**Application of DEMATEL Method for Evaluation of the Effective Barriers in GSCM implementation**

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**Abstract:** The present research analyzes the barriers for the implementation of GSCM. The results show Organization Management has great impact on success of GSCM implementation among main aspects. Among criteria of Organization Management ‚ Lack of top management support has Great Influence on other criteria. Also‚ among criteria of Organizational Culture ‚ the lack of incentive legislation for the Green Supply Chain has Great Influence on other criteria. Also‚ among criteria of Organizational Structure‚ Lack of information and data required has Great Influence on other criteria. Also‚ among criteria of Rules and guidelines ‚ Lack of supply chain integration has Great Influence on other criteria.

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**1. Introduction**

Creating value through supply chain integration has become a potentially valuable way of securing competitive advantage and improving organizational performance, since competition is no longer between organizations, but among supply chains (Li et al., 2006). The integration of a supply chain not only focuses on tangible resources and assets, but also on intangibles such as knowledge. Knowledge is becoming the only resource capable of offering competitive advantage and continued growth and prosperity for supply chain partners. Thus, the effective creation of knowledge has become a top priority in a supply chain. The tangible consequences of knowledge creation include improved employee and customer satisfaction, an enhanced image, and an increased share valuation (Coulson-Thomas, 2004). Effective supplychain management (SCM) has become a potentiallyv aluable wayof securing competitive advantage and improving organizational performance since competition is no longer between organizations, but among supplychains.

Supply chain management (SCM) seeks to enhance competitive performance by closely integrating the internal functions within a company and effectively linking them with the external operations of suppliers, customers, and other channel members. The benefit of such supply chain integration can be attained through efficient linkage among various supply chain activities, and the linkage should be subject to the effective construction and utilization of various supply chain practices for an integrated supply chain.

The concept of SCM has received increasing attention from academicians, consultants, and business managers alike. Manyor ganizations have begun to recognize that SCM is the keyto building sustainable competitive edge for their products and/or services in an increasinglycro wded marketplace. Mentzer et al. (2001) define a supply chain as “a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from source to customer.” Stank et al. (2005) describe supply chain management as a “strategic level concept.” Supply chain management (SCM) is a technique that is linked to the adoption of the lean production system (Cox, 1999). For many organizations, developing the lean production system is a key element is their SCM practice. This involves seeking to:

. Improve value delivery to customers;

. Rely on just-in-time system;

. Eliminate waste;

. Get the involvement of all stakeholders in the value creation process;

. Develop close collaboration;

. Work closely with suppliers;

. Reduce the number of suppliers; and

. Develop efficient suppliers (Shadur and Bamber, 1994).

**2. Green Supply Chain Management**

Environmentally sustainable (green) supply chain management (GSCM) has emerged as an important organizational philosophy to achieve corporate profit and market share objectives by reducing environmental risks and impacts while improving ecological efficiency of these organizations and their partners. GSCM has emerged as an effective management tool and philosophy for proactive and leading manufacturing organizations. The scope of GSCM practices implementation ranges from green purchasing (GP) to integrated life-cycle management supply chains flowing from supplier, through to manufacturer, customer, and closing the loop with reverse logistics. A number of definitions of GSCM exist (Zhu and Sarkis, 2004).

Literature survey has thrown light on various kinds of barriers that hinder an organization from going green. Simpson et al. (2004) found that most of the SMEs feel that they cannot gain competitive advantage by adopting good environmental practice and it was a financial cost added to the business which could not be passed on to the customers. Lee (2008) found that the government plays an important role in improving the awareness and knowhow about environmental improvement and SMEs’ lack information resources or expertise to deal with the environmental issues and also attributed the firm’s size to be a significant factor for a firm to practice green supply chain; a bigger size firm tends to be more willing to participate in green supply chain initiative. Also, firms with greater resources are more likely to incorporate pollution prevention innovations. Perron (2005) summarized that there are four barrier categories that impede the adoption of green initiatives in SMEs such as attitudinal and perceptions barriers (resistance of management to change, fear of failure etc.), information related barriers (lack of awareness on environmental legislations, environmental impact of the operations in an organization), resources barriers (financial barriers and human resource barriers) and technical barriers (lack of new technologies, materials or lack of technical expertise).

**3. Effective Barriers in GSCM implementation**

Based on the previous literature review, we focus on four main aspects including Organization Management ‚ Organizational Culture, Organizational Structure and Rules and Guidelines. From these main aspects, 18 Effective Barriers in GSCM implementation are maintained. The classification of those main Criteria and their Sub-Criteria are shown in Table 1.

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| Table 1.Effective Barriers in GSCM implementation |  |
| **Criteria** | **Sub-Criteria** | **Reference** |
| Organization Management | Instability of the senior management | Sarkis (2009), Balasubramanian (2012), Ravi and Shankar‚ (2005), Yu & Hui ‚(2008)  |
| Lack of top management support | Helen and Neil (2012), Ravi and Shankar‚ (2005), Yu & Hui ‚(2008)  |
| Lack of knowledge and experience of staff | Balasubramanian (2012), Ravi and Shankar‚ (2005), Hall (2006)  |
| Employee dissatisfaction | Sarkis (2009), Balasubramanian (2012), Ravi and Shankar‚ (2005),  |
| Organizational Culture | Weak Organizational Culture | Sarkis (2009), Balasubramanian (2012), Ravi and Shankar‚ (2005),  |
| Lack of attention in Green Innovation | Sarkis (2009), Balasubramanian (2012), Ravi and Shankar‚ (2005),  |
| Lack of resources | Sarkis (2009), Helen and Neil (2012), Ravi and Shankar‚ (2005),  |
| the lack of incentive legislation for the Green Supply Chain | Balasubramanian (2012), Ravi and Shankar‚ (2005), Hall (2006) |
| Organizational Structure | Uncertainty in the Supply Chain | Sarkis (2009), Balasubramanian (2012), Helen and Neil (2012)  |
| Lack of technical infrastructure | Sarkis (2009), Balasubramanian (2012), Ravi and Shankar‚ (2005)  |
| Lack of information needed | Sarkis (2009), Balasubramanian (2012), Ravi and Shankar‚ (2005)  |
| Lack of communication between members of the supply chain | Sarkis (2009), Balasubramanian (2012), Ravi and Shankar‚ (2005)  |
| attention to the short-term profit | Sarkis (2009), Balasubramanian (2012), Ravi and Shankar‚ (2005)  |
| Rules and Guidelines | Lack of financial resources | Balasubramanian (2012), Ravi and Shankar‚ (2005)  |
| Lack of government support | Balasubramanian (2012), Ravi and Shankar‚ (2005), Sarkis (2009)  |
| Slow Return to capital after the implementation of green supply chain | Helen and Neil (2012), Ravi and Shankar‚ (2005),  |
| Lack of supply chain integration | Balasubramanian (2012), Ravi and Shankar‚ (2005), Hall (2006) |
| Lack of appropriate strategies for green supply chain vision and mission | Balasubramanian (2012), Helen and Neil (2012), Sarkis (2009), Hall (2006) |

**4. DEMATEL Technique**

The DEMATEL method was first conducted by The Battelle Memorial Institute through its Geneva Research Centre in 1973. DEMATEL is an extended method for building and analyzing a structural model for analyzing the influence relation among complex criteria. However, making decisions is very difficulty in fuzzy environment to segment complex factors.

The procedures of the DEMATEL method (Fontela & Gabus, 1976) are discussed below.

Step 1: *Generating the direct-relation matrix.*

We use five scales for measuring the relationship among different criteria: 0 (no influence), 1 (very low influence), 2 (low influence), 3 (high influence), and 4 (very high influence). Next, decision makers prepare sets of the pair**-**wise comparisons in terms of effects and direction between criteria. Then the initial data can be obtained as the direct-relation matrix which is an *n × n* matrix *T* where each element of *aij* is denoted as the degree in which the criterion *i* affects the criterion *j*.

Step 2: *Normalizing the direct-relation matrix.* Normalization is performed using the following,

$$K=\frac{1}{max\_{1\leq i\leq n}\sum\_{j=1}^{n}a\_{ij}} i,j=1,2,…,n (1)$$

$$S=K.T (2)$$

Step 3: *Attaining the total-relation matrix.* The total relation matrix *M* can be acquired by using Eq. (3), where *I* is denoted as the identity matrix

$$M=X(I-X)^{-1} (3)$$

Step 4: *Producing a causal diagram.* The sum of rows and the sum of columns are separately denoted as vector *D* and vector *R* through Eqs. (4-6). Then, the horizontal axis vector (*D* + *R*) named ‘‘Prominence’’ is made by adding *D* to *R*, which reveals the relative importance of each criterion. Similarly, the vertical axis (*D* **-** *R*) named ‘‘Relation’’ is made by subtracting *R* from *D*, which may divide criteria into a cause and effect groups. Generally, when (*D* **-** *R*) is positive, the criterion belongs to the cause group and when the (*D* **-** *R*) is negative, the criterion represents the effect group. Therefore, the causal diagram can be obtained by mapping the dataset of the (*D* + *R*, *D* **-** *R*), providing some insight for making decisions.

$$M=\left[m\_{ij}\right]\_{n×n}, i,j=1,2,…,n (4)$$

$$D=\left[\sum\_{j=1}^{n}m\_{ij}\right]\_{n×1} =\left[t\_{i.}\right]\_{n×1} (5)$$

$$R=\left[\sum\_{i=1}^{n}m\_{ij}\right]\_{1×n} =\left[t\_{j.}\right]\_{1×n} (6)$$

Where D and R denote the sum of rows and the sum of columns, respectively. Finally, a causal and effect graph can be acquired by mapping the dataset of (D + R, D **-** R), where the horizontal axis (D + R) is made by adding D to R, and the vertical axis (D **-** R) is made by subtracting R from D.

**5. Data analysis**

Data collected from the experts was analyzed with the DEMATEL method. The degree of central role (Dx +‏ Rx (in DEMATEL represents the strength of influences both dispatched and received. On the other hand, if (Dx **-** Rx) is positive, then the evaluation criterion x dispatches the influence to other evaluation criteria more than it receives. If (Dx **-** Rx) is negative, the evaluation criterion x receives the influence from other evaluation criteria more than it dispatched. Total relationships matrices are demonstrated in Tables 2 to Table 6.

The results show Organization Management has great impact on success of GSCM implementation among main aspects.

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| Table 2.The matrix X (I-X)-1 for Main aspect. |
|  | Organization Management | Organizational Culture | Organizational Structure | Rules and Guidelines | D | D+R | D-R |
| Organization Management | 0.453 | 0.481 | 0.521 | 0.416 | 1.871 | 3.496 | 0.246 |
| Organizational Culture | 0.475 | 0.574 | 0.216 | 0.281 | 1.546 | 3.125 | -0.033 |
| Organizational Structure | 0.256 | 0.199 | 0.268 | 0.562 | 1.285 | 2.674 | -0.104 |
| Rules and Guidelines | 0.441 | 0.325 | 0.384 | 0.157 | 1.307 | 2.723 | -0.109 |
| R | 1.625 | 1.579 | 1.389 | 1.416 |  |  |  |

Among criteria of Organization Management‚ Lack of top management support has Great Influence on other criteria.

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| Table 3.The matrix X (I-X)-1 for factor of Organization Management. |
|  | Instability of the senior management | Lack of top management support | Lack of knowledge and Experience | Employee dissatisfaction | D | D+R | D-R |
| Instability of the senior management | 0.568 | 0.412 | 0.458 | 0.369 | 1.807 | 3.73 | -0.116 |
| Lack of top management support | 0.625 | 0.365 | 0.305 | 0.445 | 1.74 | 3.191 | 0.289 |
| Lack of knowledge andExperience | 0.369 | 0.257 | 0.357 | 0.469 | 1.452 | 3.057 | -0.153 |
| Employee dissatisfaction | 0.361 | 0.417 | 0.485 | 0.256 | 1.519 | 3.058 | -0.02 |
| R | 1.923 | 1.451 | 1.605 | 1.539 |  |  |  |

Among criteria of Organizational Culture ‚ the lack of incentive legislation for the Green Supply Chain has Great Influence on other criteria.

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| Table 4.The matrix X (I-X)-1 for factor of Organizational Culture. |
|  | Poor organizational culture | Lack of green initiatives | Lack of resources | The lack of incentive rules | D | D+R | D-R |
| Poor organizationalculture | 0.344  | 0.524 | 0.412 | 0.257 | 1.537 | 2.932 | 0.142 |
| Lack of greeninitiatives | 0.524 | 0.257 | 0.452 | 0.367 | 1.6 | 3.331 | -0.131 |
| Lack of resources | 0.287 | 0.361 | 0.415 | 0.247 | 1.31 | 2.804 | -0.184 |
| The lack of incentive rules | 0.258 | 0.352 | 0.452 | 0.524 | 1.586 | 2.999 | 0.173 |
| R | 1.395 | 1.731 | 1.494 | 1.413 |  |  |  |

Among criteria of Organizational Structure‚ Lack of information and data required has Great Influence on other criteria.

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| Table 5.The matrix X (I-X)-1 for factor of Organizational Structure. |  |
|  | Uncertainty in the Supply Chain | Lack of technical infrastructure | Lack of information | Lack of communication between members of the supply chain | Attention to short-term profit | D | D+R | D-R |
| Uncertainty in the Supply Chain | 0.314 | 0.521 | 0.268 | 0.336 | 0.415 | 1.854 | 3.978 | -0.27 |
| Lack of technical infrastructure | 0.287 | 0.342 | 0.269 | 0.645 | 0.357 | 1.9 | 4.101 | -0.301 |
| Lack of information | 0.447 | 0.526 | 0.361 | 0.452 | 0.360 | 2.146 | 3.855 | 0.437 |
| Lack of communication between members of the supply chain | 0.392 | 0.441 | 0.426 | 0.306 | 0.520 | 2.085 | 4.208 | -0.038 |
| Attention to short-term profit | 0.517 | 0.293 | 0.385 | 0.462 | 0.472 | 2.129 | 4.086 | 0.172 |
| R | 2.124 | 2.201 | 1.709 | 2.123 | 1.957 |  |  |  |

Among criteria of Rules and guidelines ‚ Lack of supply chain integration has Great Influence on other criteria.

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| Table 6.The matrix X (I-X)-1 for factor of Rules and guidelines. |  |
|  | Financial implications | lack of government support | Slow Return of Capital | Lack of supply chain integration | Lack of sustainable GSCM Strategies in organizations vision and mission | D | D+R | D-R |
| Financial implications | 0.256 | 0.514 | 0.482 | 0.360 | 0.287 | 1.899 | 3.782 | 0.016 |
| lack of government support | 0.524 | 0.413 | 0.288 | 0.355 | 0.514 | 2.094 | 4.165 | 0.023 |
| Slow Return of Capital | 0.462 | 0.384 | 0.185 | 0.309 | 0.410 | 1.75 | 3.457 | 0.043 |
| Lack of supply chain integration | 0.373 | 0.446 | 0.390 | 0.350 | 0.419 | 1.978 | 3.768 | 0.188 |
| Lack of sustainable GSCM Strategies in organizations vision and mission | 0.268 | 0.314 | 0.362 | 0.416 | 0.412 | 1.772 | 3.814 | -0.27 |
| R | 1.883 | 2.071 | 1.707 | 1.79 | 2.042 |  |  |  |

**7. Conclusion**

This research uses the DEMATEL method as the tool that determines the Prioritization and Influence severity of each factor. The results show Organization Management has great impact on success of GSCM implementation among main aspects. Among criteria of Organization Management‚ Lack of top management support has Great Influence on other criteria. Also‚ among criteria of Organizational Culture ‚ the lack of incentive legislation for the Green Supply Chain has Great Influence on other criteria. Also‚ among criteria of Organizational Structure‚ Lack of information and data required has Great Influence on other criteria. Also‚ among criteria of Rules and guidelines ‚ Lack of supply chain integration has Great Influence on other criteria.

Handfield et al. (2002) developed a decision model to measure environmental practice of suppliers using a multiattribute utility theory approach. Kainumaa and Tawarab (2006) proposed the multiple attribute utility theory method for assessing a supply chain including re-use and recycling throughout the life cycle of products and services. Handfield et al. (2005) observed the increasing importance of supply-chain strategy as management increasingly adopts environmental practices. Effectively achieving corporate green goals means linking an environmental corporate strategy with every business functional strategy, thus eliminating obstacles to environmental integration. Decision-makers should appropriately modify the contents and aims of environmental practices to match changes in business development. Many companies have just begun exploring environmental concerns and implemented environmentally-friendly activities, so they have not yet identified many environmentally-related factors.

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