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ANALYTIC HIERARCHY PROCESS FOR SUPPLIER EVALUATION IN PROCUREMENT AND SUPPLY CHAINS

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Abstract

In the evolving landscape of industrial and service sectors, the focus has shifted towards optimizing outputs and analyzing the intricate dynamics of the supply chain's upper and lower components. This paradigm shift underscores the realization among industrial and service units in developed countries that sustained profitability lies in achieving a harmonious and efficient integration of components within the supply chain. The traditional approach of supplier selection based solely on recommended prices has proven inadequate. In this complex environment, managers grapple with various factors such as opportunities, threats, competitor evaluation, and the delicate balance between quality and price. This paper delves into the multifaceted challenges faced by contemporary businesses in navigating the complexities of supply chain management and underscores the imperative of holistic strategies for sustained success.

INTRODUCTION

With the appearance of supply chain, attention of many industrialists and service units has changed to output and the analysis of upper and lower part of supply chain. Nowadays, industrial and service units understand in developed country that their long-term profits are hidden in balanced and proper functioning of component and supply change integration. The other policies of choosing suppliers based on recommended price cannot be remedial. Opportunities and threats, evaluation of competitors, quality and price are factors that produce a complicated mystery among managers. The most important point is that it may not be a place for trial and error. This is because failure may lead to bankruptcy and losses. Choosing suppliers is not based on recommended price. Suppliers understand perfectly that quality assurance is useful for entering materials and component, and also investigation of commodity entered is not applied. In this type, factors interfere with choosing directly things like time of order, quality, guarantee, experience of cooperation etc. The technique of analytical hierarchy process was first recommended by Saati in 1980 (Tracey, 2011). This technique is introduced as a powerful and flexible

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tool in multi-criteria for solving complicated problem in deciding international association in science. AHP has three main concepts:

1, Organize complicated decision problem in the form of hierarchy of goal and criteria.

2, Compare every level of hierarchy with each criterion from previous level.

3, Integrate the different levels of hierarchy vertically (Rad et al., 2011).

Nowadays, the analytical hierarchy process has been developed theoretically and practically. Saati (1980) explained in an audit that several auditors have published in the field of theory of analytical hierarchal process from the beginning of its existence. So, large numbers of auditors have published in it generally. Nowadays, the centers of making decision as seen in traditional method and cheapest prices are needed to have non-scientific choices in industrial and service organizations. Suppliers are chosen based on the popularity of the suppliers and other parameters like situation of machines and physical space of workshops. In buying, relevant formalities are tracked as well as the basis of technical studies and price of last suppliers. Surely, this method of choosing has a lot of errors and the best choice would not be taken. Because choosing criteria and evaluation techniques are very important, discussion and confidence need to be configured (Ghodsi, 2005). Referring to researches done, one of the basic steps in managing the supply chain of supplier is to decrease suppliers (Monczka et al., 1995). This action can have the following benefits for producers:

1. Decreasing the total cost of products
2. Buying best suppliers
3. Using all supplier's facilities
4. Less cost of supplier's management and ability to perform advanced purchase policies
5. Ability to develop suppliers
6. Different models are designed to reach the above goals.

The works that have been performed till date can be categorized into two: choosing criteria and types of techniques and evaluating suppliers to be studied. From the most primary models, one can point categorized models in choosing supplier based on Timmerman (1986)'s explanation. These models were based on the experience of suppliers relevant to series of criteria. A method used by suppliers was weight-linear method that tried to categorize method better by weighing criterion. Finally, suppliers were ranked by calculating the final score of performance. Grando and Sianesi (1996) recommended a non-compensatory model. This model makes the decider doubtful because it cannot combine the relevant points of different criteria. Another model used mathematical programming to choose suppliers and simultaneously using weight models. Current and Weber (1994) has used mathematical programming facilities to choose suppliers. Another mathematical model relevant to choosing supplier can be found in the research of Buffa and Jackson (1983), Chaudhry et al. (1993) and Das and Tyagi (1994). Several mathematical models have limitations in term of quality, services and delivery. Several mathematical models were used in the research of Arianejad (2003), Degraeve and Roodhooft (2000), PaIij (1989) and Sadrian and Yoon (1998). Another models emphasized the basis of performing actions and technique of calculating paid expenses (total costs relevant to buying, giving services, quality and return items, technology) (Ellram, 1993). Main fact relevant to mathematical models is emphasizing on quantity items; quality criteria do not have a big role. We can refer to statistics model from another model used by Ronen and Trietsch (1988) or simulation model of Thompson (1990). These models are less practical in choosing suppliers because of the complicated methods. Few actions are taken to develop this. Masella and Rangone (2000) studied and emphasized on choosing supplier based on logistics and strategic integration between suppliers and buyers. He mentioned the method of hierarchy analysis as tools for making integration between different criteria. Other researchers that mentioned AHP technique include Razmi et al (1997), Ghodsi Poor (2005), Barbarosoglu and Yazgac (1997),

Handfield and Nichols (1999) and Narasimhan (1983). These researchers lay emphasis on multi-criteria. Compared to multi-goals, their analyses are only limited in quality and are less. Lee et al. (2011) have used AHP method to solve technological issues of hydrogen energy. Fuzzy scales are used instead of final numbers to solve decision problem in AHP method (Table 1).

LITERATURE REVIEW

The process of hierarchal analysis

The process of hierarchal analysis is a good model with several properties. Some of its properties are: its unity and uniqueness, compatibility, repetition of the process, judgment and collective agreement etc. Table 1 shows the preferred values in the process of hierarchal analysis.

The classic view varies and different factors are presented by different articles of authors for evaluating and choosing action of suppliers presented. Most of these criteria are based on experience of buyers in relation to suppliers (Monczka et al., 1981). In the first studies performed by Dickson (1966), 23 separated criteria are presented to decide what is relevant to suppliers. These factors are separated from types of products and are shown in Table 2; after that, Weber and Desai (1996) showed that the problems of choosing suppliers are multi-goal. More than one criterion can cause evaluation success and choosing of supplier. Spikman (1988) has emphasized on the relationship between buyer and supplier in reaching strong competitive success. It is also emphasized on making co- operation and short relationship with a supplier instead of

short relationship with several suppliers (Nydick and Hilt, 1992). In other words, complete and new criteria are prioritized over traditional criteria to make strategic relationship between supply chain members. Criteria presented are relevant to suppliers by Ellram (1987), who tried to gain strategic members. These criteria are in Tables 2-4. Spikman (1988) lays emphasis on quality criterion, amount of confidence to deliver and raise performance of product in choosing suppliers; and in addition, Spekman (1988) determines the plan of continues improvement and product design teams to improve the relationship with supplies. Min and Galle (1994) emphasize other criteria. Searching for suppliers of components of buyers, specifying quality and quantity criteria and giving suppliers' properties are categorized as important factors in choosing suppliers in three types of management of information system between organization, risk management and quality management system.

Quality management system standards ISO 9001 2000

By developing relevant concepts to quality management, we can say this system guarantees last and first component of each order that has the same property. Configuring the quality management system is important in business world today in different companies with suppliers considering concepts like continuous improvement and perspective process of this system. As

Table 3. Elram's criterion (1987).

Criterion	Detailed criterion
finance	Economic performance and financial stability
Strategy and corporate	Feeling of openness with suppliers

culture	Management relevant to behavior and view of organization Suitable strategy for senior management to cope with the conditions Consistent performance levels between supplier and buyer companies Organization structure of company
Issues related to technology	The allocation of capacity and facilities The allocation of capacity building for the structure design capability of suppliers Development rate of suppliers
Another factors	History of provider reliable and business reference considered as a basis for the customer

Table 4. Min and Gal's criterion (1994).

Criterion	Detailed criterion	
	financial	Penalty fees Type of paying
	Quality assurance	Teams quality control and audit quality control
	Predictive risk	Political stability Personnel and labor issues Doing interlocutor under low payment control
	Service performance	Delivery on time and technical assistance
	Relationship between purchaser - supplier	Financial stability and chatting between them
	Relevant Barriers to culture and communication	Cultural similarities Cultural standards Relevant capacity to send data electronically

Trade restrictions	Tariff and number of customs and transactions

5. Delivering the commodity on time

Information system management of organizations

In the last decade, Yu (2001) and Ball and Ma (2002) have researched on the advantages of sharing information and science. Supply chain causes competitive advantages as follows:

A. Decreasing the time of cycle
B. Configuring redesign of practical process
C. Using more opportunities of buying D. Controlling customers' supply chain by members (Handfield and Walton, 2002). As information has a role in supply chain, most companies are based on information systems that work better, that is, performing higher than the border of organizations. In fact, all the members of supply chain can gain information and based on the ability of sharing information, they can use information technology better and cause manager and decider to reach each part of the information chain. Holland (1995) and Williams (1997) are researchers that perform a lot of researches on properties of information system. We can say if information has new and clear properties about members' properties of information system, decisions of supply chain will be successful.

CASE STUDY (RECYCLING THERMAL POWER PLANT BOILERS)

This part consists of how to use analytical hierarchy in power industry and in the field of plant's boilers of heat recovery in a special manner.

About boiler, heat recovery plant or HRSG, process of buying commodity and services are performed specially with attention to instruction and construction of boiler.

These are divided into 5 chapters:

1. Raw materials
2. Semi-manufactured materials
3. Equipment
4. Machinery and equipment manufacturing
5. Technical services (including designing and producing services like construction of different parts of boiler).

The point is that special criterion is considered in different types of commodity. In referring to tables in choosing types of criteria, structure and property of boiler, it is recommended to use Dickson's table to determine criterion. So after getting statistics, some of these criteria use some items. And also the above cases decrease from 5 – 4, as shown in Table 5. To gain relevant weight, business managers and engineering designer were interviewed based on criterion, bazars and evaluation. The method of this research is descriptive and scaling. Description can be used for anything that attends to situation, general belief and current process.

1. Dickson's parameter in purchase of raw and semi manufactured material: Gaining of raw material as the main item of production has special importance. Quality, quantity and last profit gained from commodity are important.

2. Dickson's theory in selling equipment: Works of important mechanism are very important in selling needed equipment, that are relevant to companies' goal, added value and gathering of equipment in the process of producing commodity. Because of this, operation of some parameters can affect the goals of company.

3. Dickson's theory in giving services: Giving services is from new science and technology of boilers in this organization. So, technical science is bought from Asian and European country. And special cases should be considered in choosing parameters.

The process of hierarchy analysis

This part concentrates on the scientific method for raw and semi-manufactured material and the table of criterion value that competent people could gain at the time of preparing this audit.

In the process of hierarchy analysis, each level is compared with the same case in the upper level and in paired manner. And also their weight is calculated. These weights are called relative weight. Therefore, final weight is calculated by combining relative weight, called absolute weight. At first, suppliers consider criteria as matrix of paired comparisons and finally absolute weight of choices is calculated. And lastly suppliers will be chosen (Ghodsi, 2005).

Calculating the relative weight of three suppliers based on criterion 1, pure price (including discount and costs of transportation)

This is presented in Table 6.

Now, we calculate relative weight by arithmetic average method (Table 7).

Preference vector shows preferences of suppliers 1, 2, 3 based on pure price of criterion: (0/656,0/265,0/080).

Calculating another relative weights

Nowadays, weight of supplier (ability of each supplier to gain quality property and time of delivery) involves calculating weight of tables with final weight as seen in Tables 8-10.

Table 8. Paired comparison matrix for the three suppliers in quality property (First type of Mapna boiler buying - raw material and semimanufactured).

	Supplier 1	**Supplier 2**	**Supplier 3**
Supplier 1	1	3	5
Supplier 2	1/3	1	4
Supplier 3	1/5	1/4	1

Table 9. Paired comparison matrix for the three suppliers in delivery time (First type of Mapna boiler buying - raw material and semi-manufactured).

	Supplier 1	**Supplier 2**	**Supplier 3**
Supplier 1	1	4	4
Supplier 2	1/4	1	6
Supplier 3	1/4	1/6	1

Table 10. Paired comparison matrix for the three suppliers in supplier's financial situation (First type of Mapna boiler buying - raw material and semi-manufactured).

	Supplier 1	**Supplier 2**	**Supplier 3**
Supplier 1	1	3	4
Supplier 2	1/3	1	3
Supplier 3	1/4	1/3	1

We calculate weight of suppliers in each criterion by using arithmetic average method. Generally a lot of soft-wares are available to solve problems like making excellent choice, because of complication of analytical hierarchy; and thus needs to be calculated with high volume. Now, tables of paired comparison are shown for calculating criteria weight (Table 11).

We calculate weight of suppliers in each criterion by using arithmetic average method (Table 12).

Calculating final weight of supplier

Final weight of each supplier can be got from weight of total product to weight of relevant choice. Table 13 shows weight of suppliers' criterion.

Then final weight of each choice is gained by using relative calculated weight (Table 14). As seen in the table, supplier 1 is the best choice. In this part, in summary we are showing only weight of table for each group of buyers. Steps for solving and choosing suppliers are enough like solved method.

Second group (project equipment and machinery)

This is presented in Table 15a.

Third group (Engineering services)

One of the advantages of the process of analytical hierarchy is that it is compatible in judging and deter-

Table 15a. Paired comparison matrix criterion (Second group of Mapna boiler buying - project equipment and machinery).

	(1)	**(2)**	**(4)**	**(4)**	**(6)**	**(9)**	
	1	3	2	6	5	4	(1)
(2)	1/3	1	1/3	4	3	2	
(3)	1/2	3	1	5	4	3	
(4)	1/6	1/4	1/5	1	1/4	1/3	
(6)	1/3	5	5	4	1	1/4	
(9)	1/4	1/2	1/3	3	4	1	

Table 15b. Paired comparison matrix criterion (third group-Engineering).

	(1)	**(4)**	**(8)**	**(12)**	**(16)**	
	1	6	4	4	5	(1)
(4)	1/6	1	1/5	1/5	1/3	

(8) 1/4 5 1 2 3 (12) 1/4 5 1/2 1 4
(16) 1/5 3 1/2 1/4 1

Mining important coefficient of criteria. Saati spotted compatibility in judging calculation of coefficient called incompatibility coefficient. Analysis of compatibility is performed. These criteria should be less than 0.1. Using this coefficient helps the analysis before making final choice. Incompatibility of criterion consists of raw and semi-manufactured materials that can give us high and reliable power for deciding.

RESULTS AND SUGGESTIONS

Multi-criteria deciding model is shown to evaluate and choose supplier in this auditing. As seen above, the process of choosing supplier is a dynamic process (unlike previous model that chose supplier once for all of the periods). This model can divide them into different situations like buying workshop and representing special criterion for each group. Due to its importance to organizations, we can choose best supplier with high assurance coefficient using model of hierarchy analysis. Consistency and productivity can be improved this way. We evaluated the process of buying using the process of hierarchy in the Mapna boiler in this survey-descriptive research. The result of this research shows the best choice for buying that helps managers and decider of company, and also determines paired comparison matrix for the criteria of second and third group; it also shows how to make best choice with suppliers and decrease next concerns of managers and deciders. It shows the reliability of customers to represent high quality production and cheaper organization, by using the best buying equipment and services. With this research and reaching the above reasonable result, it is recommended to use new and advanced way to increase performance and influence decision. Technical usage in the process of hierarchy analysis can spot several goals based on criterion. These two techniques can make a model to spot different goals by considering different criteria.

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