SYNOPSIS

In the last two decades, both academicians as well as practitioners have been showing keen interest on both research and application of various factors of supply chain management. Globalization of market, increased competition, sinking gap between products in terms of quality and performance are compelling the academicians and practitioners to rethink about how to manage relevant business operations more efficiently and effectively.

Since, scope for improvement within an organization is decreasing; the academicians and practitioners are looking for newer alternatives of integrating the business activities beyond the organization’s boundary. More specifically, they are trying to align and coordinate the business processes and activities of the channel members to improve the overall performance of the supply chain.

Moreover, as the market globalization, product diversity and technological breakthroughs stimulate independent companies to collaborate in a supply chain. The contemporary focus of competitiveness has to among supply chains, instead of specific companies. Practitioners, academics, and consultants have extolled the importance of coordination and its promise of significant inter-organizational gains. Within a supply chain setting, coordination involves two or more independent companies working together to jointly achieve greater success than what can be attained in isolation.

Some of the popular supply chain coordination schemes (SCCSs) are quantity discount, quantity flexibility, revenue sharing, advance discount booking, vendor managed inventory, quick response, collaborative planning forecasting and replenishment etc. Various coordination schemes have been proposed and developed to capture various managerial scenarios. Hence it is difficult to select an appropriate SCCS for a given SC environment.

Most supply chain coordination studies concentrate on pricing and contracting as coordination mechanisms, only Xu and Beamon (2006) propose subjective type of selection process for selecting any coordination mechanism. The proposed selection process was based on environmental factors that are expressed as interdependencies between organizations, uncertainty, and information technology. The features of a
desired coordination mechanism are described using resource-sharing structure, level of control, sharing risk and decision style as the attributes. Subsequently, mechanisms have been proposed to meet these features. However this selection process proposed by Xu and Beamon seems to be affected by some inherent shortcomings of subjectivity focused method. This research report by the scholar reflects an attempt for proposing a selection process, primarily based on quantitative analysis adding sufficient objectivity in this strategic decision. The prime objective of this research project is selection of the most appropriate supply chain coordination schemes in a given supply chain environment. The integrated framework as shown in Figure 0.1 represents the steps of this research project.

**Figure 0.1: Proposed framework of selection of SCCS**

![Flowchart of proposed framework of selection of SCCS]

- Selection of appropriate SCCS
  - Literature review
  - Exploration of factors relevant to SCCS selection to SCCS selection
  - Questionnaire
  - One sample one tailed T-test for identifying important influencing factors
  - Questionnaire
  - Apply DEMATEL & MMDE to analyse interrelationship between factors
  - Find total relationship matrix
  - Development of structure for ANP
  - Normalize total relationship matrix and apply ANP to find un-weighted supermatrix
  - Apply DANP to find weighted supermatrix and stable supermatrix
  - Prioritization and selection of SCCS
Exploration of managerial factors relating to SCCS selection

The research project was initiated with a systematic literature review on classification of SCCS. A classification on SCCS has been proposed on the basis of organizational interdependencies supported by different parameters like level of control, decision style, resource sharing, and risk and reward sharing. All the schemes are classified into three groups like symmetric and cooperative, symmetric and competitive, and asymmetric and cooperative. Also total forty eight influencing factors have been explored through extensive literature review and consultation with experts. These forty eight influencing factors are broadly classified into four dimension namely supply chain environment, requirement, risk and benefit.

Supply chain environment represents the potential capability, suitability or appropriateness for implementation of any coordination strategy. It is made up of variety of internal and external influences. Some of these influences are favorable and others are unfavorable. The favorable influences are supporting the SCCS implementation, whereas unfavorable ones are opposing smoother execution of SCCS. Thus SC environment dimension is composed of four components like Internal Favorable Environment (IFE), Internal Unfavorable Environment (IUE), External Favorable Environment (EFE) and External Unfavorable Environment (EUE). Further, implementation of a particular SCCS necessitates study and assessment of required conditions and infrastructure available in managing a supply chain. In fact, these are nothing but the minimum requirements or essentials for initiation or implementation of SCCS. Selection of a SCCS is also associated with assessment of the possible risk factors, which may act adversely on implementation or maintenance of SCCS. Moreover, selection process essentially requires information and knowledge on possible benefits expected to be derived from implementations of a SCCS. Each of these above four dimensions can once again be expanded to various factors. Management researchers propose 20 factors on supply chain environment and 28 factors on other dimensions.
Empirical study on influencing factors for selection process of SCCS

It is difficult to take decision when we consider all the factors while selecting SCCS. Hence the researcher tried to discard the least important factors through empirical study. Questionnaire with two distinct sections was prepared to capture the importance/applicability of SCCSs in Indian environment, and the importance of factors in SCCS selection process. The respondents are supposed to respond to questions relating to importance/applicability of SCCS in section A and the importance of relevant factors for selecting SCCS in section B keeping in view their relevance in Indian perspective. Respondents were requested to rate using closed end five-point Likert scale ranging from 1 = least applicable / important to 5 = most applicable / important.

Total twenty five complete responses were received from industry. Further, academician (both faculty and research scholar in supply chain management) from premier institutes have been included in this survey to improve the quality of survey. Eleven valid responses were received out of 89 academicians, who have been contacted for this survey. Total thirty six responses have been as a result of this survey. Chronbach’s alpha for this empirical study found to be 0.902 which is considered excellent.

The descriptive statistics of all the issues are calculated and then, one-sample t-test is applied to test whether the mean values of issues are significant. First we consider important factors as having mean value more than or equal to three at 95% confidence interval. It has been found that all the factors fulfill this criterion. So the cutoff value has been increases to four at 95% confidence interval. But the set of external unfavorable factors disqualifies as per this criterion, which is an important component of supply chain environment dimension. It is not intended to discard this component for further analysis, but at the simultaneous factors of manageable size and high importance to be considered for further analysis. Thus attempt was made to gradually and systematically reduce the importance level from four to three instead of increasing gradually from three to four. Only two factors from external unfavorable component qualify at mean value of 3.6. But there should be minimum three factors for meaningful outcome for study of pair wise interrelationship which was considered in subsequent analysis. Therefore, the level of importance is further reduced and finally settled down
at 3.5 mean value at 95% confidence interval. The result is shown in Table 0.1 and Table 0.2. Factors having t-value greater than equal to -1.689 are only considered as important factors. Total thirty eight factors qualify this criterion and these factors considered for further analysis. Similarly, the descriptive analysis of importance or applicability of SCCS is carried out as the next step. Three SCCSs like CPFR, Quantity discount and Revenue sharing have been selected for further analysis because these have highest value in terms of importance or applicability with respect to proposed classification of SCCS.

Table 0.1: T-test table for Supply chain environment when $\mu \geq 3.5$ at 95% confidence interval

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Factors</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>t-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply chain environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC IFE</td>
<td>Organizational leadership (E1)</td>
<td>3.58</td>
<td>0.906</td>
<td>0.552</td>
</tr>
<tr>
<td></td>
<td>Availability of resources (E2)</td>
<td>3.36</td>
<td>0.931</td>
<td>-0.896</td>
</tr>
<tr>
<td></td>
<td>Top management commitment (E3)</td>
<td>3.69</td>
<td>1.142</td>
<td>1.022</td>
</tr>
<tr>
<td></td>
<td>Inter-departmental relevant managerial skills (E4)</td>
<td>4.08</td>
<td>0.770</td>
<td>4.546</td>
</tr>
<tr>
<td></td>
<td>Intra-departmental relevant managerial skills (E5)</td>
<td>4.12</td>
<td>0.762</td>
<td>8.472</td>
</tr>
<tr>
<td></td>
<td>Global reputation (E6)</td>
<td>3.03</td>
<td>0.845</td>
<td>-3.354</td>
</tr>
<tr>
<td>SC IUE</td>
<td>Managerial complexity (E7)</td>
<td>3.94</td>
<td>0.791</td>
<td>3.372</td>
</tr>
<tr>
<td></td>
<td>Over emphasis on local performance matrices (E8)</td>
<td>3.56</td>
<td>0.773</td>
<td>0.431</td>
</tr>
<tr>
<td></td>
<td>Lack of firm resources (E9)</td>
<td>3.61</td>
<td>0.964</td>
<td>0.691</td>
</tr>
<tr>
<td></td>
<td>Lack of professional skills (E10)</td>
<td>3.61</td>
<td>0.838</td>
<td>0.796</td>
</tr>
<tr>
<td></td>
<td>Aversion to change (E11)</td>
<td>3.08</td>
<td>0.874</td>
<td>-2.860</td>
</tr>
<tr>
<td></td>
<td>Lack of clear alliance guidelines (E12)</td>
<td>3.33</td>
<td>0.717</td>
<td>-1.394</td>
</tr>
<tr>
<td>SC EFE</td>
<td>Technology advancement (E13)</td>
<td>4.19</td>
<td>0.856</td>
<td>4.868</td>
</tr>
<tr>
<td></td>
<td>Economic globalization (E14)</td>
<td>3.67</td>
<td>0.793</td>
<td>1.261</td>
</tr>
<tr>
<td>Factors</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>t-values</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
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<td></td>
</tr>
<tr>
<td>Liberalization (E15)</td>
<td>3.81</td>
<td>0.856</td>
<td>2.142</td>
<td></td>
</tr>
<tr>
<td>High expectation of customers (E16)</td>
<td>3.44</td>
<td>0.735</td>
<td>-0.454</td>
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</tr>
<tr>
<td>Economical &amp; political uncertainty (E17)</td>
<td>3.5</td>
<td>1.0</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Geographical laws such as tax, excise duty (E18)</td>
<td>3.5</td>
<td>0.910</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Environmental lobby (E19)</td>
<td>3.36</td>
<td>0.833</td>
<td>-1.000</td>
<td></td>
</tr>
<tr>
<td>Subjective or geocentric implementation (E20)</td>
<td>3.44</td>
<td>0.504</td>
<td>-0.661</td>
<td></td>
</tr>
<tr>
<td>Resource sharing (Re1)</td>
<td>3.89</td>
<td>0.950</td>
<td>2.457</td>
<td></td>
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<tr>
<td>Information technology infrastructure (Re2)</td>
<td>4.17</td>
<td>0.910</td>
<td>4.394</td>
<td></td>
</tr>
<tr>
<td>Common goals and objectives (Re3)</td>
<td>4.25</td>
<td>0.906</td>
<td>4.965</td>
<td></td>
</tr>
<tr>
<td>Joint planning and promotions (Re4)</td>
<td>4.08</td>
<td>0.770</td>
<td>4.546</td>
<td></td>
</tr>
<tr>
<td>Communication and information sharing (Re5)</td>
<td>4.42</td>
<td>0.692</td>
<td>7.950</td>
<td></td>
</tr>
<tr>
<td>Joint knowledge creation (Re6)</td>
<td>3.75</td>
<td>0.806</td>
<td>1.861</td>
<td></td>
</tr>
<tr>
<td>Sharing risk and rewards (Re7)</td>
<td>4.19</td>
<td>0.920</td>
<td>4.528</td>
<td></td>
</tr>
<tr>
<td>Channel trust (Ri1)</td>
<td>3.56</td>
<td>1.054</td>
<td>0.316</td>
<td></td>
</tr>
<tr>
<td>Organizational culture (Ri2)</td>
<td>3.69</td>
<td>0.822</td>
<td>1.420</td>
<td></td>
</tr>
<tr>
<td>Confidentiality (Ri3)</td>
<td>3.69</td>
<td>0.951</td>
<td>1.227</td>
<td></td>
</tr>
<tr>
<td>Willingness to share information (Ri4)</td>
<td>3.47</td>
<td>0.845</td>
<td>-0.197</td>
<td></td>
</tr>
<tr>
<td>Commitment of partners (Ri5)</td>
<td>3.39</td>
<td>0.871</td>
<td>-0.765</td>
<td></td>
</tr>
<tr>
<td>Reduced inventory cost (By1)</td>
<td>4.19</td>
<td>0.889</td>
<td>4.689</td>
<td></td>
</tr>
<tr>
<td>Reduced overall product costs (By2)</td>
<td>3.97</td>
<td>0.910</td>
<td>3.114</td>
<td></td>
</tr>
</tbody>
</table>

Table 0.2: T-test table for requirement, risk and benefit when $\mu \geq 3.5$ at 95% confidence interval
### Reduced purchasing cost (By3)
- Value: 3.17
- Confidence: 0.811
- Impact: -2.467

### Improved productivity (By4)
- Value: 3.19
- Confidence: 0.786
- Impact: -2.332

### Reduced transportation cost (By5)
- Value: 3.22
- Confidence: 0.929
- Impact: -1.794

### Improved customer service (Be1)
- Value: 4.14
- Confidence: 0.762
- Impact: 5.033

### Strong focus on core competencies (Be2)
- Value: 2.89
- Confidence: 1.090
- Impact: -3.365

### Faster speed to market of new products (Be3)
- Value: 2.83
- Confidence: 1.207
- Impact: -3.314

### Improved product quality (Be4)
- Value: 3.86
- Confidence: 0.723
- Impact: 2.99

### On time delivery (Be5)
- Value: 4.31
- Confidence: 7.10
- Impact: 6.808

### Reduced lead time (Be6)
- Value: 4.28
- Confidence: 0.741
- Impact: 6.297

### Increased customer responsiveness (Be7)
- Value: 3.19
- Confidence: 0.710
- Impact: -2.582

### Increased sharing of ideas and technology (Be8)
- Value: 3.53
- Confidence: 0.774
- Impact: 0.215

### Market penetration (Be9)
- Value: 2.22
- Confidence: 0.681
- Impact: -11.261

### Increased market competitiveness (Be10)
- Value: 3.86
- Confidence: 0.762
- Impact: 2.845

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**Structural modeling to capture the interrelationship between influencing factors**

The main objective of this research is to extract meaningful information and insights for making the selection process of supply chain coordination schemes effective and meaningful. As the first step in this pursuit, the interrelationships among the factors relevant to SCCS selection are studied. The study includes analysis of interdependency in terms of influences at dimension level, component level and subsequently at factor level. Decision Making Trial and Evaluation Technique (DEMATEL) supported by Maximum Mean De-Entropy (MMDE) methodology has been applied in order to carry out this exercise.

In this research project the DEMATEL-MMDE technique is applied to study and analyze the role of factors and their mutual influences and interrelations by developing a structural model. The perceptions of experts have been captured through a survey and are used as input to DEMATEL, which subsequently leads to development of a relationship graph. Twenty four respondents have provided the input data to DEMATEL application. The ultimate outcome of DEMATEL is Impact Relations Map.
(IRM) as shown in Figure 0.2 through Figure 0.6 for various levels of the decision making framework.

**Selection of supply chain coordination schemes**

Since there exist the interrelationships at both dimension and factor level, it was decided to depict the decision making process of SCCS as a network structure. The DEMATEL confirms the influential relationships between the criteria. DEMATEL along the ANP (DANP) is applied here to capture the dependence and feedback and finally, to assess influential weight of each criterion so that SCCSs may be selected objectively and meaningfully.

**Figure 0.2:** Impact relations map for different dimensions

**Figure 0.3:** Impact relations map for Supply Chain Environment (SCE)
Figure 0.4: Impact relations map for different requirements
The main objective of this section is to prioritize the supply chain coordination schemes in a given supply chain environment. The dimensions like SC environment, requirement, risk and benefit may be assumed as four primarily dimensions for this selection process which are depicted at level 1 of the proposed hierarchical structure shown in Figure 0.7. The factors under these dimensions may be treated as the criteria for selection process. The scholar could identify 38 influencing factors relevant to SCCS selection from the survey and analysis mentioned earlier. It is difficult to handle all the factors and it increases the complexity, if we consider in all these factors. In order to make the issue more lucid scholars considers the supply chain components (SC IFE, SC IUE, SC EFE and SC EUE) treated as the criteria under supply chain environment dimension which are at level 2. At level 3, there are the three alternatives schemes like CPFR, Quantity discount and Revenue sharing as identified earlier by empirical study.
Figure 0.7: Hierarchical structure of selection process of SCCS
The next step in this selection process is to apply DEMATEL-based ANP (i.e. DANP). Another questionnaire survey is conducted for getting the opinion of experts as the required inputs to the DANP model. Two types of inputs are acquired through this questionnaire – the degree of influence of one criterion upon another and the importance of different criteria for selection of schemes using Saaty’s nine point scale. Total eleven respondents have acted as the members of the expert group for providing input data to the proposed DANP application.

The performance score for each alternative is computed by incorporating the global weight of each criterion along with the rating of the alternative schemes applying the solution algorithm of DANP. The global performance score is found to be 0.688 for Collaborative Planning Forecasting and Replenishment (CPFR), 0.127 for quantity discount and 0.190 for revenue sharing. CPFR have scored the maximum value due to its symmetric and cooperative characteristics.

**Conclusion**

This report includes the outcome of a research project on study and subsequent analysis of the selection process of an appropriate SCCS in Indian environment. The selection proposes a hierarchical structure and subsequently a DANP-based method for selecting a right type of SCCS in a given environment. The input data have been executed by an empirical study for application of the proposed model.

The study also helps in extracting relevant insights on the behavior and interrelation of the factors which affect the selection process and management of SCCS. It is expected that the supply chain managers will be immensely benefited by this outcome which will be subsequently carried forward to the end customer in terms of better quality, right price and also improved customer service.

Authors admit existence of some limitation in this study outcome. Although this research gives some insight on selection process of SCCS, it has its own limitation. This research work is based on a relatively small size of respondents. Hence it is not sufficient to draw meaningful inferences for putting it into practice. Moreover, as the roles and importance of supply chain management related factors, and their interrelationship do vary from industry to industry, the parameters of the model will be
somewhat unique for each sector. So admitting it as limitation and the future scope of work, it is proposed that a specific model may be developed for selecting SCCS in a specific industrial sector considering opinions of practitioner and expert relevant to that sector. Detailed sensitivity analysis different factors on the selection process may also be considered as future scope of research.

**Organization of the thesis**

This research project consists of six chapters. The first chapter includes the basic concepts and the role of supply chain coordination. Second chapter includes the contemporary research on supply chain coordination. The current scenario of Indian supply chain management and coordination is described in this chapter. A systematic literature survey has been carried out to explore the influencing factors relevant to SCCS selection. Also a literature review has been carried on classification of different SCCSs and subsequently a classification scheme of SCCS has been proposed at the end of this chapter. Chapter three consists of empirical study on importance of influencing factors and importance or applicability of different SCCS in Indian context. Chapter four covers the analysis of interrelationship of factors selected in the previous chapter. DEMATEL supported by MMDE is used to analyse the interrelationship and develop Impact Relationship Map. Chapter five includes the application of DEMATEL based ANP (DANP) as multi-criteria decision making tool to prioritize the different SCCS alternatives. Ultimate conclusion and discussion are included in chapter six.