Developing the preferred supplier relationships – a case study

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Abstract: The manufacturer-supplier relationships along the manufacturing supply chains have become the rich sources for generating the sustainable competitive advantages. Consequently in developing these relationships, often the manufacturers are inclined to have preferred supplier relationships established so as to cater their long-term requirements. In this regard, a manufacturer must adopt a scientific process to favourably associate with few selected suppliers and eventually choose to develop the right suppliers in order to generate the supply base advantages over the other manufacturers. However, in practice often the right suppliers are not systematically promoted and thereby the opportunities for achieving the potential growth of manufacturing supply chains are greatly lost. Considering this issue, the current study is focused on proposing a systematic approach for establishing the preferred supplier relationships. By implementing the proposed process, a manufacturer can ensure that the right suppliers are professionally endorsed and the manufacturer-supplier relationships are optimally flourished.

Keywords: preferred supplier concept; fuzzy analytical hierarchy process; fuzzy TOPSIS; manufacturer-supplier relationships; preferred supplier status.

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1 Introduction

The well established and capable supplier networks along the manufacturing supply chains would enable the manufacturers to competitively source, manufacture and distribute (Rajagopal et al., 2009; Ross, 2015; Mahmood et al., 2015) and Routroy and Sunil Kumar, 2016). So, in order to have the competent suppliers to be part of the supply chains, the manufacturers may have to proactively coordinate with the suppliers and timely extend the preferential treatment to the right suppliers. By practicing the preferred supplier concept, a manufacturer can ensure that the right suppliers are given the due significance and thereby stir a healthy competition to achieve Preferred Supplier Status (PSS) among the suppliers (Walter et al., 2003; Schiele and Vos, 2015; Sunil Kumar and Routroy, 2016). In general, a manufacturer will have to work with multiple suppliers so as to avoid monopoly of a supplier especially in a non-oligopolistic supplier environment as well as to avoid the supplier risks. By working with multiple suppliers, a manufacturer can avoid suppliers’ complacency by optimally leveraging the orders among them (Sunil Kumar and Routroy, 2016). On the other hand a manufacturer can choose to incentives the suppliers through PSS in order to increase the supplier reliability (Tang et al., 2014). Overall, a manufacturer can use the preferred supplier concept not only to work with the right suppliers but also to use it as a means for inspiring the suppliers to eagerly take part in the value addition processes (Krause and Scannell, 2002; Ivens et al., 2013). Although the preferred supplier concept can assist a manufacturer to have stronger supply base established, there is hardly any systematic approach suggested and followed for implementing the concept in a developing country like India. This is often leading to the scarcity of good suppliers which would ultimately affect the capability of the manufacturing supply chains. Moreover, this is more stringent in the current scenario where the manufacturers have to focus on the core competencies and bring in the specialised suppliers to deliver the competitive products and services. Another important aspect is that, without a scientific process in place even though the manufacturers do not intend to show the biasness while working with the suppliers often the suppliers perceive so. This is because conventionally the suppliers are used to perceive their manufacturers
as exploitative and biased. Due to this, many a time manufacturers are often confronted with the suppliers complaining about the credibility of the manufacturing systems and the decision making. In the light of the abovementioned issues, an attempt is made in the current study to suggest a process for a manufacturer’s assistance. For practicing the preferred supplier concept, the most common preferred supplier enablers (PSEs) that a manufacturer can pursue in assigning the PSS are considered and screened using fuzzy analytical hierarchy process (FAHP). Further to assist a manufacturer in deciding the supplier with whom it has to favourably associate, the fuzzy technique for order performance by similarity to ideal solution (TOPSIS) is applied. The proposed process was applied in an Indian electronic manufacturing company and its utility is established for industrial practice.

2 Literature review

The increasing emphasis on the supply chain management among the manufacturing companies has made the suppliers’ role in the value addition processes to become strategically significant. As a result, the manufacturers are objectively choosing to conduct the supplier development programs (SDPs) for mutual success of both manufacturers and suppliers (Pender, 1993). The manufacturers usually being in the stronger positions than the suppliers are expected to lead SDPs, set the benchmark for the suppliers to perform, convey the performance measures and appropriately chalk out the improvement plans for the suppliers (Pender, 1993). But traditionally due to the transactional approach with the suppliers, the manufacturers are confronted with numerous barriers to SDPs (Sunil Kumar and Routroy, 2014). Nowadays, the manufacturers cannot afford to ignore the suppliers’ standings as there is scarcity of good suppliers. In this regard, the explicit practice of preferred supplier concept would assist the manufacturers to ensure that the right suppliers are given the due importance. On the other hand, suppliers also cannot afford to be used as just in case supplier or to be dropped from a manufacturer’s supply base but they must target to become the preferred suppliers for the manufacturers (Bhattacharya et al., 1995; Ulaga and Eggert, 2006).

Many researchers have described the term ‘preferred supplier’ in different ways. The noteworthy descriptions are excerpted and emphasised in the current discussion. Caddick and Dale (1998) have mentioned that preferred suppliers are technically and commercially significant for a manufacturer and from whom around 70% of the total requirements are purchased. Halley and Nollet (2002) stated that a supplier is preferred if it is the best in responding to the strategic requirements of the large order givers. Yilmaz-Börekçi et al. (2015) have mentioned that the suppliers who are resilient and capable of adapting to the dynamic requirements of the manufacturers would be often contracted as a preferred supplier. Sunil Kumar and Routroy (2015) have stated that a preferred supplier is the one who persuade a manufacturer to favourably associate and develop the relationship in view of long-term benefits. The preferred supplier concept among the manufacturer-supplier relationships is not a new one to ponder as it has been very well pursued by various researchers in different contexts. In this section, an attempt is made to highlight and connect to the contextual inferences made by various researchers with regards to the preferred supplier concept.
2.1 Motives for adopting preferred supplier concept

Because of growing tremendous cost pressures (i.e., to reduce to cost as well as increasing capital costs), scarcity of resources and global competition, the manufacturers have to rationalise their supply bases (Ulaga and Eggert, 2006). In this regard, the manufacturers are inclined to have fewer reliable suppliers in their supply bases with a view of meeting their long-term requirements and eventually to enter into the long-term agreements with the preferred suppliers (Roy and Potter, 1996; and Ulaga and Eggert, 2006). Moreover, while the competition between the supply chains is tremendously increasing, the manufacturers have to adopt the preferred supplier concept for the suppliers so as to get the supplier innovations transferred (Nord, 1997). Thus, on one hand the manufacturers have to ensure that the preferred suppliers are retained and on the other hand the suppliers also have to ensure that they qualify to become a preferred supplier (Bhattachrya et al., 1995).

2.2 Research gaps

The manufacturer-supplier relationships evolve or devolve over a period of time but in practice often manufacturers are rarely aware of the suppliers’ position (Bhattachrya et al., 1995). Also, the preferred supplier concept has been inherently adopted by most of the manufacturing companies mainly based on the experience and intuition of the senior personnel working for the companies. Consequently, despite the conscientious efforts of the senior professionals often the decisions made seems to be biased. Even the suppliers often resort to complain against the decisions made by the manufacturers as there are no scientific methods in practice to justify the resolutions made. Hence, in the current study, the focus is laid on proposing and validating a method for practicing the preferred supplier concept in a specific manufacturing environment. In this regard, the PSEs that a manufacturer has to consider for cultivating the preferred supplier relationships are extracted from the previous research studies and are tabulated in Tables 1 to 3. The current paper is structured as follows: in Section 3, the proposed methodology for working with preferred suppliers is presented; in Section 4, the case application conducted in the Indian electronic manufacturing company is discussed; Section 5 presents the results and discussions; and finally in Section 6, the conclusions derived from the study are presented.

3 Proposed methodology for working with preferred suppliers

A manufacturer working with multiple suppliers will have to practice the preferred supplier concept in order to meet its long-term objectives. In this regard, a methodology is suggested by integrating FAHP and fuzzy TOPSIS. With the help of the proposed methodology, a manufacturer can prioritise the PSEs and accordingly choose to associate with the right suppliers. The PSEs used in this study are grouped under various components namely manufacturer interest component (MIC), common interest component (CIC) and supplier characteristic component (SCC) (see Tables 1–3). The significance of chosen PSEs can be determined by following steps of fuzzy AHP.
Table 1 PSEs under manufacturer interest component

<table>
<thead>
<tr>
<th>Preferred supplier enabler</th>
<th>References highlighted about the PSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier loyalty (SLY)</td>
<td>Ruben et al. (2007), Hüttinger et al. (2012) and Mortensen and Arlibjorn (2012)</td>
</tr>
<tr>
<td>Supplier flexibility (SFL)</td>
<td>Erdem and Göçen (2012) and Zhang et al. (2014)</td>
</tr>
<tr>
<td>Supplier responsiveness (SRP)</td>
<td>Caddick and Dale (1998) and Zhang et al. (2014)</td>
</tr>
<tr>
<td>Supplier reliability (SRY)</td>
<td>Caddick and Dale (1998) and Ruben et al. (2007)</td>
</tr>
<tr>
<td>Supplier’s environmental conscious manufacturing (SEM)</td>
<td>Handfield et al. (2002), Delmas and Montiel (2009) and Heikkurinen (2010)</td>
</tr>
<tr>
<td>Supplier pricing structure (SPS)</td>
<td>Johnson (1992), Caddick and Dale (1998) and Ruben et al. (2007)</td>
</tr>
<tr>
<td>Preferred customer perception (PCP)</td>
<td>Caddick and Dale (1998) and Baxter (2012)</td>
</tr>
<tr>
<td>Supplier responsibility (SRE)</td>
<td>Caddick and Dale (1998) and Lavastre et al. (2012)</td>
</tr>
<tr>
<td>Supplier integration achieved (SIA)</td>
<td>Schiele (2012) and Van Blokland et al. (2013)</td>
</tr>
<tr>
<td>Supplier performance level (SPL)</td>
<td>Johnson (1992), Handfield et al. (2002), Chen and Wu (2013), Zhang et al. (2014) and Gosling et al. (2015)</td>
</tr>
</tbody>
</table>

3.1 Fuzzy analytic hierarchy process for screening the PSEs

The AHP method was developed mainly to solve the multiple criteria problems which are complex in nature. However, the pair wise comparisons made among the PSEs in applying the AHP are highly subjective in nature and so there will be some uncertainty involved in the qualitative expressions made. The AHP used in so, in order to precisely capture the qualitative opinions the researchers have started using fuzzy AHP (Chang, 1996). Many researchers adopted the FAHP over method over AHP for solving various supplier research problems and reported improved decision making. The said research problems include but not limited to evaluating the risk of green components (Hu et al., 2009); supplier selection and evaluation (Alinezad et al., 2013); supplier evaluation and ranking (Tadić et al., 2014); supplier segmentation (Lo and Sudjatmika, 2016); analysing the barriers to supplier development (Dalvi and Kant, 2017); The procedural steps followed for determining the relative importance of PSEs in terms of weights.

Step 1 Form a cross functional team (CFT)

A CFT has to be formed by drawing the experts from various cross functional departments who are closely related to the suppliers. It must be ensured that the selected CFT experts must have minimum average experience, skills, expertise and knowledge about the processes outsourced to the suppliers.
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Step 2  Construction of pairwise comparison matrices (PWCMs) for PSEs

Construct the PWCMs of preferred supplier components as well as their corresponding PSEs. Then fill in the PWCMs by recording the relative importance among the elements of the aforesaid matrices. These pairwise comparisons are to be made on a one to ten scale (Saaty, 1990) (see Table 4).

Step 3  Verification of consistency in the opinions recorded along the PWCMs

The relative importances recorded along the PWCMs are to be verified by conducting certain consistency checks. Though these checks, a manufacturer can ensure that there are no over-ridings made in the opinions recorded. In conducting the consistency checks, the consistency ratios (CRs) of the PWCMs are determined and are used as a basis for decision making. The CRs are calculated as follows; normalisation of the values in each column of the PWCMs by dividing each entry with the column sum. Then, a principal vector (PV) is formed by taking the average of the entries along each row. If the PWCM is denoted as M1, and the PV is denoted as M2, then M3 = M1 * M2 and M4 = M3 / M2. If $\lambda_{\text{max}}$ is the average of the outcomes of M4, then the consistency index (CI) can be calculated by, $CI = \frac{\lambda_{\text{max}} - N}{N-1}$, where ‘N’ is the number of components or the PSEs considered under the respective component. The CR is calculated by, $CR = \frac{CI}{RI}$, where $RI$ is the random index corresponding to ‘N’ (see Table 5). If the CR value is less than or equal to 10% (allowed percentage of error in the consistency), then the judgments made are considered to be consistent. If it is not consistent then the CFT can be requested to improve their judgments so that the $CR \leq 10\%$.

Step 4  Fuzzification of PWCMs obtained from the CFT members (Lee, 2009)

The importance measures collected for the preferred supplier components and their corresponding PSEs are to be fuzzified by replacing them with the corresponding TFNs (as shown in Table 6). The TFNs used for comparing a preferred supplier component/ PSE with other component/ PSE ‘j’ for an expert ‘k’ of CFT is denoted by $(P_{ijk}, Q_{ijk}, R_{ijk})$.

Step 5  Integration of fuzzified PWCMs

The fuzzified PWCMs obtained in the previous step are can be integrated by applying the geometric mean method. The equations used for the integration of fuzzified PWCMs along the spreads of TFNs denoted by $(a_{ij}, b_{ij}, c_{ij})$ are shown below (Lee et al., 2009a).

$$a_{ij} = \left\{ \prod_{k=1}^{S} P_{ijk} \right\}^{1/s} \quad \forall i, j = 1, 2, \ldots, N$$

$$b_{ij} = \left\{ \prod_{k=1}^{S} Q_{ijk} \right\}^{1/s} \quad \forall i, j = 1, 2, \ldots, N$$
\[ c_{ij} = \left( \prod_{j=1}^{S} R_{ijk} \right)^{1/s} \quad \forall i, j = 1, 2, \ldots, N \]  

where ‘s’ denotes the number of members in the CFT formed for the data collection.

**Step 6 Determination of FSEs of components and PSEs**

Determine the FSE for each preferred supplier component/PSE ‘t’ denoted by \( W_t \) according to the equations shown below (Lee, 2009; Lee et al., 2009a, 2009b; Chang, 1996):

\[ W_t = \left( m_t^c, m_t^i, m_t^s \right) \]

\[ W_t = \left( \frac{\sum_{i=1}^{N} a_{ij}}{\sum_{i=1}^{N} N_{ij}}, \frac{\sum_{i=1}^{N} b_{ij}}{\sum_{i=1}^{N} N_{ij}}, \frac{\sum_{i=1}^{N} c_{ij}}{\sum_{i=1}^{N} N_{ij}} \right) \quad \forall i = 1, 2, \ldots, N \]  

**Table 2** PSE under common interest component

<table>
<thead>
<tr>
<th>Preferred supplier enabler</th>
<th>References highlighted about the PSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutual visits by competent personnel (MCP)</td>
<td>Delmas and Montiel (2009), Hüttinger et al. (2012), Nollet et al. (2012) and Ellegaard and Koch (2012)</td>
</tr>
<tr>
<td>Cost savings and value addition (CSV)</td>
<td>Christiansen and Maltz (2002), Winter and Lasch (2011) and Schiele et al. (2011)</td>
</tr>
<tr>
<td>Trust (TRU)</td>
<td>Hald et al. (2009), Dahwa et al. (2013), Yeniyurt et al. (2014) and Horn et al. (2014)</td>
</tr>
<tr>
<td>Top management commitment from both sides (TMC)</td>
<td>Delmas and Montiel (2009), Schiele (2010), Nollet et al. (2012), Schiele et al. (2011) and Horn et al. (2014)</td>
</tr>
<tr>
<td>Buyer-supplier cooperation (BSC)</td>
<td>Forker and Stannack (2000), Caniëls et al. (2013) and Leuschner et al. (2013)</td>
</tr>
<tr>
<td>Buyer-supplier collaboration (BCL)</td>
<td>Park et al. (2010) and Najafi Tavani et al. (2013)</td>
</tr>
<tr>
<td>Buyer-supplier compliance (BCP)</td>
<td>Nollet et al. (2012), Hüttinger et al. (2012), La Rocca et al. (2012) and Yeniyurt et al. (2014)</td>
</tr>
<tr>
<td>Buyer-supplier communication (BCM)</td>
<td>Ellegaard et al. (2003), Ruben et al. (2007), Delmas and Montiel (2009) and Hoffmann et al. (2013)</td>
</tr>
<tr>
<td>Certifications, listings and accreditations (CAC)</td>
<td>Delmas and Montiel (2009), Hüttinger et al. (2012), Lager and Storm (2012) and Arroyo-López et al. (2012)</td>
</tr>
<tr>
<td>Improvement in ethical and moral business values (EMB)</td>
<td>Ramsay and Wagner (2009), Schiele et al. (2011) and Ellis et al. (2012)</td>
</tr>
</tbody>
</table>
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Table 3  PSE under supplier characteristic component

<table>
<thead>
<tr>
<th>Preferred supplier’s characteristic features</th>
<th>References highlighted about the PSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier’s supplier condition (SSC)</td>
<td>Lee et al. (2009b) and Routroy and Sunil Kumar (2014)</td>
</tr>
<tr>
<td>Supplier’s business history (SBH)</td>
<td>Choy et al. (2005) and Erdem and Göçen (2012)</td>
</tr>
<tr>
<td>Supplier’s financial capability (SFC)</td>
<td>Caddick and Dale (1998), Swinney and Netessine (2009) and Zhang et al. (2014)</td>
</tr>
<tr>
<td>Supplier’s resource capability (SRC)</td>
<td>Johnson (1992), Caddick and Dale (1998), Sevkli et al. (2007), Erdem and Göçen (2012) and Zhang et al. (2014)</td>
</tr>
<tr>
<td>Supplier reputation and brand name (SRB)</td>
<td>Sevkli et al. (2007), Heikkurinen (2010) and Zhang et al. (2014)</td>
</tr>
<tr>
<td>Supplier project completion capability (SPC)</td>
<td>Gosling et al. (2015)</td>
</tr>
<tr>
<td>Supplier’s physical distribution system (SPD)</td>
<td>Johnson (1992), Halley and Nollet (2002) and Ruben et al. (2007)</td>
</tr>
<tr>
<td>Supplier’s facility distribution (SFD)</td>
<td>Halley and Nollet (2002) and Bates et al. (2012)</td>
</tr>
<tr>
<td>Supplier’s organisational culture (SOC)</td>
<td>Handfield et al. (2006) and Cannon et al. (2010)</td>
</tr>
</tbody>
</table>

Table 4  Scale for pair wise comparisons

<table>
<thead>
<tr>
<th>Importance measure</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equally important</td>
</tr>
<tr>
<td>2</td>
<td>Equally to moderately more important</td>
</tr>
<tr>
<td>3</td>
<td>Moderately more important</td>
</tr>
<tr>
<td>4</td>
<td>Moderate to strongly more important</td>
</tr>
<tr>
<td>5</td>
<td>Strongly more important</td>
</tr>
<tr>
<td>6</td>
<td>Strong to very strongly more important</td>
</tr>
<tr>
<td>7</td>
<td>Very strongly more important</td>
</tr>
<tr>
<td>8</td>
<td>Very to extremely strongly more important</td>
</tr>
<tr>
<td>9</td>
<td>Extremely more important</td>
</tr>
</tbody>
</table>

Source: Saaty (1990)

Table 5  Random index values

<table>
<thead>
<tr>
<th>Number of outcomes</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random index</td>
<td>0</td>
<td>0</td>
<td>0.58</td>
<td>0.9</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
</tr>
<tr>
<td>Number of outcomes</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Random index</td>
<td>1.45</td>
<td>1.49</td>
<td>1.51</td>
<td>1.48</td>
<td>1.56</td>
<td>1.57</td>
<td>1.59</td>
<td></td>
</tr>
</tbody>
</table>

Source: Saaty (2000)
Table 6  Membership functions of the fuzzy numbers

<table>
<thead>
<tr>
<th>Crisp judgment of the pairwise matrix</th>
<th>Triangular fuzzy number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(1, 1, 2)</td>
</tr>
<tr>
<td>2</td>
<td>(x – 1, x, x + 1) for x = 2, 3, …, 8</td>
</tr>
<tr>
<td>9</td>
<td>(8, 9, 9)</td>
</tr>
<tr>
<td>1/x</td>
<td>(2 – 1, 1 – 1, 1 – 1)</td>
</tr>
<tr>
<td>1/9</td>
<td>[(x + 1) – 1, x – 1, (x – 1) – 1] for x = 2, 3, …, 8</td>
</tr>
<tr>
<td></td>
<td>(9 – 1, 9 – 1, 8 – 1)</td>
</tr>
</tbody>
</table>

Source:  Lee (2009)

Step 7  Calculation of DOPs

The FSE of each component/ PSE is compared with the FSEs of the rest of the components/ PSEs respectively and a value called degree of possibilities (DOPs) \( \mu(F_i) \) Chang (1996) and Zhu et al. (1999) are calculated as mentioned below.

\[
\mu(F_2 \geq F_1) = \begin{cases} 
1, & m_2 \geq m_1 \\
0, & m_1^* \geq m_2^* \\
\frac{\left[ m_1^* - m_2^* \right]}{\left( (m_2 - m_2^*) - (m_1 - m_1^*) \right)} & \text{otherwise}
\end{cases}
\]  \hspace{1cm} (5)

Step 8  Determination of weights

The minimum value among the DOPs [\( \mu(F_i) \)] of preferred supplier component/PSE ‘i’ will be the weight ascribed for the respective component/PSE. By following the above procedural steps, the weights attached to the components as well as their corresponding PSEs can be obtained. Further, the weights of PSEs should be normalised with the components’ weights.

3.2  Fuzzy TOPSIS

By applying the FAHP method detailed in the previous section, a manufacturer could have obtained the emphasis that it has to levy on various preferred supplier components and enablers. Having ascertained the influences that make a manufacturer to assign preferred supplier status, the fuzzy TOPSIS method has been integrated so as to assist a manufacturer to choose the right preferred suppliers to associate with. The FAHP method provides the significant PSEs that a manufacturer has to consider in working with the preferred suppliers but in order to rank the supplier the fuzzy TOPSIS method is integrated with FAHP. The procedural steps for applying the fuzzy TOPSIS are detailed as shown below:

Step 1  Selection of enablers

Based on the weights assigned to the preferred supplier components and the enablers, the significant attributes (say \( C_1, C_2, …, C_n \)) are to be chosen as the criteria for ascribing the preferential ratings to the suppliers.
Step 2  Selection and rating of suppliers

A manufacturer can consider certain group of its suppliers \((S_1, S_2, \ldots, S_m)\) in order to evaluate its preferences to be attached with respect to the aforementioned criteria. The suppliers can then be rated by seeking the opinions (expressed in terms of linguistic responses) of CFT of experts (say \(E_1, E_2, \ldots, E_l\)) along the criteria \((C_1, C_2, \ldots, C_n)\) expressed in the form of supplier evaluation matrices (SEMs) as shown below.

\[
SEM = \begin{bmatrix}
C_1 & C_2 & C_3 & \cdots & C_n \\
S_1 & A_{11} & A_{12} & A_{13} & \cdots & A_{1n} \\
S_2 & A_{21} & A_{22} & A_{23} & \cdots & A_{2n} \\
S_3 & A_{31} & A_{32} & A_{33} & \cdots & A_{3n} \\
\vdots & \vdots & \vdots & \ddots & \cdots & \vdots \\
S_m & A_{m1} & A_{m2} & A_{m3} & \cdots & A_{mn}
\end{bmatrix}
\]

Step 3  Fuzzify the elements of supplier evaluation matrices

The linguistic responses obtained from the experts in terms of SEMs are quantified on a scale of one to five (where one refers to no influence and five refer to very high influence) see Table 7. Subsequently, the quantified values are fuzzified along the triangular fuzzy numbers to capture the uncertainties in the experts’ opinions.

<table>
<thead>
<tr>
<th>Linguistic terms</th>
<th>Performance rating</th>
<th>Triangular fuzzy numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>No influence (No)</td>
<td>1</td>
<td>(0, 0, 0.25)</td>
</tr>
<tr>
<td>Very low influence (VL)</td>
<td>2</td>
<td>(0, 0.25, 0.50)</td>
</tr>
<tr>
<td>Low influence (L)</td>
<td>3</td>
<td>(0.25, 0.50, 0.75)</td>
</tr>
<tr>
<td>High influence (H)</td>
<td>4</td>
<td>(0.50, 0.75, 1.00)</td>
</tr>
<tr>
<td>Very high influence (VH)</td>
<td>5</td>
<td>(0.75, 1.00, 1.00)</td>
</tr>
</tbody>
</table>

Step 4  Development of defuzzified supplier evaluation matrices

The fuzzified SEMs are then defuzzified using the CFCS (converting the fuzzy data into crisp scores) method (Opricovic and Tzeng, 2003). The steps adopted from the CFCS in defuzzifying the SEMs are mentioned below:

a  Normalisation

\[
\begin{align*}
x_{iy} &= \left( v_y - \min l_y \right) / \Delta_{\text{max}} \\
x_{m_y} &= \left( m_y - \min l_y \right) / \Delta_{\text{max}} \\
x_{l_y} &= \left( l_y - \min l_y \right) / \Delta_{\text{max}}
\end{align*}
\]
(where, $\Delta_{\text{min}}^{\text{max}} = \max r_{ij} - \min l_{ij}$) \hfill (9)

b Left and right spread measures of normalised fuzzy numbers

\[ x_{ij} = x_{ij}/(1 + x_{ij} - x_{ij}) \hfill (10) \]
\[ x_{ij} = x_{ij}/(1 + x_{ij} - x_{ij}) \hfill (11) \]

c Compute total normalised crisp score

\[ x_{ij} = \left[ \frac{x_{ij}(1 - x_{ij})}{(1 - x_{ij} + x_{ij})} \right] \hfill (12) \]

d Compute crisp value

\[ z_{ij} = \min l_{ij} + x_{ij} \times \Delta_{\text{min}}^{\text{max}} \hfill (13) \]

**Step 5** Development of average supplier evaluation matrix (ASEM)

Having computed the crisp values for all the elements of fuzzified SEMs the corresponding Defuzzified SEMs (DSEMs) are constructed. Further these DSEMs from all the CFT experts are averaged to obtain the ASEM.

If $z_1, z_2, z_3, \ldots, z_l$ are the DSEMs obtained then the ASEM ($A$) is obtained as shown below:

\[ A = \left( \sum_{k=1}^{l} z_{ik} \right) / l \hfill (14) \]

The elemental values of ASEM can be represented as $[a_{ij}]_{m \times n}$.

**Step 6** Determining the weighted supplier evaluation matrix (WSEM)

The ASEM obtained in the previous step has to be normalised as per the following equation:

\[ S = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{m} (a_{ij})^2}} \hfill (15) \]

The matrix $S$ can be termed as a normalised SEM (NSEM) and it has to be further multiplied by the weights obtained for the PSEs (taken as criteria $C_1, C_2, \ldots, C_n$) to construct the WSEM. The following expression can be used for constructing WSEM denoted as $V$.

\[ V = S_{ij} \times (W_j) \hfill (16) \]

**Step 7** Determining the ideal positive and negative solutions for the suppliers

The ideal positive ($I^+$) and ideal negative ($I^-$) solutions can be determined by extracting the best and worst situations among the alternatives along the chosen criteria. The following equations are to be used in deriving the ideal positive and negative solutions for the suppliers:

\[ I^+ = \{ \tilde{V}_1^+, \tilde{V}_2^+, \ldots, \tilde{V}_n^+ \} \hfill (17) \]
Developing the preferred supplier relationships

where \( V_j^+ = \max_i \left( V_{ij} \right) \) for \( i = 1, 2, 3, \ldots, m \) and \( j = 1, 2, 3, \ldots, n \)

\[
I^- = \left\{ V_1^-, V_2^-, \ldots, V_n^- \right\}
\]

where \( V_j^- = \max_i \left( V_{ij} \right) \) for \( i = 1, 2, 3, \ldots, m \) and \( j = 1, 2, 3, \ldots, n \)

Step 8 Determining the distances of each supplier alternative from the ideal solutions

The distance of each supplier alternative (\( i = 1, 2, 3, \ldots, m \)) from the ideal positive \((I^+)\) and ideal negative \((I^-)\) solutions are to be determined by using the following equations.

\[
\begin{align*}
D^+ &= \sqrt{\sum_{i=1}^{n} (V_{ij}^- - V_j^+)} \\
D^- &= \sqrt{\sum_{i=1}^{n} (V_{ij}^- - V_j^-)}
\end{align*}
\]

Step 9 Determine the closeness coefficients for the supplier alternatives

The closeness coefficient \((CC_i)\) can be used as a basis for ranking the supplier alternatives and in turn the manufacturer can discern its choice to favourably associate with the best suppliers. The said \( CC_i \) values for every alternative \( i = 1, 2, 3, \ldots, m \) can be computed by the following equation. The supplier having \( CC_i \) value closer to one is considered to be the best choice.

\[
CC_i = \frac{D^+}{D^+ + D^-}
\]

By following the above procedural steps a manufacturer can scientifically ascribe the preferential relationships to its suppliers.

4 Case application conducted in Indian electronic manufacturing

The proposed process for working with the preferred suppliers was applied in an Indian electronic manufacturing company located in the southern part of India. In this regard, the procurement head of the company was approached and the operational details of the abovementioned process were discussed. The proposed idea was very well appreciated by the company’s procurement team and they shared that the case company is inherently practicing the preferred supplier concept with its suppliers. However, the company personnel believed that a systematic process is certainly required to ensure such that a scientific basis in cultivating the preferred supplier relationships. From here on in the current discussion the case company will be referred as ‘G’ in order to respect the company’s security and privacy policy. The company ‘G’ is a well-known 35 year old supplier of high end technology electronic devices manufactured for reputed OEM companies from electronic, automotive, defence and aerospace industries in India and abroad. It has multiple suppliers structurally partnered to specifically meet the requirements of its customers. The case company is working multiple suppliers just to avoid the monopoly of the suppliers. Nonetheless, it is also inclined to have few reliable
suppliers developed in order to eventually increase the essential supplier integration. In this regard, the company has been conscious and vigilant about its partnerships and in leveraging the contracts with the suppliers. Accordingly, the due preferences to the suppliers were implicitly ascribed with respect to the suppliers’ contributions in the value addition processes and the associated long-term benefits with the suppliers. But there was no scientific basis in extending the preferential relationships, to justify its preferences and in turn stir a healthy competition among the suppliers. Also, there was dearth for a process to support a manufacturer in developing its suppliers along its long-term requirements.

Having got the company personnel convinced about the necessity and practical significance of the proposed process the procedural steps as explained in the previous section were executed. A CFT of 12 experts with mostly senior managers (having more than ten years of experience in the company) including the procurement head (with 25 years of rich experience in the supply management) was formed. Then the lists of PSEs under the respective PSCs were shared with the CFT of experts. They were requested to express their opinions in terms of PWCMs with regards to the specific manufacturing environment of their company (see Table 8 to envisage the quantified PWCM obtained from a CFT member for the PSEs under MIC). The PWCMs were further processed by applying the FAHP to get the key factors that are to be considered for working with the preferred suppliers. After applying the FAHP method, a manufacturer will have the weights it assigns to the factors in extending the preferred supplier relationships. Based on these weights of the principal PSEs, the manufacturer has to consider in assigning the preferred supplier relationships can be extracted.

<table>
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<th>PSE</th>
<th>SFC</th>
<th>SRC</th>
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<th>SPC</th>
<th>SPD</th>
<th>SPR</th>
<th>SFD</th>
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<th>SBH</th>
<th>SRB</th>
<th>SFD</th>
<th>SOC</th>
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Notes: $\lambda_{max} = 12.083$, CI = 0.0075, RCI = 1.48, CR = 0.0051, since CR <= 0.1. It is consistent.

Having obtained the principal PSEs, the manufacturer is proposed to apply fuzzy TOPSIS method to analyse the preferences that it can assign to its suppliers. At this juncture, the experts from the CFT were asked to consider a group of multiple suppliers (named as S1, S2, S3, S4, S5, and S6) to analyse the preferences being extended to their suppliers. Further, by considering the significant PSEs (named as criteria) the supplier alternatives
can be analysed through the fuzzy TOPSIS method. With the help of fuzzy TOPSIS a manufacturer will have the group of suppliers that it can accordingly adopt the preferred supplier concept as well as the group of suppliers who do not qualify to get preferred supplier status. The results obtained along the procedural steps of the proposed process along with their interpretation are detailed in the next section.

Table 9 The SEM obtained from a CFT member

<table>
<thead>
<tr>
<th>Supplier/PSEs</th>
<th>SIC</th>
<th>SFL</th>
<th>SRP</th>
<th>PCP</th>
<th>SFC</th>
<th>SRC</th>
<th>TRU</th>
<th>SPC</th>
<th>TMC</th>
<th>BCL</th>
<th>CSV</th>
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5 Results and discussions

The PSEs with regards to the suppliers, manufacturer (case company) and both the manufacturer and suppliers were processed to rationally exercise the preferred supplier concept. In this regard the FAHP method was applied and the weights of all PSEs in specific to the case company’s manufacturing environment were determined. Based on these weights the prominent PSEs from each side (i.e., suppliers, manufacturer and both the manufacturer and suppliers) were chosen. Then the relative significance of the prominent PSEs were further determined. The prominent PSEs along with their relative weights were SIC: 0.133, SFL: 0.132, SRP: 0.13, PCP: 0.128, SFC: 0.096, SRC: 0.096, TRU: 0.093, SPC: 0.087, TMC: 0.051, BCL: 0.048, CSV: 0.005. Based on the obtained weights it can be inferred that the SIC, SFL, SRP and PCP are relatively more important in ascribing the preferred supplier status. Hence, the case company can comparatively focus on these aspects in exercising the preferred supplier concept. Nonetheless, all the eleven PSEs were considered for further analysis as they were the prominent ones chosen from the suppliers’, manufacturer’s and both the manufacturer’s and suppliers’ sides. Further, the weights of these eleven prominent PSEs obtained by applying the FAHP method were taken as input in the application of fuzzy TOPSIS. At this juncture, the CFT members were asked to consider a group of key supplier alternatives to determine the priority it has to follow in extending the preferred supplier relationships. In this regard, the CFT members proposed seven of its key supplier alternatives (say S1, S2, S3,…, S7) to be considered for the analysis. As per the procedural Step 2, the SEMs were constructed by capturing the ratings (using linguistic expressions) for all the seven supplier alternatives along the eleven prominent PSEs as criteria. The SEM constructed with the help of a CFT member is shown in Table 9. The SEMs from all CFT members were further quantified, fuzzified and defuzzified to get the crisp scored SEMs. Then the SEMs were averaged to get the mean SEM termed as ASEM. The ASEM was then normalised to form NSEM and subsequently it was transformed into weighted SEM termed as WSEM with the help of the weights obtained for the prominent PSEs. Then the ideal
positive and ideal negative solutions for the suppliers along the chosen criteria were
determined. Based on these the performance gaps of the suppliers were determined by
computing the distances of suppliers’ ratings from the ideal positive and ideal negative
solutions. Finally, the closeness coefficients for the chosen supplier alternatives were
determined and based on which the priority that a manufacturer has to follow in
cultivating the preferred supplier relationships is established. The obtained closeness
coefficients for the chosen supplier alternatives were $S_1$: 0.4985, $S_4$: 0.4872, $S_2$: 0.4626,
$S_6$: 0.4543, $S_3$: 0.4517, $S_7$: 0.4366 and $S_5$: 0.4355. Based on these values it can be inferred
that the suppliers $S_1$ and $S_4$ are to be given more importance for cultivating preferred
supplier relationships. The CFT members were convinced by the results obtained and
agreed that the suppliers $S_1$ and $S_4$ would be the potential suppliers who will be able to
meet the long-term requirements of the case company. Thus, through the proposed
process a manufacturer can logically practice the concept of preferred supplier which can
greatly influence the buyer-supplier relationships. The process also assists the
manufacturers to alleviate their relationships with the deserving suppliers and can ensure
that a reliable supply base is established. It can be observed that the choice of integrating
the fuzzy AHP and fuzzy TOPSIS methods would enable the practitioners to focus on the
right significant PSEs and eventually in associating with the right preferred suppliers.
Despite the results obtained in the current study are more specific to the case company,
the approach can be extended to any case situation provided the environmental conditions
are accordingly considered. However, the study can be extended as an empirical study to
make the results applicable to large group of companies. Since the practice of preferred
supplier concept is the need of the hour in order to develop certain good suppliers more
approaches towards preferred supplier centric are needed. In this regard, the future
research can be more focused on measuring preferred status over a period of time and
accordingly base the decisions for working with the preferred suppliers.

6 Conclusions

In the current study, the importance of preferred supplier concept in the
manufacturer-supplier relationships has been established. The basic idea behind the study
is that a manufacturer must have a scientific method in practice for working with the
preferred suppliers. In this regard, the FAHP integrated with fuzzy TOPSIS method was
adopted to screen out the PSEs a manufacturer has to focus and also for prioritising the
order in extending the preferred supplier relationships. The proposed process was applied
in an Indian electronic manufacturing company and accordingly the prominent PSEs that
a manufacturer has to focus were suggested. Further, seven key suppliers’ preferential
positions of the case company were analysed and the sequential priorities that the
manufacturer has to extend to the suppliers were determined. The results obtained from
the case application were convincing for the top management. They also acknowledged
that a scientific process as suggested in the current study is definitely needed to not only
make the decisions regarding the preferred supplier relationships but also to healthily
induce the suppliers to participate in the value addition processes.
References


Developing the preferred supplier relationships


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