Sustainable Supply Chain management in a small & medium scale industry – Fuzzy Logical Approach

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Abstract: As a developing country, economic and environmental performance has to be balanced in India. Sustainable supply chain management (SSCM) is emerging as an important proactive approach for Indian enterprises for improving environmental performance of processes and products in accordance with the requirements of environmental regulations.

Various approaches for implementing green sustainable chain management practices have been proposed and recognized earlier, yet no investigation has identified the reliability and validity of such approaches particularly in small and medium scale industry. The fuzzy analytic hierarchy process method is applied to prioritize the relative importance of five dimensions and eighteen approaches among eleven small and medium scale enterprises. The findings indicate that these enterprises would emphasize in the crucial role of implementing green supply chain management. Establishing an environmental database of products, insisting on production systems and top management support are among the most important approaches.

The results for the implications of sustainable supply chain management implementation in industry investigated in this work generate a generic hierarchy model for decision-makers who can prioritize those approaches for implementing sustainable supply chain management in the country.

Key words - Sustainable Supply chain management, priority approaches, SME’s, fuzzy analysis, hierarchy process,

I. INTRODUCTION

A consensus is growing with the increased environmental awareness and concerns during the past decade that environmental pollution issues accompanying industrial development should be addressed together with supply chain management, thereby contributing to Sustainable green supply chain management (SSCM) (Sheu et al., 2005). Nowadays, similar practices and regulations have been spread throughout the world in the US, Europe and major Asian countries as well; the emerging issue of green product seems to be quickly picked up in India. Some countries such Japan, Taiwan and Korea in Asia are the heralds in terms of green products (Boysère and Beard, 2006). Thus, it is inferred that SSCM practice can be viewed as the primary strategy capable of complying with the requirements of legislations and maintaining the competitive advantage. The issue of SSCM is significant for India’s industry as recent studies have shown that most of the world’s manufacturing will be relocated to Asia within the next two decades (US-AEP, 1999).

More than 3,000 companies were affected by the directives of the Governments. These directives also have a far-reaching influence on supply chain partners for multinational enterprises (Huang, 2005). Although, to the best of our knowledge, various investigations have proposed different approaches to implement SSCM (Lamming and Hampson, 1996; Lippmann, 1999; US-AEP, 1999; Bowen et al., 2001; Yang and Kiellkewicz-Yuang, 2001; Rao, 2002; Evans and Johnson, 2005; Zhu et al., 2005), there have been far less research on identifying the consistency and priority approaches to SSCM implementation with the systematic analysis, particularly in small and medium scale industry. This is because the complexity of SSCM practices, customer and cost pressures and regulation uncertainty, implementing SSCM is considered as a thankless task that increases overall product cost.
These shortcomings result in significant problems when implementing SSCM. Furthermore, increased regulations result in difficulties executing SSCM practices. Hence, enterprises cannot determine whether their executive strategies conform to regulations or ensure that current management approaches are working and have a low risk. Consequently, enterprise embraces the appropriate approaches for implementing SSCM practice and it is significant to mitigate potential risks from green supply chain. The central purpose of this study is to establish the consistency and priority approaches for implementing SSCM in response to environmental regulations. The fuzzy analytic hierarchy process (FAHP), which is applied to conduct the relative importance of different approaches, is extremely crucial, since the results can be used by managers implementing and adopting their own SSCM practices.

II. METHODOLOGY

To improve the AHP method and to recognize consistent strategies for Implementing SSCM, this Study applies the FAHP and uses triangular fuzzy numbers to express comparative judgments of decision makers. A systematic approach of FAHP to identify priority approaches for SSCM implementation was adopted based on a complex and multi-criteria environment. FAHP is utilized to recognize the priority approaches that will affect the implementation of SSCM practice in small and medium scale enterprises. The methodology consists of three phases, including (1) constructing the hierarchy of SSCM practice, (2) collecting data from industrial feedback and (3) determining the normalized weights of individual dimensions and approaches. The SSCM practices implementation and FAHP will be discussed through a literature review and the construction of the hierarchy of SSCM implementation will also be presented herewith.

A. SSCM implementation

A number of approaches for implementing SSCM practice have been proposed earlier, in which they are aimed at mitigating the risks associated with green supply chain interruptions or delays and protecting a company’s reputation and brand image from damaging due to public controversies. Lippmann (1999) proposed various critical elements for the successful implementation of supply chain environmental management. Those components include the production of written SSCM policies, supplier meetings, training, collaborative R&D, top-level leadership, cross-functional integration, effective communication within companies and with suppliers, effective processes for targeting, evaluating, selecting and working with suppliers and restructuring relationships with suppliers and customers. Some of the common SSCM tools employed by these firms are as follows:

- Suppliers for green procurement to be prequalified.
- Environmental concern during the purchasing phase to be stipulated.
- Environmental orientation at Suppliers stage.
- Product Design to incorporate environmental considerations.
- Coordinating with suppliers and consumers for environmental requirement
- Working with industry to standardize requirements (for suppliers and purchasing items)
- Awareness of environmental concerns by Suppliers.
- Exchange of information and communication

An analysis to explore the implementing patterns was conducted by Bowen et al. (2001) and inductively derived three main types of green supply. The first type, i.e. greening the supply process, represents adaptations to supplier management activities, including collaboration with suppliers to eliminate packaging and recycling initiatives. The second type, i.e. product-based green supply, attempts to manage the by-products of supplied inputs such as packing. The third type, i.e. advanced green supply, includes more proactive approaches such as the use of environmental criteria in risk-sharing, evaluation of buyer performance and joint clean technology programs with suppliers.
An overview of current practices in managing sustainability issues in supply networks was presented by Yuang and Kielkiewicz-Yuang (2001). Organizations make available to their customers/suppliers their sustainability purchasing policy, goals and future targets via open days. Moreover, organizations have specific criteria as well as recognized standards, technical and performance specifications that its suppliers must meet to be recognized as preferred suppliers. In addition, supplier performances can be enhanced through on-site third-party auditing or periodic self-assessment by suppliers. Through collaboration with suppliers, training not only is administered to companies that provide advice on sustainability issues in purchasing, but also is delivered to suppliers to provide them with information on product life cycle. Rao (2002) argues that SSCM practices should include working collaboratively with suppliers on green product designs.

The companies have to integrate the ideas of green purchasing to total quality management in terms of employee empowerment, customer focus, continuous improvement and zero waste, life cycle analysis and environmental marketing. Green purchasing comprises a number of environment-based initiatives, including a supplier environmental questionnaire, supplier environmental audit and assessments, environmental criteria for designating approved suppliers, requiring suppliers to undertake independent environmental certification, jointly developing cleaner technology/processes with suppliers, engaging suppliers in eco-design and product/process innovation.

Sustainable environmental management is a key to and require cross-functional cooperation rather than simply being oriented to a single function or department. They suggested that green purchasing and improving business performance in terms of management commitment and cross-functional cooperation. Commitment of senior managers is extremely conducive to the implementation and adoption stages for SSCM, because without such upper management support, most programs are bound to fail. All SSCM practices are integrative eco-design are two emerging approaches and companies should focus on the inbound or early portions of the product supply chain.

Currently, large customers have exerted pressure on their suppliers to achieve better environmental performance, resulting in greater motivation for suppliers to cooperate with customers for environmental objectives.

**B. Fuzzy Analytic Hierarchy Process**

The analytical hierarchy process (AHP) method, introduced by Saaty (1980), directs how to determine the priority of a set of alternatives and the relative importance of attributes in a multi-criteria decision making problem (Saaty, 1980; Wei et al., 2005). The primary advantage of the AHP approach is the relative ease with which it handles multiple criteria and performs qualitative and quantitative data (Kahraman et al., 2004; Meade and Sarkis, 1998). However, AHP is frequently criticized for its inability to adequately accommodate the inherent uncertainty and imprecision associated with mapping decision-maker perceptions to extract number (Kwong and Bai, 2003; Chan and Kumar, 2007). It is difficult to respond to the preference of decision-makers by assigning precise numerical values. The FAHP, therefore, was applied to determine weight among various approaches for implementing SSCM and provided the priority of those approaches for enterprise to adopt and adjust their current SSCM practices. The following steps are essential and adopted as follows:

1. **Analysing the hierarchical structure**

Constructing the hierarchical structure with decision elements, decision-makers are requested to make pair-wise comparisons between decision alternatives and criteria using a six-point scale. All matrices are developed and all pair-wise comparisons are obtained from each $n$ decision-makers.
2. Estimating the consistency

To ensure that the priority of elements is consistent, the maximum eigenvector or relative weightages and \( \lambda_{\text{max}} \) is calculated. Then the consistency index CI for each matrix order \( n \) is calculated by using equation (1). Based on the CI and the random index (RI), the consistency ratio (CR) is calculated using equation (2). The CI and CR are defined as follows (Saaty, 1980):

\[
CI = (\lambda_{\text{max}} - n) / (n - 1) \quad (1)
\]

\[
CR = CI / RI \quad (2)
\]

where, \( n \) is the number of items being compared in the matrix, \( \lambda_{\text{max}} \) is the largest eigen value and RI is a random consistency index obtained from a large number of simulation runs and varies upon the order of matrix (Table 1).

<table>
<thead>
<tr>
<th>( n )</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>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.I.</td>
<td>0</td>
<td>0.061</td>
<td>0.89</td>
<td>1.09</td>
<td>1.27</td>
<td>1.36</td>
<td>1.39</td>
<td>1.48</td>
<td>1.51</td>
<td>1.54</td>
<td>1.48</td>
<td>1.55</td>
<td>1.56</td>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Random index

Step 3: Developing a fuzzy positive matrix

A decision-maker transforms the score of pair-wise comparison into linguistic variables via the positive triangular fuzzy number (PTFN). The fuzzy positive reciprocal matrix can be defined as (Buckley, 1985)

\[
\sim k \quad \sim k
\]

\[
A_i^j = [A_{ij}] \quad (3)
\]

where, \( A_i^j \) is a fuzzy position reciprocal matrix of decision-maker \( k \); \( A_{ij} \sim k \) is the relative importance between \( i \) and \( j \) of decision elements.

\[
A_{ij} = 1, \quad \forall i = j, \quad A_i^j = 1/ A_{ij}, \quad \forall i, j = 1, 2, \ldots, n
\]

Step 4: Evaluating fuzzy weights value

According to the Lambda-Max method proposed by Csutora and Buckley (2001), the fuzzy weights of the hierarchy can be calculated. This process is described as follows:

- Let \( \alpha = 0 \) to obtain the lower bound of the positive matrix of decision elements. \( \sim k \) \( A_i^j \) can be obtained as follows:

\[
A_i^j = [a_{ij}]_{n \times n}. \quad \text{Then, the AHP is applied to calculate weight matrix } W_k^m. \quad (4)
\]

- Let \( \alpha = 0 \) to obtain the lower bound and upper bound of the positive matrix of decision-maker, \( A_i^j \) \( A_{ij}^k \) can be obtained as follows:

\[
A_i^j = [a_{ij}]_{n \times n} \quad \text{and} \quad A_i^j = [a_{ij}]_{n \times n}. \quad \text{Then, apply the AHP to calculate the weight matrix: } W_k^l \quad \text{and} \quad W_k^u. \quad (5)
\]

- To ensure the fuzziness of weight, two constants, i.e. \( S_k^l \) and \( S_k^u \), are calculated as follows:

\[
S_k^l = \min \{ w_i^k / w_j^k \mid 1 \leq i \leq n \} \quad (7)
\]

\[
S_k^u = \min \{ w_i^k / w_j^k \mid 1 \leq i \leq n \} \quad (8)
\]

The lower bound ( \( W_k^l \) ) and upper bound ( \( W_k^u \) ) of the weight matrix are defined as follows:

\[
W_k^l = [w_i^k^l] \quad \text{and} \quad W_k^u = [w_i^k^u] \quad (9)
\]

- Aggregating \( k \) \text{ I W}, \( k \) \text{ m W} and \( k \) \text{ u W}, the fuzzy weight for decision-maker \( k \) can be acquired as follows:

\[
\bar{w}_i^k = [w_i^k^l, w_i^k^m, w_i^k^u] \quad (11)
\]

- Applying the geometric average to incorporate the opinions of decision-makers is defined as follows:

\[
\bar{W}_i^k = [w_i^k^l, w_i^k^m, w_i^k^u] \quad (11)
\]
\[ \hat{W}_i = I/k (\hat{W}^1_i \otimes \hat{W}^2_i \otimes \ldots \otimes \hat{W}^k_i) \]  

where, 
\( \hat{W}_i \): the fuzzy weight of decision-makers \( i \) is incorporated with \( K \) decision-makers. 
\( \hat{W}^k_i \): the fuzzy weight of decision element \( i \) of \( k \) decision-maker. 
\( k \): number of decision-makers.

### Table 2: Triangular fuzzy numbers

<table>
<thead>
<tr>
<th>Variables</th>
<th>Positive triangular fuzzy number</th>
<th>Positive reciprocal triangular fuzzy number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely strong</td>
<td>(9, 9, 9)</td>
<td>(1/9, 1/9, 1/9)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>(7, 8, 9)</td>
<td>(1/9, 1/8, 1/7)</td>
</tr>
<tr>
<td>Very strong</td>
<td>(6, 7, 8)</td>
<td>(1/8, 1/7, 1/6)</td>
</tr>
<tr>
<td>Strong</td>
<td>(5, 6, 7)</td>
<td>(1/7, 1/6, 1/5)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>(4, 5, 6)</td>
<td>(1/6, 1/5, 1/4)</td>
</tr>
<tr>
<td>Moderately strong</td>
<td>(3, 4, 5)</td>
<td>(1/5, 1/4, 1/3)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>(2, 3, 4)</td>
<td>(1/4, 1/3, 1/2)</td>
</tr>
<tr>
<td>Equally strong</td>
<td>(1, 2, 3)</td>
<td>(1/3, 1/2, 1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1, 1, 1)</td>
</tr>
</tbody>
</table>

Content validity is subjectively evaluated by researchers (Yusof and Aspinwall, 2000). The content validity of the questionnaire in this work is based on an exhaustive literature review and detailed evaluations by three senior quality assurance and product assurance practitioners. Consequently, the measures of SSCM constructed by the factor analysis have content validity. Criterion-relation validity, sometimes called predictive validity or external validity, is concerned with the extent to which a measuring instrument is related to an independent measure of the relevant criterion (Badri and Davis, 1995). No criterion was designed to explore the correlation with the performance of SSCM. The results of this study may provide a better understanding and help identify the opportunities of SSCM implementation.

### C. Measuring and collecting data

These companies were familiar with the SSCM practices in their organizations; they served as evaluators to determine the relative weights against a given list of approaches affecting implementation of SSCM practice. These companies were selected for promoting SSCM practice in complying with environmental regulations. Many small and medium scale enterprises, particularly in Garment, Automotive and Electronic manufacturers, are involved and embrace various green initiatives to green their supply chain, including three tasks: establishing an information management system for green supply chains; developing a recycling system and management platform for green products and generating a certification database for green parts and components. In terms of the extracted results of factor analysis, a FAHP-based questionnaire survey was designed and delivered to eighteen SME’s who have experience implementing SSCM practices for collecting data out of pair-wise comparisons.

### D. Determining the normalized weights

To determine the relative importance of the dimensions and approaches, a set of pair-wise comparison matrices were translated into the eigenvector problems and then were normalized to unify the result so as to acquire the vectors of priorities. The geometric mean is utilized to aggregate the pair-wise comparisons for all samples. The normalized local and global weights of the dimensions and
approaches were generated by the procedure aforementioned (see Tables 3 to 7). The results suggested that the overall consistency of respondents’ judgments fall within the acceptable ratio of 0.10.

III. RESULTS AND DISCUSSION

Eighteen enterprises have participated in this study, in which all were small and medium industries. In order to determine the importance of the dimensions and approaches, the judgments collected from respondents generated the normalized local and global weights for approaches to implementing SSCM. The results of priority weights determined the relative importance of individual dimensions and approaches and in turn recognized the points on which organizations should put their efforts throughout the process of SSCM implementation. In addition, the results could represent the general status of SSCM implementation in Indian industrial panorama.

Three sets of normalized weights had generated to determine the importance of approaches to SSCM implementation as shown in Table 3. The second column is the local weights with respect to the dimensions; the fourth and fifth columns are the local and global weights for each approach, respectively. The global weights of each approach have been calculated by multiplying the local weights of each approach by the local weights of each dimension.

Incorporating the analysis of FAHP evidences, the local weights for each dimension demonstrate that ‘supplier management’ (0.3937) and ‘organizational involvement’ (0.3104) are the two most important dimensions for implementing SSCM practice, followed by ‘life cycle management’ (0.1426). ‘Product recycling’ (0.1203) reveals to be the dimension with the lowest importance as shown in Table 3. The approaches of ‘product testing reports’ (0.2114), ‘produce disassembly manual’ (0.4973), top management support (0.2510) and ‘establish an environmental database of products’ (0.6982) reveal the highest importance with regard to each dimension in sequence of supplier management, product recycling, organization involvement and life cycle management, respectively.

\[
\lambda_{max} = 4.0570 \ CI=0.019 \\
\text{CR}=0.021
\]

\[
\begin{array}{cccccc}
\text{Table 3: Pairwise comparison matrix and weights with respect to the goal} \\
D_1 & D_2 & D_3 & D_4 & \text{Weights} \\
D_1 & (1, 1, 1) & (4.932, 5.944, 6.952) & (0.956, 1.387, 2.080) & (1.817, 2.190, 2.653) & 0.3937 \\
D_2 & (0.144, 0.160, 0.203) & (1, 1, 1) & (0.454, 0.575, 0.747) & (0.630, 0.928, 1.357) & 0.1426 \\
D_3 & (0.481, 0.721, 1.046) & (1.339, 1.738, 2.201) & (1, 1, 1) & (3.420, 4.481, 5.518) & 0.3104 \\
D_4 & (0.377, 0.457, 0.550) & (0.737, 1.077, 1.587) & (0.181, 0.223, 0.292) & (1, 1, 1) & 0.1203 \\
\end{array}
\]

\[
\begin{array}{cccccc}
\text{Table 4: Pairwise comparison matrix and weights with respect to supplier management dimension} \\
D_{11} & D_{12} & D_{13} & D_4 & D_{15} & D_{16} & D_{17} & \text{Weights} \\
D & (1, 1, 1) & (6.316, 1.651, 2.520, 0.347, 0.275, 1.260, (0.500) & 0.1625 \\
11 & 7.319, 3.684 & 0.585, 0.405, 1.587, 0.620, 1.957, 0.794) & (1.000) & (0.630) & (1.957) & (0.794) \\
8.320) & (1.000) & (0.630) & (1.957) & (0.794) \\
\end{array}
\]
<table>
<thead>
<tr>
<th>D1 (0.120, 0.158)</th>
<th>(1, 1, 1)</th>
<th>(0.210, 0.397)</th>
<th>(0.151, 0.281)</th>
<th>(0.210, 0.315)</th>
<th>(0.223, 0.457)</th>
<th>(0.0408)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2 (0.271, 0.606)</td>
<td>(1.587, 3.634)</td>
<td>(0.500, 2.000)</td>
<td>(0.198, 0.347)</td>
<td>(0.223, 0.457)</td>
<td>(0.1448)</td>
<td></td>
</tr>
<tr>
<td>D3 (0.511, 0.794)</td>
<td>(2.520, 4.762)</td>
<td>(0.397, 0.794)</td>
<td>(0.303, 0.794)</td>
<td>(0.198, 0.794)</td>
<td>(0.1178)</td>
<td></td>
</tr>
<tr>
<td>D4 (1.260, 2.000)</td>
<td>(2.190, 4.481)</td>
<td>(0.368, 1.000)</td>
<td>(0.437, 1.587)</td>
<td>(0.909, 2.714)</td>
<td>(0.1398)</td>
<td></td>
</tr>
</tbody>
</table>

$\lambda_{\text{max}} = 7.0145$
CI=0.0241
CR=0.0183

Table 5: Pairwise comparison matrix and weights with respect to product recycling dimension

<table>
<thead>
<tr>
<th>D21</th>
<th>D22</th>
<th>D23</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>(2.000, 2.924, 4.160)</td>
<td>(0.397, 0.693, 1.260)</td>
<td>0.3692</td>
</tr>
<tr>
<td>21 (1, 1, 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>(0.240, 0.342, 0.500)</td>
<td>(1.198, 0.251, 0.347)</td>
<td>0.1241</td>
</tr>
<tr>
<td>22 (0.240, 0.342, 0.500)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>(0.794, 1.442, 2.520)</td>
<td>(1.260, 1.957, 0.794)</td>
<td>0.4973</td>
</tr>
<tr>
<td>23 (0.794, 1.442, 2.520)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\lambda_{\text{max}} = 3.0042$
CI=0.0021 CR=0.0036

Table 6: Pairwise comparison matrix and weights with respect to organization involvement dimension
Considering the global weights, it is evident that the ten prioritized approaches for implementing SSCM in small and medium scale industry follow this order: ‘establish an environmental database of products’ (0.1025), ‘product testing report’ (0.0982), ‘top management support’ (0.0967), ‘bill of material (BOM)’ (0.0795), ‘environmental auditing for suppliers’ (0.0708), ‘compliance statement’ (0.0621), ‘green purchasing’ (0.0609), ‘produce disassembly manual’ (0.0601), ‘establishing environmental requirements for purchasing items’ (0.0573) and ‘environmental policy for SSCM’ (0.0503). Moreover, the resulting global weights have also shown that a great majority of ten prioritized approaches was the dimension of supplier management. The findings affirmed the supplier management performs in the crucial role of implementing SSCM. In addition, the priority approaches of SSCM implementation show the respondents’ perceptions about the importance of them and assisted organizations recognize their strengths to move towards continuous improvement.

Recognizing the consistency and priority approaches for implementing SSCM is important because of the uncertainties in current environmental regulations so that enterprises cannot ensure whether current management approaches can comply with the requirements of regulations. Although the

<table>
<thead>
<tr>
<th>D41</th>
<th>D42</th>
<th>Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1, 1, 1)</td>
<td>(0.232, 0.329, 0.481)</td>
<td>0.250</td>
</tr>
<tr>
<td>(1, 1, 1)</td>
<td>(0.208, 3.037, 4.309)</td>
<td>0.698</td>
</tr>
</tbody>
</table>

\(\lambda_{\text{max}} = 2.0915\) CI=0.0915 CR=0.0000

Table 7: Pairwise comparison matrix and weights with respect to life cycle management dimension
previous literature has contributed to recognize various approaches in greening the supply chain, litter is known about the consistency and priority approaches, particularly in electronics industry. The main strengths of this paper, hence, are two-folds: It recognizes the consistency approaches and provides a method for ranking approaches. This study proposed the use of FAHP to rank different approaches of SSCM implementation in small and medium scale industry. Despite focusing on the small and medium scale, the results of this study provide an insight into recognizing and prioritizing the approaches for implementing SSCM. It also proposed a generic hierarchy model for assessing the relative importance of identified approaches that would affect the SSCM implementation and the development of SSCM strategy and practice.

Different organizations can make use of the model in accordance with their specific situations and needs. In addition, the model also can help managers improve their understanding of SSCM practices and enables decision makers to assess the perception of SSCM in their organization. Although the sample in this study was insufficient, it is hoped that it can serve as a base for further research on exploring the implications of SSCM for different industry sectors and regions. The approaches for implementing SSCM in industry should be transformed to accompany changes of environmental regulations and customers in future research. In addition, it is also worth mentioning that supplier management plays the crucial part of implementing SSCM, the buyer-supplier relationships affect SSCM implementation to address the related issues.

Furthermore, the application of analytical tool in determining weights for various approaches of SSCM practice is suggested to utilize analytic network process (ANP) in terms of feedback systematic and interdependencies property.

REFERENCES