribing a "correct" decision, the AHP helps people to determine one. An AHP hierarchy is a structured means of describing the problem at hand. It consists of an overall goal, a group of options or alternatives for reaching the goal, and a group of factors or criteria that relate the alternatives to the goal. In most cases the criteria are further broken down into sub criteria, sub-sub criteria, and so on, in as many levels as the problem requires (Figure 1).The hierarchy can be visualized as a diagram like the one below, with the goal at the top, the alternatives at the bottom, and the criteria filling up the middle. In such diagrams, each box is called a node. The boxes descending from any node are called its children. The node from which a child node descends is called its parent. Applying these definitions to the diagram below, the five Criteria are children of the Goal, and the Goal is the parent of each of the five Criteria. Each Alternative is the child of each of the Criteria, and each Criterion is the parent of three Alternatives (Saaty, 1990, 1994).

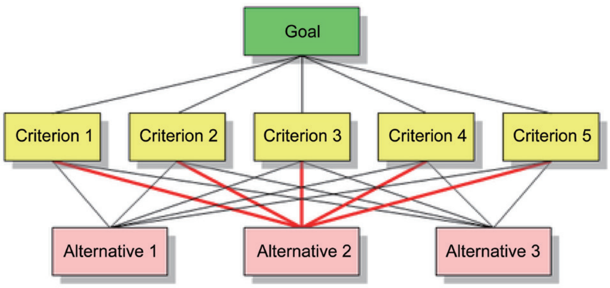

Figure 1
Hierarchical Structure for AHP (Saaty, 1977 and 1994)

Once the hierarchy is built, the decision makers systematically evaluate its various elements, comparing them to one another in pairs. In making the comparisons, the decision makers can use concrete data about the elements, or they can use their judgments about the elements' relative meaning and importance. It is the essence of the AHP that human judgments, and not just the underlying information, can be used in performing the evaluations. For this purpose a pair wise comparison scale is used, which is shown in the Table 2 given below. After that AHP converts the evaluations to numerical values that can be processed and compared over the entire range of the problem. A numerical weight or priority is derived for each element of the hierarchy, allowing diverse and often incommensurable elements to be compared to one another in a rational and consistent way. Priorities are numbers associated with the nodes of the hierarchy. The priority of the Goal is taken as 1.000. The priorities of the children of any Criterion can also vary but will always add up to 1.000, as will those of their own children, and so on down the hierarchy. If the priorities within every group of child nodes are equal then the priorities are called Default Priorities. The priority of an attribute with respect to the ultimate goal is called Global Priority. The priorities indicate the relative weights given to the items in a given group of nodes. Depending on the problem at hand, "weight" can refer to importance, or preference, or likelihood, or whatever factor is being considered by the participants. This capability distinguishes the AHP from other decision making techniques. In the final step of the process, numerical priorities are derived for each of the decision alternatives. Since these numbers represent the alternatives' relative ability to achieve the decision goal, they allow a straightforward consideration of the various courses of action.

Table 2
Pair Wise Comparison Scale (Saaty, 1977, 1980; Kumar, 2006)

The Fundamental scale for pairwise comparisons		
Intensity of importance	**Definition**	**Explanation**
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another; its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Intensities of 2, 4, 6 and 8 can be used to express intermediate values. Intensities 1.1, 1.2, 1.3, etc., can be used for elements that are very close in importance.		

Saaty (1990 and 1994) has defined the following steps for applying AHP:

i. Define the problem and determine its goal,

ii. Structure the hierarchy with the decision maker's objective at the top with the intermediate levels capturing criteria on which subsequent levels depend and the bottom level containing the alternatives, and

iii. Construct the set of n× n pair wise comparison matrices for each to the lower levels with one matrix for each element in the level immediately above. The pair wise comparisons are made suing the relative measurement scale (as discussed above). The pair wise comparisons capture a decision maker's perception of which element dominates the other.

iv. There are n(n-1)/2 judgments required to develop the set of matrices in step 3. Reciprocals are automatically assigned in each pair wise comparison.

v. The hierarchy synthesis function is used to weight the eigenvectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the hierarchy.

vi. After all the pair wise comparisons are completed, the consistency of the comparisons is assessed by using the Eigen value, **λ**, to calculate a consistency index, CI:

$$C.I. = (\lambda-n)/ (n-1) \quad (1)$$

Where n is the matrix size. Judgment consistency can be checked by taking the consistency ratio (C.R.).

$$C.R. = C.I. /R.I. \quad (2)$$

Where R.I. stands for Random Consistency Index, which with the appropriate value is given in Table 3. Saaty (1980) suggests that the C.R. is acceptable if it does not exceed 0.10. If the CR is greater than 0.10, the judgment matrix should be considered inconsistent. To obtain a consistent matrix, the judgments should be reviewed and repeated.

Table 3
Average Random Consistency Index (Saaty, 1994)

Size of Matrix	1	2	3	4	5	6	7	8	9	10
Random consistency index (R.I.)	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

2.2 The TOPSIS Method

The technique for order preference by similarity to ideal solution (TOPSIS) is one of the well known classic MCDM methods. TOPSIS is a widely accepted multi-attribute decision-making technique due to its sound logic, simultaneously consideration of the ideal and the anti-ideal solutions, and easily programmable computation procedure. This technique is based on t he concept that the ideal alternative has the best level for all attributes, whereas the negative ideal is the one with all of the worst attribute values.

The basic principle of TOPSIS is that the chosen alternative should have the shortest distance from the ideal solution and the farthest distance from the negative ideal solution. The various J alternatives are denoted as A_1, A_2 ….A_J. For alternative A_J the rating of the i^{th} aspect is denoted by f_{ij}, f_{ij} is the value of i^{th} criterion function for alternative A_J; n is the no. of criterion. The TOPSIS procedure consists of the following steps:

Step 1: Calculate the normalized decision matrix.

$$r_{ij} = \frac{fij}{\sum_{j=1}^{J} f_{ij}^2} \text{ where } j = 1,2,3,\ldots\ldots\ldots\ldots J,$$
$$i = 1, 2, 3,\ldots\ldots\ldots\ldots n \quad (3)$$

Step 2: Calculate the weighted normalized decision matrix.

The weighted normalized value is calculated as:

$$V_{ij} = w_{ij} \times r_{ij} \quad (4)$$

Where w_i is the weight of the i_{th} attribute or criterion, and it is calculated by AHP method.

$$w_i = 1 \quad (5)$$

Step 3: Determine the ideal and negative-ideal solution.

$$A^* = \{v_1^*, v_2^*, \ldots\ldots\ldots\ldots v_i^*\} = \{(\max v_{ij}/i\text{Є}I')_i.(\min v_{ij}/j\text{Є}I'')_j\} \quad (6)$$

$$A^- = \{v_1^-, v_2^-, \ldots\ldots\ldots\ldots v_i^-\} = \{(\min v_{ij}/i\text{Є}I')_i.(\max v_{ij}/j\text{Є}I'')_j\} \quad (7)$$

Step 4: Calculate the separation measures, using the n dimensional Euclidean Distance.

The separation of each alternative from the ideal solution is given as:

$$D_j^* = \sqrt{\sum_{i=1}^{n} (vij - vi^*)^2}; \text{ where } j = 1, 2, 3\ldots\ldots\ldots\ldots J. \quad (8)$$

Similarly, the separation from the negative ideal solution is given as:

$$D_j^- = \sqrt{\sum_{i=1}^{n} (vij - vi-)^2}; \text{ where } j = 1, 2, 3\ldots\ldots\ldots\ldots J. \quad (9)$$

Step 5: Calculate the relative closeness to the ideal solution.

The relative closeness of the alternative a_j is defined as:

$$CC^*_j = \frac{Dj^*}{Dj^* + Dj-} \quad (10)$$

Step 6: Rank the preference order (Lu & Zhao, 2008).

3. CASE STUDY

In present example the vendors selected for the analysis are three in number. In this paper we test the knowledge sharing capability level of the different on the anvil of different criteria.

The detailed evaluation plan is given as follows:

a. Determine the priorities of different criteria using AHP. For this, Pairwise comparison between the different criterions is made and the criteria are assigned the values from 1 to 9 according to Pair wise comparison scale (Saaty, 1977; Saaty, 1980; & Kumar, 2006). After Pair wise comparison, the results of the comparison are represented in n×n matrix form and the Eigen values of the matrix are evaluated along with the Consistency Ratio (CR) values. In this research work the AHP software is used. The details of priority values and CR value are given in Table 4.

Table 4
Priority Values for Criteria Using AHP

S. No	Criteria classification	Abbreviations	Priority values
1	Top management support, commitment & encouragement	TMSCE	0.0941
2	Technological infrastructure	TI	0.103
3	Staff retirement and deflection	SRD	0.0789
4	Motivation & reward	MR	0.0981
5	Social networks	SN	0.090
6	Organization structure	OS	0.0644
7	Organization culture	OC	0.0664
8	Vision and goals	VG	0.0648
9	Interpersonal trust	IT	0.0709
10	Open leadership climate	OLC	0.0718
11	Methodology	M	0.0528
12	Sharing culture	SC	0.0454
13	Data management capability	DMC	0.0546
14	Learning orientation	LO	0.0504
Consistency Ratio: 0.099<0.10			

b. Now in order to calculate the evaluation of knowledge sharing capabilities the questionnaire are circulated to the vendors which contain questions related to knowledge sharing activities. After that numerical weights are assigned to the vendors according to the entries provided by them. Table 5 gives the details.

Table 5
Judgment Data Matrix

Criteria/ → Suppliers ↓	TMSCE	TI	SRD	MR	SN	OS	OC	VG	IT	OLC	M	SC	DMC	LO
Weights →	0.0941	0.103	0.0789	0.0981	0.090	0.0644	0.0664	0.0648	0.0709	0.0718	0.0528	0.0454	0.0546	0.0504
I	7	8	6	9	4	5	1	7	6	3	9	8	5	4
II	8	8	7	9	6	4	8	7	6	4	7	8	9	9
III	2	3	1	4	5	8	7	9	5	4	6	7	8	9
V_{ij}	10.81	11.70	9.27	13.34	8.77	10.24	10.67	13.37	9.84	6.40	12.88	13.30	13.04	13.34

c. Form data obtained from Table 5 the values of ideal solution A* and negative ideal solution A^- will be calculated:

A* = (0.0116, 0.00333, 0.00637)

A^- = (0.007199, 0.009101, and 0.005395)

d. Now the separation of candidates from ideal and negative ideal solutions will be calculated:

D* = (0.107, 0.057, 0.080)

D^- = (0.084, 0.095, and 0.073)

e. Finally, the relative closeness to the ideal solution will be calculated as per equ. (10)

Table 6 gives the details.

Table 6
Evaluation of Suppliers

S.No	Supplier	CC_j^*
1	I	0.439
2	II	0.477
3	III	0.625

Thus the order of the alternatives is III > II > I. That is alternative III is the optimal one.

CONCLUSION

In this research paper, we have focused on the knowledge sharing capabilities of different suppliers. We have reviewed different criteria and find the level of knowledge sharing capabilities of different suppliers. For such type of comparison the methods of AHP and TOPSIS seem to be useful. From this research work, we can find that there are possibilities in the research for knowledge management activities of suppliers and constructive attempts should be made in this direction.

REFERENCES

Bross, M. E., & Zhao, G. (2004). *Supplier selection process in emerging markets: A case study of Volvo Bus Corporation in China* (Master's thesis). Retrieved from Goteborg University: https://gupea.ub.gu.se/handle/2077/2278

Dickson, G. W. (1966). An analysis of vendor selection systems and decisions. *Journal of Purchasing, 2*(1), 5-17.

Ellram, L. M. (1990). The supplier selection decision in strategic partnerships. *Journal of Purchasing and Material Management, 26*(4), 8-12.

Ge, Y. (2009). Research on Green Suppliers' Evaluation based on AHP & genetic algorithm. *International Conference on Signal Processing Systems*, 615-619.

Handfield, R. B., & Jr Nichols, E. L. (1999). *Supply chain management*. Englewood Cliffs, NJ: Prentice-Hall.

Huysman, M., & De Wit, D. (2004). Practices of managing knowledge sharing: Towards a second wave of knowledge management. *Journal of Knowledge and Process Management, 11*(2), 81-92.

Kumar, P. (2006). Integrated project evaluation and selection using multi attribute decision making technique, *International Journal of Production Economics, 103*, 90-103.

Leee, H. L., & Whang, S. (2000). Information sharing in a supply chain. *International Journal of Technology and Management, 20* (¾), 373-383.

Lin, H. F. (2007). Effects of extrinsic and intrinsic motivations on employee intentions to share knowledge. J*ournal of Information Science, 33*(2), 135-149.

Lu, J. C., & Zhao, Z. W. (2008). Improved TOPSIS based on rough set theory for selection of suppliers. *IEEE Journal*, 1-4.

Mishra, R., Lal, S., & Das, S. (2002). Introduction to supply chain management. *Journal of Productivity, 42*, 531-538.

Saaty, T. L. (1977). Modeling unstructured decision problems: A theory of Analytical Hierarchies. *Proceedings of the first International Conference on mathematical Modeling*, 69-77.

Saaty, T. L. (1980). *The analytical hierarchy process*. New York: Mc Graw Hill.

Saaty, T. L. (1990). How to make a decision: The analytical hierarchy process. *European Journal of Operational Research, 48*, 9-26.

Saaty, T. L. (1994). Highlights and Critical Points in theory and application of the Analytical Hierarchy Process. *European Journal of Operational Research, 74*, 426- 447.

Saaty, T. L. (1994). How to make a decision: The analytical hierarchy process. *Inferences, 24*, 19-43.

Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. (2000). *Designing and managing the supply chain: Concepts, strategies and case studies*. New Delhi: Mc Graw-Hill.

Singh, M. D., & Kant, R. (2008). Knowledge management barriers: An interpretive structural modeling approach. *International Journal of Management Science & Engineering Management, 3*(2), 141-150.

Tullous, R., & Munson, J. M. (1991). Trade-offs under uncertainty: Implications for industrial purchasers. *International Journal of Purchasing and Materials Management, 27*(3), 24-31.

Weber, C. A., Current, J. R., & Benton, W. C. (1991). Vendor selection criteria and methods. *European Journal of Operational Research, 50*(1), 2-18.

Yang, Z. H., & Tu, J. (2009). Evaluation of information sharing capability of supply chain partners. *Proceedings of the IEEE Forth International Conference on Computer Science & Education*, 651-655.

APPENDIX A

Pair wise Comparison Matrix

Criteria	TMSCE	TI	SRD	MR	SN	OS	OC	VG	IT	OLC	M	SC	DMC	LO
TMSCE	1	1	2	2	1	1	1	2	2	1	2	2	3	1
TI	1	1	2	2	1	3	2	1	3	1	3	2	1	1
SRD	1/2	1/2	1	1	1	1	3	1	3	1	2	1	2	1
MR	1/2	1/2	1	1	3	3	1	2	2	1	1	2	3	1
SN	1	1	1	1/3	1	3	2	3	1	2	1	2	1	2
OS	1	1/3	1	1/3	1/3	1	1	2	2	1	1	3	1	1
OC	1	½	1/3	1	½	1	1	2	1	1	1	1	3	2
VG	½	1	1	½	1/3	½	½	1	2	3	1	2	1	1
IT	½	1/3	1/3	1/2	1	½	1	½	1	2	3	4	2	2
OLC	1	1	1	1	½	1	1	1/3	½	1	3	2	2	2
M	½	1/3	½	1	1	1	1	1	1/3	1/3	1	2	2	1
SC	½	½	1	½	½	1/3	1	½	¼	½	½	1	2	2
DMC	1/3	1	½	1/3	1	1	1/3	1	½	½	1/2	½	1	5
LO	1	1	1	1	1/2	1	1/2	1	1/2	1/2	1	1/2	1/5	1