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A Framework for Supplier Selection Criteria in "LARG" Supply Chain based on a Literature Review

Sajedeh Hasanian
Department of Industrial Engineering, College of Engineering, Shiraz Branch, Islamic Azad University, Shiraz, Iran

Seyed Mohammad Hossein Hojjati[1]
Department of Industrial Engineering, College of Engineering, Shiraz Branch, Islamic Azad University, Shiraz, Iran

Abstract

Suppliers are critical component to an organization that can greatly affect the performance of the organization and its product. Through these various effects, a revision is essential in supplier selection strategies. In this paper, a framework for supplier selection criteria in "LARG" (Lean, Agile, Resilient and Green) supply chain based on a literature review is proposed. A fuzzy method is used to evaluate suppliers, based on the determined criteria and calculate the weight of them. To our knowledge, this is the first effort to present a comprehensive framework for supplier selection criteria in "LARG" supply chain. In order to validate and demonstrate the applicability of the framework, a numerical example is presented. The result shows the framework is applicable to organizations and manufacturing institutions as well as their supply chains.

Keywords: Supplier, "LARG" supply chain, framework, fuzzy.

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[1] *Corresponding author's email: mhh@iaushiraz.net*

Introduction

Supply chain management strategies, including lean, agile, resilient and green were created to respond to the market and external conditions. Lean states that products should be designed to minimize waste and increase value added for customer in order to increase profitability and quality. On the other hand, agile claims that production should be more responsible to customer and capable of rapid response to market demands. Resilience refers to the influence of external factors on the supply chain and green is associated with the effects of supply chain activity on the environment (Rao and Holt, 2005). However, these strategies alone do not provide all the solutions to meet any business environment and conditions, and each of them has its advantages and disadvantages as well. Therefore combining lean, agile, resilient and green approaches that is called "LARG" is a new strategic approach that can be used to gain a sustainable competitive advantage and meet the needs of the present age. In this paper, a framework for supplier selection criteria in "LARG" supply chain is proposed.

Companies consider criteria such as price and quality when evaluating supplier performance. Potential suppliers who can provide products at the lowest possible price, may not be the best in quality, on time delivery or production with minimum risk among competitors. Therefore, supplier selection is inherently a Multi Criteria Decision Making problem that these criteria are often in contrast with each other.

In real-world decision-makers do not have complete and accurate information about the importance of the decision criteria. In these cases, fuzzy sets theory is one of the best tools to achieve uncertainty (Amid et al., 2006). Thus in this study fuzzy numbers are used.

Although many researchers have tried to present the criteria for selecting suppliers in lean, agile, resilient and green supply chains, it appears so far it has not been regarded to present a framework for supplier selection criteria in "LARG" supply chain and this study is innovative from this view.

Literature review

Hereby several articles are mentioned that have proceed to supplier selection according to various criteria.

(Ho et al., 2010) reviewed the literature of supplier selection problem from 2000 to 2008. They concluded that the most popular criteria in previous research are quality, delivery and price/ cost. (Chang et al., 2011) posed the economic criteria to select supplier and concluded that the most important criteria are quality, cost and delivery performance.

(Beikkhakhian et al., 2015) proceed to evaluation and ranking suppliers using AHP, fuzzy TOPSIS, TOPSIS and interpretive structural model (ISM). ISM method results show that delivery time and lead time minimization variables are the most important factors influencing suppliers' agility and the cost minimization factor is in the next level. (Rajesh and Ravi, 2015) proceed to supplier selection in supply chain resilience using gray relational analysis and case study. (Soni et al., 2014) have proposed 10 enablers for supply chain resilience including agility, collaboration, knowledge sharing, sustainability, risk and revenue sharing, trust among players, visibility, risk management culture, adaptive capability and supply chain structure. (Duarte and Cruz Machado, 2011) proceed to identify lean, agile, resilient and green supply chain approaches, and investigated the relationships between them. They presented a framework to determine which areas of the management approaches are more useful to improve supply chains performance by reviewing the literature. (Abdollahi et al., 2015) presented a framework for supplier evaluation and selection based on lean and agile criteria and using ANP, DEA, DEMATEL and case study. They considered quality, cost and delivery as the main criteria for lean and human, technological, managerial systems and cultural capabilities as the main criteria for agility.

Fuzzy logic

Fuzzy set theory was introduced by (Zadeh, 1965) that is used to describe and explain uncertainty and inaccuracy at the events. A fuzzy number is illustrated by membership function that is a number between zero and one. Triangular fuzzy numbers are one of the most applicable fuzzy numbers. If triangular fuzzy number *A* being defined as *A = (a, b, c)* that a ≤ b ≤ c, the triangular membership function is defined according to formula (1).

$$\mu_A\,(x) = \begin{cases} \frac{(x-a)}{(b-a)} & a \le x \le b \\ \frac{(c-x)}{(c-b)} & b \le x \le c \\ 0 & otherwise \end{cases} \qquad (1)$$

The proposed model

First, manufacturer identifies potential "LARG" suppliers. A suitable framework for supplier selection criteria in "LARG" supply chain is suggested based on a literature review. Suppliers are evaluated according to the determined criteria based on fuzzy method. The results are the weight of (the importance of) suppliers based on the proposed criteria.

Provide a framework for supplier selection criteria in "LARG" supply chain

The proposed framework for supplier selection criteria in "LARG" supply chain is shown in figure 1 and supplier selection criteria in "LARG" supply chain are listed in table 1.

Table 1 Criteria for supplier selection in "LARG" supply chain

Criteria	Sub-Criteria
1.Quality (a; b; c; d; e; f)	1.1.Quality-related certificates (g; h; i)
	2.1.Rate of returned parts due to quality issues (g; i; f)
	3.1. Part durability (k)
2.Cost (a; b; c; l; m; e; f)	1.2. Price per unit (a; n; o; b;p; f; i; q)
	2.2. Financial strength (r)
3. Delivery (g; a; b; c; f; i; s)	1.3. On-time delivery (t; n; u; v; f; i)
	2.3. Safety and security of parts (o; w; f)
	3.3. Appropriateness of the packaging (w; o; f)
4. technical and human capability	1.4. Technology level (i)
	2.4. Capability of R&D (x; y; z; aa; e)
	3.4. Capability of design (g; i)
	4.4. Capability of preventing pollution
	5.4. Human capability (f)
5. Pollution control (bb; s)	1.5. Air emissions (n; cc; p; l; m; dd; i)
	2.5. Waste water (cc; p; dd; i)
	3.5. Solid wastes (n; cc; p; ee; dd; i)
	4.5. Energy consumption (cc; p; ff)
	5.5. Use of harmful materials (cc; ee; dd; i)
6. Environment management (p; bb; s)	1.6. Environment-related certificates (g; n; cc; u; p; gg; bb; dd; i)
	2.6. Continuous monitoring and regulatory compliance (i)
	3.6. Green process planning (i)
	4.6. Internal control process (i)
7. Green product (bb; s)	1.7. Recycle (cc; hh; i)
	2.7. Green packaging (p; ee; i)
	3.7. Reusable (hh; ii; jj)
8. Green competencies (hh; bb; i)	1.8. Materials used in the supplied parts that reduce the impact on natural resources (i)
	2.8. Ratio of green customers to total customers (n; gg; i)
	3.8. Ability to alter process and product for reducing the impact on natural resources (i)
9.Supplier's Responsiveness (e)	1.9. Supply Chain Velocity (mm; nn; oo; e)
	2.9. Supply Chain Visibility (pp; qq; rr; ss; e)
10.Supplier's Risk Reduction (tt; e; uu)	1.10. Vulnerability (vv; ww; xx; yy; e)
	2.10. Level of collaboration (zz; aaa; bbb; ccc; e)
	3.10. Risk Awareness (ddd; eee; fff; ggg; e)
	4.10. Supply Chain Continuity Management (hhh; iii; fff; e)
Legend: (a) Ho et al., 2010; (b) Chang et al, 2011; (c) Liao and Kao, 2011; (d) Kannan et al, 2013; (e) Rajesh and Ravi, 2015; (f) Abdollahi et al, 2015; (g) Kuo et al., 2010; (h) Hong-jun and Bin, 2010; (i) Hashemi et al., 2015; (k) Hassanzadeh Amin and Zhang, 2012; (l) Shaw et al., 2012; (m) Mari et al., 2014; (n) Grisi et al., 2010; (o) Punniyamoorthy et al., 2011; (p) Wang et al., 2012; (q) Jadidi et.al., 2015; (r) Pettit et al., 2010; (s) Gurel et al., 2015; (t) Chen, 2011; (u) Chen et al., 2010; (v)	

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Vinodh et al., 2011; (w) Wang, 2010; (x) Cousins et al., 2011; (y) Schiele et al., 2011; (z) Kloyer and Scholderer, 2012; (aa) Clegg et al., 2013; (bb) Kannan et al., 2014; (cc) Awasthi et al., 2010; (dd) Zhang and Xu, 2015; (ee) Ghadimi and Heavey, 2014; (ff) Yanqing and Mingsheng,, 2012; (gg) Shen et al., 2013; (hh) Buyukozkan and Cifci, 2011; (ii) Ke et al., 2011; (jj) Dobos and Vörösmarty, 2014; (mm) Jüttner and Maklan, 2011; (nn) Bode et al., 2011; (oo) Roh et al., 2014; (pp) Caridi et al., 2010; (qq) Holmström et al., 2010; (rr) Kyu Kim et al., 2011; (ss) Tse and Tan, 2012; (tt) Wu et al., 2010; (uu) Hosseininasab and Ahmadi, 2015; (vv) Whipple and Roh, 2010; (ww) Wagner and Neshat, 2010; (xx) Chan and Larsen, 2010; (yy) Hofmann, 2011; (zz) Park et al., 2010; (aaa) Lager and Frishammar, 2010; (bbb) Wagner et al., 2011; (ccc) Ha et al., 2011; (ddd) Foerstl et al., 2010; (eee) Blome and Schoenherr, 2011; (fff) Lavastre et al., 2012; (ggg) Kern et al., 2012; (hhh) Tang and Musa, 2011; (iii) Gopalakrishnan et al., 2012.

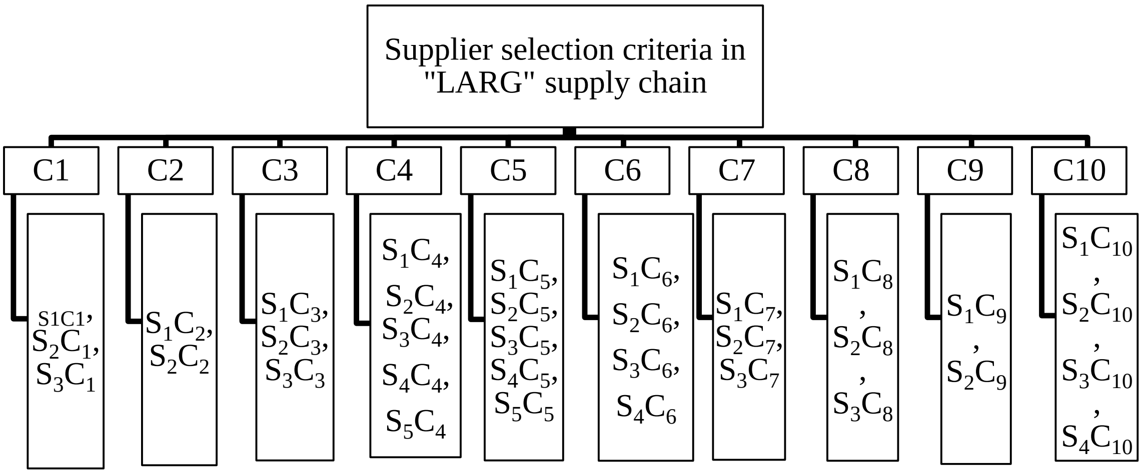

Figure 1 The proposed framework for supplier selection criteria in "LARG" supply chain

Supplier Evaluation Using Fuzzy Method

Then, lexicography and fuzzy method that are used in this article are mentioned as follows:

4.2.1.Lexicography

n=1, 2, …, N	N number of decision-makers
x=1, 2, …, X	X number of criteria
m=1, 2, …, M	M number of sub-criteria
k=1, 2, …, K	K number of qualified suppliers
i=1, 2, …, I	part I

Fuzzy Method

Fuzzy method that is used in order to evaluate and determine the weight of each supplier according to each criterion was proposed by (Hassanzadeh Amin and Zhang, 2012). The steps of this phase are as follows:

Step 1: Define appropriate criteria: Supplier selection criteria are defined at this stage.

Step 2: Define fuzzy numbers: Fuzzy numbers are used to express the decision-makers opinions about the importance of each criterion. Table 2 shows fuzzy numbers that are used in this study to determine the weights. Each decision maker establishes a level of importance for each criterion by using fuzzy numbers. Then, they are combined by formula (2) and the weights of criteria, Ca_x, are calculated.

$$Ca_x = \frac{Ca_{x1} + Ca_{x2} + \cdots + Ca_{xN}}{N} \tag{2}$$

Table 2 fuzzy numbers for determining the weights

Fuzzy number	Definition	Triangular fuzzy scale
1	Equal importance	(1,1,1)
3	Moderate importance	(1,3,5)
5	Strong importance	(3,5,7)
7	Very Strong importance	(5,7,9)
9	Extreme importance	(7,9,11)
2	Intermediate values in judgments	(1,2,4)
4		(2,4,6)
6		(4,6,8)
8		(6,8,10)

Step 3: w_{xmN} represents the importance of sub-criterion m of criterion x by decision maker N. Decision makers establish a level of importance by formula (3).

$$w_{xm} = \frac{w_{xm1} + w_{xm2} + \cdots + w_{xmN}}{N} \tag{3}$$

Step 4: Su_{xmikN} represents the assessment of supplier k that manufactures part i based on sub-criterion m of criterion x which is performed by decision maker N. Each decision maker establishes a level of importance. The aggregated weight of supplier k based on sub-criterion m and part i in criterion x, Su_{xmik}, is calculated by formula (4).

$$Su_{xmik} = \frac{Su_{xmik1} + Su_{xmik2} + \cdots + Su_{xmikN}}{N} \tag{4}$$

Step 5: In this step, the triangular fuzzy number a_{ik} is calculated by formula (5). Then, the obtained numbers, $a_{ik} = (a,b,c)$, are defuzzified by formula (6).

$$a_{ik} = \sum_{x=1}^{X} \sum_{m=1}^{M} Ca_x \times w_{xm} \times Su_{xmik} \tag{5}$$

$$be_{ik} = \frac{a+b+c}{3} \quad (6)$$

Step 6: The normalized weights (importance) of suppliers based on each criterion is calculated by formula (7). According to the obtained values, suppliers can be ranked.

$$t_{ik} = \frac{be_{ik}}{\sum_{k=1}^{K} be_{ik}} \quad (7)$$

Numerical Example

In this section, a numerical example is presented to illustrate the model. Suppose that a manufacturer sells a type of product. In addition, each product is made from four parts. It is important that which suppliers are qualified to supply required parts. The purchasing manager of the manufacturing company forms a decision making group which is composed of two decision makers. They evaluate three potential "LARG" suppliers based on each purchased part and determined framework that is shown in figure 1. The members of decision making group determine the importance of each criterion and its sub criteria by using fuzzy numbers. The results are written in table 3 and 4. In the next step, each supplier is evaluated based on each part. The results of evaluating supplier 1 based on part 1 are shown in table 5. In the next step, the final score is determined for suppliers based on each part. The final score for suppliers based on part 1 is given in table 6. In the next step, weights of suppliers based on each part are determined using formula (7). The results are written in table 7.

Table 3 The weight of each criterion x

Criteria (x)	decision maker 1(Ca_{x1})	decision maker 2 (Ca_{x2})	Weights of Criteria (Ca_x)
1- Quality	(7,9,11)	(7,9,11)	(7,9,11)
2- Cost	(7,9,11)	(7,9,11)	(7,9,11)
3- Delivery	(6,8,10)	(5,7,9)	(5.5,7.5,9.5)
4- technical and human capability	(7,9,11)	(7,9,11)	(7,9,11)
5- Pollution control	(7,9,11)	(6,8,10)	(6.5,8.5,10.5)
6- Environment management	(7,9,11)	(6,8,10)	(6.5,8.5,10.5)
7- Green product	(6,8,10)	(6,8,10)	(6,8,10)
8- Green competencies	(7,9,11)	(7,9,11)	(7,9,11)
9- Supplier's Responsiveness	(7,9,11)	(7,9,11)	(7,9,11)
10- Supplier's Risk Reduction	(7,9,11)	(7,9,11)	(7,9,11)

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Table 4 The importance of each sub-criterion m in each criterion x

Sub-Criteria	decision maker 1 (w_{xm1})	decision maker 2 (w_{xm2})	Weights of Sub-Criteria (w_{xm})
1.1.Quality-related certificates	(4,6,8)	(5,7,9)	(4.5,6.5,8.5)
2.1.rate of returned parts due to quality issues	(7,9,11)	(6,8,10)	(6.5,8.5,10.5)
3.1. part durability	(5,7,9)	(4,6,8)	(4.5,6.5,8.5)
1.2. price per unit	(6,8,10)	(7,9,11)	(6.5,8.5,10.5)
2.2. financial strength	(7,9,11)	(7,9,11)	(7,9,11)
1.3. On-time delivery	(7,9,11)	(7,9,11)	(7,9,11)
2.3. Safety and security of parts	(6,8,10)	(7,9,11)	(6.5,8.5,10.5)
3.3.Appropriateness of the packaging	(5,7,9)	(7,9,11)	(6,8,10)
1.4. Technology level	(6,8,10)	(7,9,11)	(6.5,8.5,10.5)
2.4. Capability of R&D	(6,8,10)	(7,9,11)	(6.5,8.5,10.5)
3.4. Capability of design	(7,9,11)	(7,9,11)	(7,9,11)
4.4. Capability of preventing pollution	(6,8,10)	(6,8,10)	(6,8,10)
5.4. Human Capability	(7,9,11)	(7,9,11)	(7,9,11)
1.5. Air emissions	(7,9,11)	(7,9,11)	(7,9,11)
2.5. Waste water	(6,8,10)	(7,9,11)	(6.5,8.5,10.5)
3.5. Solid wastes	(5,7,9)	(6,8,10)	(5.5,7.5,9.5)
4.5.Energy consumption	(6,8,10)	(7,9,11)	(6.5,8.5,10.5)
5.5. Use of harmful materials	(7,9,11)	(7,9,11)	(7,9,11)
1.6. Environment-related certificates	(5,7,9)	(6,8,10)	(5.5,7.5,9.5)
2.6. Continuous monitoring and regulatory compliance	(6,8,10)	(7,9,11)	(6.5,8.5,10.5)
3.6. Green process planning	(7,9,11)	(7,9,11)	(7,9,11)
4.6. Internal control process	(6,8,10)	(7,9,11)	(6.5,8.5,10.5)
1.7. Recycle	(5,7,9)	(4,6,8)	(4.5,6.5,8.5)
2.7. Green packaging	(6,8,10)	(5,7,9)	(5.5,7.5,9.5)
3.7. Reusable	(7,9,11)	(6,8,10)	(6.5,8.5,10.5)
1.8. Materials used in the supplied parts that reduce the impact on natural resources	(7,9,11)	(7,9,11)	(7,9,11)
2.8. Ratio of green customers to total customers	(4,6,8)	(5,7,9)	(4.5,6.5,8.5)
3.8. Ability to alter process and product for reducing the impact on natural resources	(7,9,11)	(6,8,10)	(6.5,8.5,10.5)
1.9. Supply Chain Velocity	(7,9,11)	(7,9,11)	(7,9,11)
2.9. Supply Chain Visibility	(7,9,11)	(7,9,11)	(7,9,11)
1.10. Vulnerability	(6,8,10)	(6,8,10)	(6,8,10)
2.10. Level of Collaboration	(7,9,11)	(7,9,11)	(7,9,11)
3.10. Risk Awareness	(6,8,10)	(7,9,11)	(6.5,8.5,10.5)
4.10. Supply Chain Continuity Management	(5,7,9)	(6,8,10)	(5.5,7.5,9.5)

Table 5 Evaluation of supplier 1 based on part 1

Sub-Criteria	decision maker 1	decision maker 2	Aggregated weights (Su_{xm11})
1.1.Quality-related certificates	(4,6,8)	(5,7,9)	(4.5,6.5,8.5)
2.1.rate of returned parts due to quality issues	(5,7,9)	(6,8,10)	(5.5,7.5,9.5)
3.1. part durability	(5,7,9)	(4,6,8)	(4.5,6.5,8.5)
1.2. price per unit	(6,8,10)	(7,9,11)	(6.5,8.5,10.5)
2.2. financial strength	(7,9,11)	(6,8,10)	(6.5,8.5,10.5)
1.3. On-time delivery	(4,6,8)	(5,7,9)	(4.5,6.5,8.5)
2.3. Safety and security of parts	(7,9,11)	(6,8,10)	(6.5,8.5,10.5)
3.3.Appropriateness of the packaging	(7,9,11)	(7,9,11)	(7,9,11)
1.4. Technology level	(6,8,10)	(7,9,11)	(6.5,8.5,10.5)
2.4. Capability of R&D	(7,9,11)	(5,7,9)	(6,8,10)
3.4. Capability of design	(6,8,10)	(7,9,11)	(6.5,8.5,10.5)
4.4. Capability of preventing pollution	(5,7,9)	(5,7,9)	(5,7,9)
5.4. Human Capability	(5,7,9)	(7,9,11)	(6,8,10)
1.5. Air emissions	(3,5,7)	(2,4,6)	(2.5,4.5,6.5)
2.5. Waste water	(6,8,10)	(6,8,10)	(6,8,10)
3.5. Solid wastes	(7,9,11)	(5,7,9)	(6,8,10)
4.5.Energy consumption	(5,7,9)	(4,6,8)	(4.5,6.5,8.5)
5.5. Use of harmful materials	(7,9,11)	(6,8,10)	(6.5,8.5,10.5)
1.6. Environment-related certificates	(6,8,10)	(7,9,11)	(6.5,8.5,10.5)
2.6. Continuous monitoring and regulatory compliance	(5,7,9)	(4,6,8)	(4.5,6.5,8.5)
3.6. Green process planning	(6,8,10)	(5,7,9)	(5.5,7.5,9.5)
4.6. Internal control process	(5,7,9)	(5,7,9)	(5,7,9)
1.7. Recycle	(6,8,10)	(6,8,10)	(6,8,10)
2.7. Green packaging	(5,7,9)	(6,8,10)	(5.5,7.5,9.5)
3.7. Reusable	(6,8,10)	(4,6,8)	(5,7,9)
1.8. Materials used in the supplied parts that reduce the impact on natural resources	(6,8,10)	(5,7,9)	(5.5,7.5,9.5)
2.8. Ratio of green customers to total customers	(6,8,10)	(6,8,10)	(6,8,10)
3.8. Ability to alter process and product for reducing the impact on natural resources	(5,7,9)	(6,8,10)	(5.5,7.5,9.5)
1.9. Supply Chain Velocity	(7,9,11)	(7,9,11)	(7,9,11)
2.9. Supply Chain Visibility	(7,9,11)	(7,9,11)	(7,9,11)
1.10. Vulnerability	(7,9,11)	(6,8,10)	(6.5,8.5,10.5)
2.10. Level of Collaboration	(7,9,11)	(7,9,11)	(7,9,11)
3.10. Risk Awareness	(7,9,11)	(6,8,10)	(6.5,8.5,10.5)
4.10. Supply Chain Continuity Management	(7,9,11)	(7,9,11)	(7,9,11)

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Table 6 The final score for suppliers based on part 1

Final score for suppliers based on part 1	Final score for supplier 1 based on part 1	Final score for supplier 2 based on part 1	Final score for supplier 3 based on part 1
1.1.Quality-related certificates	(141.75, 380.25,794.75)	(204.75,409.5,841.5)	(141.75,380.25,794.25)
2.1.rate of returned parts due to quality issues	(250.25,573.75,1097.25)	(295.75,650.25,1212.75)	(227.5,535.5,1039.5)
3.1. part durability	(141.75,380.25,794.75)	(157.5,409.5,841.5)	(141.75,380.25,794.75)
1.2. price per unit	(295.75, 650.25, 1212.75)	(295.75, 650.25, 1212.75)	(204.75, 497.25, 981.75)
2.2. financial strength	(318.5, 688.5, 1270.5)	(318.5, 688.5, 1270.5)	(318.5, 688.5, 1270.5)
1.3. On-time delivery	(173.25, 438.75, 888.25)	(134.75, 371.25, 783.75)	(211.75, 506.25, 992.75)
2.3. Safety and security of parts	(232.37, 541.87, 1047.37)	(250.25, 573.75, 1097.25)	(214.5, 510, 997.5)
3.3.Appropriateness of the packaging	(231, 540, 1045)	(214.5, 510, 997.5)	(214.5, 510, 997.5)
1.4. Technology level	(295.75, 650.25, 1212.75)	(227.5, 535.5, 1039.5)	(159.25, 420.75, 866.25)
2.4. Capability of R&D	(273, 612, 1155)	(250.25, 726.75, 1039.5)	(182, 459, 924)
3.4. Capability of design	(318.5, 688.5, 1270.5)	(318.5, 688.5, 1270.5)	(318.5, 688.5, 1270.5)
4.4. Capability of preventing pollution	(210, 504, 990)	(294, 648, 1210)	(84, 288,660)
5.4. Human Capability	(294, 648, 1210)	(318.5, 688.5, 1270.5)	(269.5, 607.5, 1149.5)
1.5. Air emissions	(113.75, 344.25, 750.75)	(295.75, 650.25, 1212.75)	(136.5, 382.5, 808.5)
2.5. Waste water	(253.5, 578, 1102.5)	(253.5, 578, 1102.5)	(147.875, 397.375, 826.875)
3.5. Solid wastes	(214.5, 510, 997.5)	(196.625, 478.125, 947.625)	(143, 382.5, 898)
4.5.Energy consumption	(190.12, 469.62, 937.125)	(724.625, 614.125, 1157.625)	(147.875, 397.375, 826.875)
5.5. Use of harmful materials	(295.75, 650.25, 1212.75)	(295.75, 650.25, 1212.75)	(182, 459, 924)
1.6. Environment-related certificates	(232.37, 541.87, 1047.37)	(232.37, 541.87, 1047.37)	(107.25, 318.75, 698.25)
2.6. Continuous monitoring and	(190.125, 469.625, 937.125)	(442, 578, 1047.375)	(147.875, 397.375, 826.875)

Final score for suppliers based on part 1	Final score for supplier 1 based on part 1	Final score for supplier 2 based on part 1	Final score for supplier 3 based on part 1
regulatory compliance			
3.6. Green process planning	(250.25, 573.75, 1097.25)	(250.25, 573.75, 1097.25)	(204.75, 497.25, 981.75)
4.6. Internal control process	(211.25, 505.75, 992.25)	(274.625, 614.125, 1157.625)	(211.25, 505.75, 992.25)
1.7. Recycle	(162, 416, 850)	(162, 416, 850)	(94.5, 286, 637.5)
2.7. Green packaging	(181.5, 450, 902.5)	(214.5, 510, 997.5)	(165, 420, 855)
3.7. Reusable	(195, 476, 945)	(253.5, 578, 1102.5)	(175.5, 442, 892.5)
1.8. Materials used in the supplied parts that reduce the impact on natural resources	(269.5, 607.5, 1149.5)	(269.5, 607.5, 1149.5)	(171.5, 445.5, 907.5)
2.8. Ratio of green customers to total customers	(189, 468, 935)	(204.75, 497.25, 981.75)	(157.5, 409.5, 841.5)
3.8. Ability to alter process and product for reducing the impact on natural resources	(250.25, 573.75, 1097.25)	(295.75, 650.25, 1212.75)	(204.75, 497.25, 981.75)
1.9. Supply Chain Velocity	(343, 729, 1331)	(220.5, 526.5, 1028.5)	(269.5, 607.5, 1149.5)
2.9. Supply Chain Visibility	(343, 729, 1331)	(245, 567, 1089)	(294, 648, 1210)
1.10. Vulnerability	(273, 612, 1155)	(252, 576, 1100)	(294, 648, 1210)
2.10. Level of Collaboration	(343, 729, 1331)	(343, 729, 1331)	(318.5, 688.5, 1270.5)
3.10. Risk Awareness	(295.75, 650.25, 1212.75)	(273, 612, 1155)	(295.75, 650.25, 1212.75)
4.10. Supply Chain Continuity Management	(269.5, 607.5, 1149.5)	(231, 540, 1045)	(231, 540, 1045)
a_{1i}	a_{11} = (8242, 18987.5, 36453)	a_{12} = (8524.75, 19485.25, 37225.75)	a_{13} = (6788.125, 16492.125, 32636.125)
b_{1i}	b_{11} = 21227.5	b_{12} = 21745.25	b_{13} = 18638.79

Table 7 The weight of supplier k for part i (t_{ik})

i/k	1	2	3
1	0.34	0.35	0.3
2	0.32	0.32	0.34
3	0.35	0.3	0.33
4	0.34	0.31	0.33

Conclusion

To increase the competitive advantage of companies as well as operate in a dynamic environment that is constantly changing, making decisions about selection of suppliers is an important issue in supply chain management because supplier has a key impact on cost, quality and on time delivery of product, environmentally friendly production and rapid responses to the customers' demand. One of the most important components of the supplier evaluation and selection is criteria formulation. In today's competitive global business environment, if an enterprise strives to maintain its competitiveness, its decision maker needs to consider all the dimensions of supplier's potency (Abdollahi et al., 2015). Till date, no study has been seen for selection of suppliers in case of a "LARG" supply chain. In this paper, a framework for supplier selection criteria in "LARG" supply chain is presented based on a literature review and fuzzy set theory is used to deal with uncertainty in the evaluation of suppliers. Thus, the importance of suppliers can be calculated. A numerical example is presented to evaluate and validate the model and Excel software, was used to calculate the weight of suppliers based on the determined criteria. The results show the efficiency and effectiveness of the model.

Recommendations for Future Research

The following is introduced appropriate tools in order to select an efficient supplier.

- Use fuzzy ANP method to calculate the weight of suppliers based on the criteria.
- Considering the presented criteria in this study in order to form alliances and selection of members in supply chains to form virtual organizations and in order to share information and skills among members.

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