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Superior Supplier Selection - A Joint Approach of Taguchi, AHP, and Fuzzy Multi-Objective Programming

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ABSTRACT

Background: Supplier selection and decision making are key strategic factors for most organizations. The nature of such decision makings is usually complicated. The aim of this research is to use a joint approach of Taguchi loss function, AHP, and Fuzzy goal programming. The mentioned approaches were studied in two phases to select suppliers and their shares in a supply chain. In the first phase, superior suppliers were selected among all suppliers using Taguchi loss function and AHP. In the second phase, defining goal functions such as supply chain visibility and risk, their shares were determined by employing Fuzzy Multi-Objective Programming (FMOP) model. The constraints include, demand, Budget, production Capacity and supply availability are taken into account. Results showed that access level to risk reduction is 65%, whereas access level to visibility is 35%, which means decision makers are risk averse and therefore, risk reduction is given the first priority.

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INTRODUCTION

Supply chain management and supplier selection process have recently attracted much attention. In the1990s, many companies searched for methods to collaborate with suppliers in order to improve management performance and its competitiveness. Much attention has recently been paid to the relations between suppliers and consumers in manufacturing companies. When long term relations exist between these two factors, the company's supply chain will be an obstacle for competitors.

The number of purchasing decisions has increased due to the increase of purchasing activity importance; since organizations have become more dependent on suppliers, direct and indirect consequences of weak decision making will be more tangible (DeBoer, 2001). In most industries, a major part of a product’s total cost is the cost of its raw material (Ghodsypour, 1998). Under such conditions, supplies sections can play a key role in organizations’ efficiency and exert a direct influence on their cost reduction, profitability, and flexibility (Ghodsypour, 2001). In fact, selecting a proper set of suppliers to work with is vital for a company's success; the issue of supplier selection has been emphasized for a long time (Zhang, 2001). Due to the creation of supply chain concept, most researchers, scientists, and managers have recently realized that selecting the proper supplier and its management is a tool which could be used to increase supply chain competitiveness (Lee, 2001). Generally speaking, the issue of supplier selection is of two kinds:

1- Supplier selection when there is no constraint; in other words, each supplier is capable of estimating a purchaser's needs such as demands, quality, delivery time, etc.

2- Supplier selection when there are constraints in the supplier's capacity, the supplier's product quality, etc. In fact, when a supplier alone is not capable of providing a purchaser's needs, the purchaser has to resort to another supplier to provide some of their needs in order to compensate for capacity constraint or low-quality of the first supplier.

Regarding the first type, a supplier can provide all needs of a purchaser (single sourcing) where management only adopts one decision which is to find out which supplier is the best; while, regarding the second type, none of the suppliers are capable of providing all the needs of purchasers on their own. As a result, more than one supplier must be used in this case (multiple sourcing) and management must adopt two decisions of: 1- Which supplier is the best? 2- How much should be bought from each supplier (Ghodsypour, 1998)? In

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this research, we will focus on an integration of these two questions. In the first phase, potential suppliers' evaluation will be performed using Taguchi loss function and AHP such that among them, a few suppliers are selected as the superior suppliers. In the second phase, taking an FMOP approach, each supplier's share among the selected ones in the previous phase is determined.

Review of literature:

Kumar *et al*. (2004) used fuzzy goal programming to solve supplier selection problem with multiple objectives and fuzzy parameters. They used real data to show the efficiency of the suggested model.

Hong *et al*. (2005) presented a mathematical programming model which regards variation in suppliers' capabilities and customers' needs in a specific time interval. The presented model was used to select a supplier in the agricultural industry of Korea.

Chen *et al*. (2006) presented a fuzzy decision making method for supplier selection problem in a supply chain system. They stated that the issue of right suppliers in a supply chain has become a strategic problem during the recent years.

Ghodsypour and O'Brien (1998) presented a decision support system in order to reduce the number of suppliers. They employed Analytical Hierarchy Process (AHP) and mixed integer programming in their decision support system. In another research, Ghodsypour and O'Brien (2009) presented a mixed-integer nonlinear programming model to solve supplier selection problem in case of multiple sourcing, which regards the total cost of logistics.

In the history of supply chain, Zsidisin (2002) investigated supply risk evaluation, while Smeltzer and Siferd (1998) studied proactive supply chain patterns, relying on risk management. Sanders and Manfredo (2002) proposed adverse risk probabilities on goods, using value-at-risk approach. Besides, Zsidisin (2003) investigated supply characteristics which affect managerial perceptions of supply risk and classified supply risk sources. Reviewing supply chain history, it is realized that supply chain risk management has significantly paid attention to risk visibility. For instance, proper supply chain visibility can result in the creation of advantages in operations' effectiveness (Smarus *et al*. 2003) and more effective supply chain designs (Peterson *et al*. 2005).

Ghodsypour and O'Brien (2009) employed integer mathematical programming to allocate orders among vendors using case based reasoning. They used three criteria of cost, quality, and delivery time in order to examine the supplier.

Using Taguchi loss function and AHP, Pi and Low (2006) attempted to examine suppliers; therefore, criteria such as price, delivery time, services, and quality were selected as the criteria of supplier selection. In a similar study, Liao and Kao (2010) used criteria such as price, quality, satisfaction with services, warranty degree, and delivery time as criteria for supplier evaluation; eventually, a mathematical goal programming model was formulated whose main aim was to minimize deviations from the weights obtained from AHP dual comparison.

Meena and Sarmah (2013) focused their studies on multiple sourcing under supplier failure risk and quantity discount with a genetic algorithm approach. This paper considers the issue of order allocation of a producer/ purchaser among multiple suppliers under supply disruption risk. Mixed-integer nonlinear programming model was developed for order allocation, considering different capacities, failure probability, and quantity discounts for each supplier. The obtained results show that supplier cost had more effect on order allocation in comparison with supplier failure probability.

Kannan *et al*. and Diabat (2013) studied integrated fuzzy multi-criteria decision making method and multi-objective programming approach for supplier selection and order allocation in a green supply chain. In order to allocate weights and select suppliers based on environmental and economic criteria, multi-objective programming and fuzzy multi-index theory were used. The aim of this mathematical model is to maximize total purchasing value and minimize total purchasing cost at the same time.

Choudhary and Shankar (2014) investigated multi-objective integer linear goal programming for inventory lot-size, supplier selection, and carrier selection decision making; to this end, three aims of net late delivered items, net cost, and net rejected items, which must be simultaneously minimized during time, were considered. The main aim of this study is to identify timing, the size of the inventory which must be prepared, the supplier, and the selection of a carrier which must be selected for each period.

In another study, the effect of supply chain and supply chain risk visibility on supply chain performance was investigated. In this study, supply chain visibility with the capability of timely and precise information sharing affecting independent variables of demand, quantity, the location of transportation-related cost, and other logistic cost throughout the supply chain was considered. Aiming to maximize supply chain visibility and minimize supply chain risk and cost, the presented mathematical model in this article has been formulated considering customers' demand limitations, producing capacity, budget, and supplier accessibility. The results of this research revealed that decision makers firstly tend to reduce supply chain risk and then, increase supply chain visibility (Yu and Goh, 2014).

Australian Journal of Basic and Applied Sciences, 9(2) February 2015, Pages: 163-170

Methodology:

Taguchi loss function has been used for evaluation due to the existence of several evaluation criteria and the lack of similar measurements. In this method, evaluation results for each criterion are shown as below. Furthermore, since the loss function is a second degree and nonlinear function, the loss amount significantly increases based on the deviation amount; such a matter results in the allocation of greater values to measures which show less deviation from the goal and increases decision making precision (Russ, 1998; Kethley *et al*. 2002). The steps of performing the research have been presented in the figure 1.

In order to evaluate suppliers using Taguchi loss function, the type of each loss function must be determined based organizations' needs. After determining the loss function of each characteristic for the items, suppliers are evaluated using loss functions. Suppliers of the company under the study are evaluated based on 5 indices of price, quality, delivery time, services, and warranty.

Taguchi showed that the deviation from a characteristic's goal results in loss, and high quality occurs when this deviation is minimum. When this amount is equal to the goal, the loss will be zero. Under other conditions, the occurred loss is measurable using a second degree function. To this end, Taguchi proposed three types of loss function (Russ, 1998; Kethley *et al*. 2002).

1- A two Way Loss Function

$$L(y) = k(y-m)^2 \tag{1}$$

2- A one way loss function with high specification limit

$$L(y) = k(y)^2 \tag{2}$$

3- A One way loss function with low specification limit

$$L(y) = k / y^2 \tag{3}$$

Where

- LY = The loss amount in the Y^{th} item
- K= Loss coefficient
- M= The specification goal

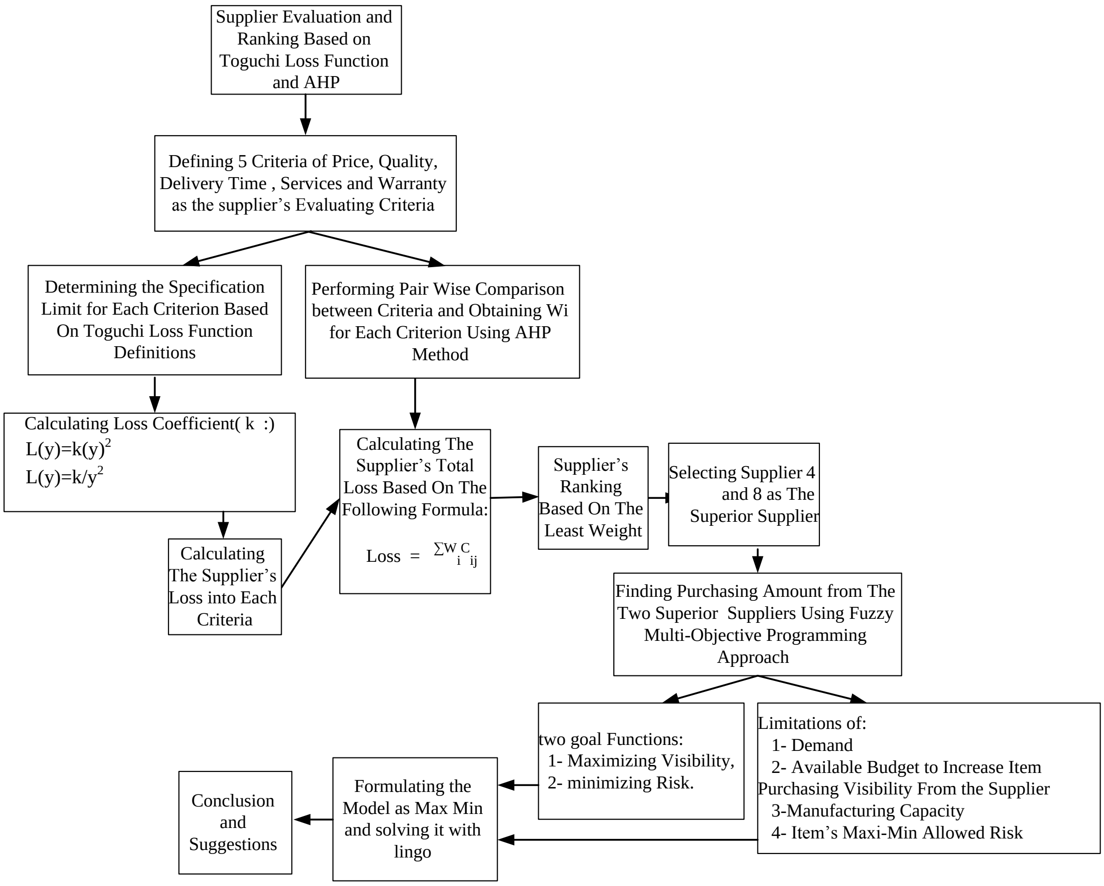

Fig. 1: Research Processes.

Regarding the price criterion, if other conditions are the same, the purchaser becomes interested in buying from those suppliers who propose cheaper prices. As a result, zero loss occurs when a purchaser buys from the supplier proposing the least price. The more the suggested price than the least price, the more the loss will be; 100% loss occurs when the least price is equal to the highest price determined by the purchaser. Consequently, one way loss function with maximum specification limit can be applied to measure the loss resulted from the price criterion.

Regarding the quality criterion in this research, the items' quality has been considered. In general, quality level has a reverse relation with defective items' ratio. Therefore, high quality level is equal to the low ratio of defective items. Thus, a proper function to evaluate the loss of this specification is a one-way loss function with maximum specification limit. A company's ideal defect ratio is zero when loss is zero. The highest defect ratio accepted by the management has been stated as 2%. This amount has been considered as the high specification limit and the amount of allowed deviation from this goal; consequently, 100% loss occurs when defective items' ratio is at least equal to this amount. Substituting the mentioned amounts in the mathematical loss function, the loss coefficient is calculated as below:

$$L(x) = kx^2 \longrightarrow 100\% = k\,(2\%)^2 \longrightarrow k = 2500 \qquad (4)$$

Regarding the criterion of delivery time, customers are interested in having the item when they need it (not sooner or later than this time). Delivering the item sooner results in maintenance cost and delivering the item later will be accompanied by shortage cost. Therefore, for such criteria, the one-way loss function can be used. In practice, however, since delay times were short, delays attracted more attention than delivering the items sooner than the required time.

The criterion of services is a criterion which cannot be understood easily. Evaluating the criterion of services includes measuring performance criteria whose quantification is costly; but they are vital for a supplier's success. These factors include solving the problem, the accessibility of technical data, sending and coherence of the data, current progress reports, the supplier's reaction to modifying efforts, and the supplier's accountability to authority. Usually, the personnel of purchasing, quality control, and production sections can provide investigators with complete reports regarding each supplier such that the mean of the opinions can be considered as the required ratio (Monczka and Trecha, 1998). Table 1 shows the company's policy towards these 5 criteria and Table 2 shows each supplier's situation in relation with each criterion.

Table 1: The Specification Limit and the Domain of 5 Decision Making Criteria for Supplier Selection.

Criteria	Target Value	Range	Specification Limit
Quality	(0) %	0 - (-2) %	2%
On Time Delivery	0	0 - (7) %	7
Price	The Least Price	0 - (-12) %	20 % More
Satisfaction with Services	100%	60 - 100 %	60%
Warranty	100%	85 - 100 %	85%

Table 2: Specifications and Relative Values of the Suppliers in relation with the Criteria.

	Quality		On Time Delivery		Price		Satisfaction with Services		Warranty	
Supplier	Amount	The Relative Amount	Amount	The Relative Amount	Amount	The Relative Amount	Amount	The Relative Amount	Amount	The Relative Amount
1	1.7 %	1.7 %	2	2	100 %	0%	95%	95%	90%	90%
2	1.5%	1.5%	1	1	115%	15%	85%	85%	96%	96%
3	1.6%	1.6%	3	3	120%	20%	97%	97%	92%	92%
4	1%	1%	1	1	105%	5%	65%	65%	95%	95%
5	1.5%	1.5%	5	5	118%	18%	80%	80%	95%	95%
6	1.4%	1.4%	4	4	112%	12%	78%	78%	90%	90%
7	1.9%	1.9%	6	6	107%	7%	90%	90%	93%	93%
8	1.2%	1.2%	3	3	106%	6%	68%	68%	90%	90%

After the calculation of loss coefficient based on Taguchi formula and the specification of the loss function type and also the specification of the supplier's value in each criterion, each supplier's loss has been obtained based on the table 3.

Table 3: Each Supplier's Taguchi Loss in Relation with each Criterion.

Supplier	Quality	On Time Delivery	The Criterion of Price	Services	Warranty
1	72.25	8.16	0	39.88	93.29
2	56.25	2.04	56.25	49.82	89.19
3	64	18.36	100	38.26	78.39
4	25	2.04	6.25	85.20	85.36
5	56.25	51.02	81	56.25	80.05
6	49	32.65	36	59.1716	80.05
7	90.25	73.46	12.25	44.44444	89.19
8	36	18.36	9	77.85467	83.53

In the next step, pairwise comparison matrix has been formed for 5 criteria whose results have been processed in Expert Choice Software; the final results have been presented in the following table:

Table 4: The Calculated Weights Using AHP Method.

Criterion	Quality	On Time Delivery	Price	Services	Warranty
Weight	0.319	0.133	0.437	0.039	0.072

In the final step of Taguchi loss function, each supplier's total loss in relation with each criterion has been obtained based on the following formula:

$$loss_j = \sum_{i=1}^{n} w_i c_{ij} \tag{5}$$

Table 5: Each Supplier's Total Loss.

	Quality		On Time Delivery		Price		Services		Warranty		Each Supplier's Total Loss	
Supplier	Weight	Taguchi Loss	Weight	Taguchi Loss	Weight	Taguchi Loss	Weight	Taguchi Loss	Weight	Taguchi Loss		Suppliers' Ranking
1	319	72.25	133	8.16	437	0	039	39.88	072	93.29	32.41	3
2	319	56.25	133	2.04	437	56.25	039	49.82	072	89.19	51.16	5
3	319	64	133	18.36	437	100	039	38.26	072	78.39	73.70	8
4	319	25	133	2.04	437	6.25	039	85.20	072	85.36	20.45	1
5	319	56.25	133	51.02	437	81	039	56.25	072	80.05	68.08	7
6	319	49	133	32.65	437	36	039	59.1716	072	80.05	43.78	4
7	319	90.25	133	73.46	437	12.25	039	44.44444	072	89.19	52.07	6
8	319	36	133	18.36	437	9	039	77.85467	072	83.53	26.91	2

As has been shown in the table 5, the fourth and eighth suppliers are selected as the superior ones and the manufacturing company purchases items 1, 2, 3, 5, and 9 from these two suppliers.

The Second Step: A Fuzzy Multi-Objective Programming Approach:

In this phase, the amounts of purchasing each of these items from each of these suppliers are calculated, defining two goal functions of risk and visibility. Therefore, this problem will be changed as follow:

$$\text{Max visibility} \cong \sum_i \sum_j \tilde{V}_{ij} Y_{ij} \tag{6}$$

$$\text{Min risk} \cong \sum_i \sum_j \tilde{R}_{ij} Y_{ij} \tag{7}$$

Subject to:

$$\sum_j \tilde{V}_{ij} CV_{ij} Y_{ij} \tilde{\leq} B_i \qquad \forall i \tag{8}$$

$$\sum_j \tilde{V}_{ij} Y_{ij} \tilde{\geq} V_i \qquad \forall i \tag{9}$$

$$\sum_j Q_{ij} = D_i \qquad \forall i \tag{10}$$

$$\sum_i Q_{ij} \leq C_j Y_{ij} \qquad \forall j \tag{11}$$

$$\sum_j \tilde{R}_{ij} Y_{ij} \tilde{\leq} R_i \qquad \forall i \tag{12}$$

$$Q_{ij} \geq m_{ij} Y_{ij} \qquad \forall i,j \tag{13}$$

$$Q_{ij} \leq N Y_{ij} \qquad \forall i,j \tag{14}$$

$$Q_{ij} \geq 0 \qquad \forall i,j \tag{15}$$

$$Y_{ij} \in \{0,1\} \qquad \forall i,j \tag{16}$$

In the above mentioned problem, i index specifying the supplier and j index specifying the item are required. Q_{ij} is the amount of j item which is supplied by the i^{th} supplier; Y_{ij} is the virtual variable which determines whether item j is supplied by supplier i or not. B_i is the available budget in order to increase supply chain visibility of item i. C_j determines the production capacity of supplier j. CV_{ij} is the cost of increasing the visibility of item i provided by supplier j. D_i is the demand level for item i; m_{ij} is the least required order of item i for supplier j; IR_{ij} is the effect of purchasing risk of item i from supplier i; R_i determines the most allowed risk level for item i; V_{ij} is the visibility of the supply chain of buying item i from supplier j. Eventually, V_i specifies the least amount of the required visibility for item i supply (Yu and Goh 2014).

Supplier selection may impose different ranges of risk on suppliers' production capacity, their abilities, and the natural environment. Since each item imposes a certain risk (because they are used in different items, sold in different markets, and have different prices), risk may be stated in a triangular fuzzy way for each product provided by the suppliers (these values have been presented by the experts).

Table 6: The Risk of Purchasing Item i from supplier j.

Item i	The Fourth Supplier	The Eighth Supplier
1	(0, 5, 1, 1, 3)	(0, 65, 1, 1, 1, 4)
2	(0, 75, 1, 1, 1,5)	(0, 8, 1, 3, 1, 6)
3	(0, 25, 0, 75, 1)	(0, 4, 1, 1, 1)
4	(0, 8, 0, 95, 1, 1)	(0, 95, 1, 1, 1, 3)
5	(0, 3, 0, 6, 0, 9)	(0, 45, 0, 75, 1, 1)

The visibility of each purchased item from suppliers is also considered as fuzzy mathematics (much, average, low) which have been presented in Table 7.

Table 7: The Visibility of Purchasing Item i from Supplier j.

Item i	The Fourth Supplier	The Eighth Supplier
1	(2, 2, 1, 2, 3)	(2, 1, 2, 2, 2, 3)
2	(1, 9, 2, 2, 2)	(2, 1, 2, 2, 2, 4)
3	(2, 3, 2, 5, 2, 7)	(2, 3, 2, 6, 2, 7)
4	(2, 1, 2, 2, 2, 3)	(2, 2, 2, 3, 2, 5)
5	(1, 8, 2, 2, 2, 5)	(2, 2, 1, 2, 6)

The answer of the model is also obtained from the following process:
Step 1- The problem is solved for each of these goals using Zimmermann approach (Maxi-Min).
Step 2- Membership function is then, found for each goal.
Step 3- Fuzzy limitations are defuzzied using beta probability distribution. The weight is considered as 6.4 in an optimistic and 6.1 in pessimistic states.

Table 8: Defuzzing Risks

Item i	The Fourth Supplier	The Eighth Supplier
1	0.96	1.07
2	1.1	1.26
3	0.7	0.91
4	0.95	1.1
5	0.6	0.75

Table 9: Defuzzing Visibility

Item i	The Fourth Supplier	The Eighth Supplier
1	2.1	2.2
2	2.01	2.21
3	2.5	2.5
4	2.2	2.3
5	2.18	2.16

Fuzzy limitations are defuzzied using the weighted mean which employs beta probability function. FMOP Model is rewritten and it is then, solved under the title of a certain single-objective model. A weighted certain single-objective model is employed to solve FMOP Model which includes k objectives (presented by Ghodsypour). In this model, λ_k determines access level of reaching to the k goal.

This problem has been solved considering equal weights for each of these two goals (equal to 2.1):

Australian Journal of Basic and Applied Sciences, 9(2) February 2015, Pages: 163-170

$$Max\sum_{k=1}^{K} w_k\lambda_k \tag{17}$$

Subject to:

$$\lambda_k \le \mu_k(Z_k(x)) \qquad k=1,2,...,K \tag{18}$$

$$\sum_j [(\frac{1}{6})V_{ij}{}^{p}CV_{ij}Y_{ij}+(\frac{4}{6})V_{ij}{}^{m}CV_{ij}Y_{ij}+(\frac{1}{6})V_{ij}{}^{o}CV_{ij}Y_{ij}] \le B_i \qquad \forall i \tag{19}$$

$$\sum_j [(\frac{1}{6})V_{ij}{}^{p}Y_{ij}+(\frac{4}{6})V_{ij}{}^{m}Y_{ij}+(\frac{1}{6})V_{ij}{}^{o}Y_{ij}] \ge V_i \qquad \forall i \tag{20}$$

$$\sum_j [(\frac{1}{6})R_{ij}{}^{p}Y_{ij}+(\frac{4}{6})R_{ij}{}^{m}Y_{ij}+(\frac{1}{6})R_{ij}{}^{o}Y_{ij}] \le R_i \qquad \forall i \tag{21}$$

$$\lambda_k \in [0,1] \qquad k=1,2,...,K \tag{22}$$

$$\sum_{k=1}^{K} w_k\lambda_k = 1 \tag{23}$$

$$Y_{ij} \in [0,1] \qquad \forall i,j \tag{24}$$

Table 10: The Results of Revised FMOP Model

	The Amount of Purchasing Item i from Supplier j			
Item i	4	8	Goal Function Value	Access Level
1	11100	8900	155507	0.35
2	5300	4700	66478	0.65
3	6550	3450		
4	11500	8500		
5	6350	3650		

As the results show, access level to risk reduction is relatively more than access level to visibility increase, since most decision makers are risk averse and therefore, risk reduction is given the first priority.

Conclusion:

Many researchers and scholars have mentioned the advantages of supply chain management. In order to increase competitive advantages, many companies regard a proper supply chain management's design and implementation as an important tool. Under such conditions, creating a close and long term relation between the supplier and purchaser is one of the key elements of supply chain creation success. Consequently, the issue of supplier selection is the most important issue in successfully implementing supply chain.

On the other hand, the issue of supplier selection in general faces imprecise and ambiguous data and using the theory of fuzzy sets in considering this kind of uncertainty seems logical.

To this end, decision making approaches such as AHP were used in this research; besides, a fuzzy approach was also employed in order to be close to real data. This research was conducted in two phases. In the first phase, suppliers were evaluated taking Taguchi and AHP approaches; and then, their shares were specified taking the fuzzy goal programming approach. The results proved that the company under the study was risk averse, which was in harmony with commercial realities.

REFERENCES

Amid, A., S.H. Ghodsypour and C. O’Brien, 2009. A weighted additive fuzzy multiobjective model for the supplier selection problem under price breaks in a supply chain. International Journal of Production Economics, 121(2): 323-332.

Chen, C.T., C.T. Lin and S.F. Huang, 2006. A fuzzy approach for supplier evaluation and selection in supply chain management. International Journal of Production Economics, pp: 102.

Choudhary, D. and R. Shankar, 2014. A goal programming model for joint decision making of inventory lot-size, supplier selection and carrier selection. Computers & Industrial Engineering, 71: 1-9.

DeBoer, L., E. Labro and P. Morlacchi, 2001. A review of methods supporting supplier selection. European Journal oF Purchasing & Supply Management, pp: 7.

Ghodsypour, S.H. and C. O’Brien, 2001. The total cost of Logistics in supplier selection, under conditions of multiple souring, multiple criteria and capacity constraint. International Journal of Production Economics, 73.

Ghodsypour, S.H. and C. O'Brien, 1998. A decision support system for suppleir selection using onintegrated analytic hierarchy process and linear programing. Internation Journal of Production Economics, pp: 56-57.

Govindan, K., S. Rajendran, J. Sarkis and P. Murugesan, 2013. Multi criteria decision making approaches for green supplier evaluation and selection: a literature review. Journal of Cleaner Production. In Press, Corrected Proof . doi:10.1016/j.jclepro.2013.06.046.

Hong, G.H., S. Chanpark, D. Sikjang and H. Min Rho, 2005. An effective supplier selection method For constructing a competitive supply-relationship. Expert system with applications, 28(4): 629-639.

Kannan, D., R. Khodaverdi, L. Olfat, A. Jafarian, and A. Diabat, 2013. Integrated fuzzy multi criteria decision making method and multi-objective programming approach for supplier selection and order allocation in a green supply chain. Journal of Cleaner Production, 47: 355–367.

Kumar, M., P. Vrat and R. shankar, 2004. A fuzzy goal programming approach for vendor selection problem in a supply chain, Computers & industrial Engineering, pp: 46.

Lee, E.K., S. Ha and S.K. Kim, 2001. Supplier selection and management system considering relationships in supply chain management. IEEE transactions on Engineering Management, 48(39).

Liao, C.N. and H.P. Kao, 2010. Supplier selection model using Taguchi loss function, analytical hierarchy process and multi-choice goal programming. Computers & Industrial Engineering, 58(4): 571-577.

Meena, P. and S. Sarmah, 2013. Multiple sourcing under supplier failure risk and quantity discount: A genetic algorithm approach. Transportation Research Part E: Logistics and Transportation Review, 50: 84-97.

Monczka, R.M. and S.J. Trecha, 1988. Cost-based supplier performance evaluation. Journal of Purchasing and Materials Management, 24(1): 2-7.

Petersen, K., G. Ragatz and R. Monczka, 2005. An examination of collaborative planning effectiveness and supply chain performance .The Journal of Supply Chain Management, 41(2): 14-24.

Pi, W.N. and C. Low, 2006. Supplier evaluation and selection via Taguchi loss functions and an AHP. The International Journal of Advanced Manufacturing Technology, 27(5-6): 625-630.

Ross, P.J., 1995. Taguchi techniques for quality engineering: loss function, orthogonal experiments, parameter and tolerance design. McGraw-Hill Professional, 2nd edition, New York, USA.

Sanders, D. and M. Manfredo, 2000. The role of value-at-risk in purchasing: An application to the foodservice industry .Journal of Supply Chain Management, 38(2): 38-45.

Smaros, J., J. Lehtonen, P. Appelqvist and J. Holmstrom, 2003. The impact of increasing demand visibility on production and inventory control efficiency. International Journal of Physical Distribution & Logistics Management, 33(4): 336-354.

Smeltzer, L. and S. Siferd, 1998. Proactive supply management: The management of risk. International Journal of Purchasing and Materials Management, 34(4): 38-45.

Yu, M.C. and M. Goh, 2014. A multi-objective approach to supply chain visibility and risk. European Journal of Operational Research, 233(1): 125-130.

Zhang, Z., J. Lei, N. Cao, K. To and K. Ng, 2001. Evolution of supplier selection criteria and methods. European Journal of Operational Research, 4(1): 335-342.

Zsidisin, G.A., 2003. Managerial perceptions of supply risk. Journal of supply chain management, 39(4): 14-26.

Zsidisin, G., 2002. A grounded definition of supply risk. Journal of Purchasing and Supply Management, 9: 217-224.