

LIMITATION TO IMPLEMENT GREEN SUPPLY CHAIN MANAGEMENT IN BANGLADESHI INDUSTRIES PERSPECTIVE

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ABSTRACT

The green supply chain management (GSCM) is a powerful way to differentiate a company from its competitors and it can greatly influence the plan success. Due to public awareness, economic, environmental or legislative reasons, the requirement of GSCM has increased. The purpose of this paper is to identify and prioritize obstruction to implement GSCM practice in the Bangladeshi industries. Based on the literature review, interviews with industry experts, and pilot studies from industrial area (Battery industry, Garments Industry, Cement Industry) eleven obstructions have been developed. It has been identified contextual relationships among the identified limitations. In addition to this, a structural model of obstruction to implement in Bangladeshi industry has also put forward using Interpretive Structural Modeling (ISM) technique. Finally this paper also suggests the removal of those barriers.

Keywords: *Green supply chain management, interpretive structural modeling, green manufacturing, reverse logistics.*

1. INTRODUCTION

In recent years the natural environment became a major issue as global warming and resource scarcity became more prevalent and oil prices continued to rise. In addition, the recent economic global crisis has accelerated the need for sustainable growth where better usage of natural resources creates the potential to develop a greener economy. That is why companies need to react to the challenges of green issues by implementing GSCM (Eltayeb, 2009; Sarkis, 2011). Actually GSCM means integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers, and end-of-life management of the product after its useful life. GSCM is defined as “green procurement green manufacturing green distribution reverse logistics” (Srivastava, 2007; Lee, 2008). The idea of GSCM is to eliminate or minimize waste (energy, emissions, chemical/hazardous, solid wastes) along supply chain (Bonsi, 2008). Companies may choose to adopt GSCM for many different reasons like one may be forced due to laws and regulations, one may use GSCM to differentiate oneself in a competitive industry by being environmentally friendly and lastly one might need to implement GSCM to stay competitive if your competitors already have adopted GSCM. Environmentally preferable purchasing (EPP) or green purchasing is process of selection and acquisition of product and services which minimize negative impact over the life cycle of manufacturing, transportation, use and recycling (Quariguasi, 2008; Lippmann, 1999). In Green manufacturing, manufacturing equipment is made to be fast, reliable, and energy efficient. Not only it will benefit the environment, but it will impact consumer, the shareholders, and the company perception in the market. The Fig.1 shows that three dimensions of GSCM and intersection of these three indicates human well being. The objective of this paper is to identify various obstructions to implement GSCM in Bangladeshi industries, to identify further the contextual relationship among the identified obstruction to implement GSCM, to classify these obstructions depending upon their driving and dependence power and finally to develop Interpretive structural modeling (ISM) based model of these obstructions. ISM is a well established methodology for identifying relationship among specific item which define a problem.

Some of the initial best practices of modern supply chains, such as lean and just- in-time (JIT) manufacturing can be traced to Henry Ford’s efforts to vertically integrate the automotive supply chain and organizational practices. The concept of GSCM at that time focused on enhancing operational efficiency and minimizing waste .GSCM is the summing up of green purchasing, green manufacturing, green packing, green distribution and marketing.

Concepts and models related to environmental issues have been suggested by different researchers. Some of them have been described. Interpretive structural modeling (ISM) methodology was utilized to understand the mutual influences among the barriers so that those driving obstructions, which can aggravate few more obstructions and those independent barriers, which are mostly influenced by driving barriers are identified (Quariguasi, 2008) GSCM practices adopted by the electrical and electronic industry in Taiwan were investigated, which was dominated by original equipment manufacturing and original designing and manufacturing. It was believed that significant growth

and opportunities to understand our world exist at the nexus of these important environmental-based organizational research fields.



Figure 1: Three dimensions of GSC.

2. METHODOLOGY

At first it has been selected those industries which were more responsible for polluting environment and facing problem for implementing GSCM. The industries were Battery industry, Garments Industry, Cement Industry, Brick Industry, Shipbuilding Industry and Lather Industry. It was discussed with supply chain officers of those industries for investigating the obstructions to implement GSCM. Eleven obstructions were developed. We summarized all the causes with the eleven causes. The obstructions were:

- Inadequate IT implementation
- Inadequate Technology Advancement Adoption
- Inadequate Organization support
- Inadequate technical knowledge and skills of Human Resources
- Market contest and insecurity
- Inadequate government legal enforcement
- Inadequate knowledge for implementing Green practices
- Inadequate Top and Middle management support
- Cost Implications
- Inadequate Supplier willingness for changing towards GSCM
- Inadequate awareness of customer

Then a structural model of obstructions to implement GSCM in Bangladeshi industries has also put forward using ISM technique. And finally also suggests the removal of these obstructions. Interpretive Structural Modeling (ISM) is a methodology used to identify relationship among specific items, which define a problem or issue; it was firstly developed in 1970's (Warfield J.W,1974).ISM is interpretive as judgment of the selected group for the study decides whether and how the variables are related. ISM generally has following steps Method divided into some steps.

- Step 1: Variables affecting the system are listed; in our research work obstructions to implement GSCM in Bangladeshi industries have been identified as variables.
- Step 2: From the variables identified in step 1, contextual relationship among the variables with respect to which pairs of variables are examined.
- Step 3: A Structural Self-Interaction Matrix (SSIM) is developed for variables, which indicates pair wise relationship among variables of the system under consideration.
- Step 4: A reachability matrix is developed from the SSIM and the matrix is checked for transitivity. The transitivity of the contextual relationships is a basic assumption made in ISM. It states that if variable A is related to variable B and variable B is related to variable C, then variable A is necessarily related to variable C.
- Step 5: The Reachability Matrix obtained in Step 4 is partitioned into different levels.
- Step 6: Based on the contextual relationships in the reachability matrix, a directed graph is drawn and the transitive links are removed.

Step 7: The resultant diagram is converted into an Interpretive Structural Model by replacing variable nodes with statements.

3. DATA COLLECTION

The obstructions to implement GSCM in Bangladeshi Industries have been collected from Supply Chain Manager of different Industries. In developing SSIM, following four symbols have been used to denote the direction of relationship between two obstruction i and j .

- V- Limitation i will lead to limitation j ;
- A-Limitation j will lead to limitation i ;
- X- Limitation i and j will lead to each other;
- O- Limitation i and j are unrelated

Based on the contextual relationships, the SSIM has been developed and shown in Table 1. obstruction 2 leads to limitation 9 so symbol 'V' has been given in the cell (2,9); obstruction 7 leads to obstruction 10 so symbol 'A' has been given in the cell (7, 10); obstruction 7 and 11 lead to each other so symbol 'X' has been given in the cell (7,11); obstruction 1 and 11 do not lead to each other so symbol 'O' has been given in the cell (1,11) and so on. The number of pair wise comparison question addressed for developing the SSIM are $((N)*(N-1)/2)$, where N is the number of obstructions.

Table 1: structural self intersection matrix (SSIM) for obstruction to implement GSCM

| S.N. | Limitation to implement GSCM | Obstruction number | | | | | | | | | | |
|------|--|--------------------|----|---|---|---|---|---|---|---|---|---|
| | | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 | Inadequate IT implementation | O | O | V | A | V | O | O | V | O | V | X |
| 2 | Inadequate Technology Advancement Adoption | X | V | V | A | V | A | V | X | V | X | |
| 3 | Inadequate Organization support | O | V | V | A | V | A | V | V | X | | |
| 4 | Inadequate technical knowledge and skills of Human Resources | O | V | V | A | V | O | V | X | | | |
| 5 | Market contest and insecurity | O | O | V | O | X | O | X | | | | |
| 6 | Inadequate government legal enforcement | V | V | V | V | V | X | | | | | |
| 7 | Inadequate knowledge for implementing Green practices | X | A | A | V | X | | | | | | |
| 8 | Inadequate Top and Middle management support | O | V | O | X | | | | | | | |
| 9 | Cost Implications | X | A | X | | | | | | | | |
| 10 | Inadequate Supplier willingness for changing towards GSCM | O | X | | | | | | | | | |
| 11 | Inadequate awareness of customer | X | | | | | | | | | | |

3.1 Reachability matrix

The SSIM has been converted in to a binary matrix, named Initial Reachability Matrix by substituting V, A, X, O by 1 or 0 applying following rules:

- ✓ If (i, j) value in the SSIM is V, (i, j) value in the reachability matrix will be 1 and (j, i) value will be 0; for V(1,7) in SSIM, '1' has been given in cell(1,7) and '0' in cell(7,1) in initial reachability matrix.
- ✓ If (i, j) value in the SSIM is A, (i, j) value in the reachability matrix will be 0 and (j, i) value will be 1; for A(2,8) in SSIM, '0' has been given in cell(2,8) and '1' in cell(8,2) in initial reachability matrix.
- ✓ If (i, j) value in the SSIM is X, (i, j) value in the Reachability Matrix will be 1 and (j, i) value will also be 1; for X(5,7) in SSIM, '1' has been given in cell(5,7) and '1' in cell(7,5) also in initial reachability matrix. “*” means change 0 to 1 from shown in Table No 2 to Table No 3.

- ✓ If (i, j) value in the SSIM is O, (i, j) value in the reachability matrix will be 0 and (j, i) value will also be 0; for O(3,11) in SSIM, '0' has been given in cell(3,11) and '0' in cell(11,3) also in initial reachability matrix.

By applying these rules, an initial reachability matrix for the limitation to implement GSCM has been obtained and shown in Table 2. The final reachability matrix has been obtained by adding transitivity as explained in Step 4 earlier and shown in Table 3. The driving power and the dependence power of each limitation has also been shown in the Table 3.

3.2 Partitioning of levels

The reach ability and antecedent set for each obstruction have been determined from the final reachability matrix. The reach ability set for an obstruction consists of the obstruction itself and the other obstructions, which it influences. The antecedent set consists of the obstruction itself and other obstructions, which may influence it. Reachability and Antecedent set and Intersection sets are found for the all obstructions. Obstruction having same reachability set and the intersection set is assigned as top level obstruction in the ISM hierarchy or Level 1 is shown in Table 4. It has been identified six levels in the study.

4. RESULT AND ANALYSIS

Table 2: Initial Reachability Matrix for obstructions to Implement GSCM in Bangladeshi industries

| S.N. | Obstructions to implement GSCM | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|------|---|---|---|---|---|---|---|---|---|---|----|----|
| 1 | Inadequate IT implementation | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 2 | Inadequate Technology Advancement Adoption | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| 3 | Inadequate Organization support | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| 4 | Inadequate technical knowledge and skills of Human | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| 5 | Market contest and insecurity | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 6 | Inadequate government legal enforcement | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 7 | Inadequate knowledge for implementing Green practices | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 |
| 8 | Inadequate Top and Middle management support | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 9 | Cost Implications | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| 10 | Inadequate Supplier willingness for changing towards GSCM | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| 11 | Inadequate awareness of customer | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |

Table 3: Final Reachability Matrix for obstructions to Implement GSCM in Bangladeshi Industries

| S. N. | Limitation to implement GSCM | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Driving Power |
|-------|--|----|----|----|----|----|----|----|----|----|----|----|---------------|
| 1 | Inadequate IT implementation | 1 | 1 | 1* | 1 | 1* | 0 | 1 | 0 | 1 | 1* | 1* | 09 |
| 2 | Inadequate Technology Advancement Adoption | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1* | 08 |
| 3 | Inadequate Organization support | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1* | 08 |
| 4 | Inadequate technical knowledge and skills of Human Resources | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1* | 08 |
| 5 | Market contest and insecurity | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 04 |
| 6 | Inadequate government legal enforcement | 1* | 1 | 1 | 1* | 1* | 1 | 1 | 1 | 1 | 1 | 1 | 11 |
| 7 | Inadequate knowledge for implementing Green practices | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1* | 0 | 1 | 04 |
| 8 | Inadequate Top and Middle management support | 1 | 1 | 1 | 1 | 1* | 0 | 1 | 1 | 1* | 1 | 1* | 10 |
| 9 | Cost Implications | 0 | 0 | 0 | 0 | 1* | 0 | 1 | 0 | 1 | 0 | 1 | 04 |
| 10 | Inadequate Supplier willingness for changing towards GSCM | 0 | 0 | 0 | 0 | 1* | 0 | 1 | 0 | 1* | 1 | 1 | 05 |
| 11 | Inadequate awareness of customer | 0 | 0 | 0 | 0 | 1* | 0 | 1 | 0 | 1 | 0 | 1 | 04 |
| | Dependence Power | 03 | 06 | 06 | 06 | 11 | 01 | 11 | 02 | 11 | 07 | 11 | 75/75 |

Table 4: First Iteration to find levels of obstructions to Implementation GSCM in Bangladeshi Industries

| Limitation S. N. | Reachability Set | Antecedent Set | Intersection | Level |
|------------------|-------------------------|-------------------------|--------------|-----------------|
| 1 | 1,2,3,4,5,7,9,10,11 | 1,6,8 | 1 | 4 th |
| 2 | 2,3,4,5,7,9,10,11 | 1,2,3,4,6,8 | 2,3,4 | 3 rd |
| 3 | 2,3,4,5,7,9,10,11 | 1,2,3,4,6,8 | 2,3,4 | 3 rd |
| 4 | 2,3,4,5,7,9,10,11 | 1,2,3,4,6,8 | 2,3,4 | 3 rd |
| 5 | 5,7,9,11 | 1,2,3,4,5,6,7,8,9,10,11 | 5,7,9,11 | 1 st |
| 6 | 1,2,3,4,5,6,7,8,9,10,11 | 6 | 6 | 6 th |
| 7 | 5,7,9,11 | 1,2,3,4,5,6,7,8,9,10,11 | 5,7,9,11 | 1 st |
| 8 | 1,2,3,4,5,7,8,9,10,11 | 6,8 | 8 | 5 th |
| 9 | 5,7,9,11 | 1,2,3,4,5,6,7,8,9,10,11 | 5,7,9,11 | 1 st |
| 10 | 5,7,9,10,11 | 1,2,3,4,6, 8,10 | 10 | 2 nd |
| 11 | 5,7,9,11 | 1,2,3,4,5,6,7,8,9,10,11 | 5,7,9,11 | 1 st |

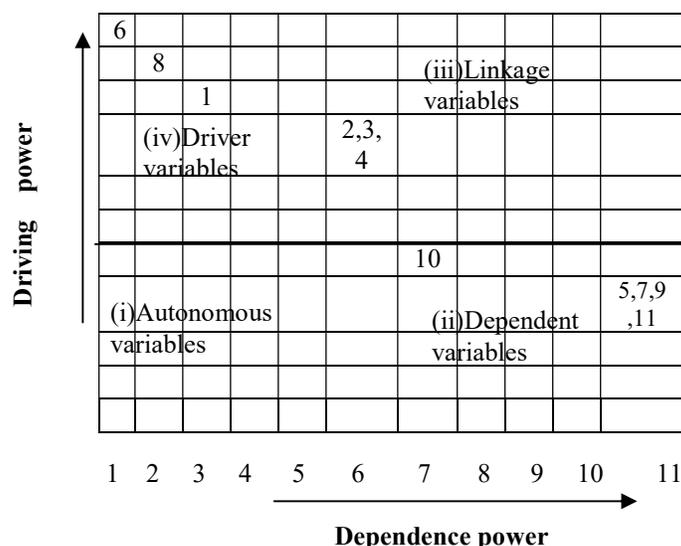


Figure 2: Cluster of obstructions to implement GSCM in Bangladeshi industry

4.1 Classifications of obstructions

The graph between dependence power and driving power for the obstructions to implement GSCM in Bangladeshi industry is given in Fig. 2. Variables are classified in to four clusters. Autonomous variables (first cluster) have weak driving power and dependence. In this study, no barrier lies in this range. The second cluster is named dependent variables. They have weak driving power and strong dependence power. Five obstructions respectively 5, 7, 9, 11 and 10 are lying in this range. The third cluster named linkage variables having strong driving power and strong dependence power. Obstructions 2, 3 and 4 respectively are lying in this range. The fourth cluster named independent variables has strong driving power and weak dependence power. In this study, three obstructions 6, 8 and 1 respectively are lying in this range.

4.2 ISM Based model

All levels have been summarized in the Table 5. After removing the transitivity’s as described in the ISM methodology, ISM Model has been made as shown in Fig.3. Market contest and insecurity, inadequate knowledge for implementing Green practices, Cost implications, inadequate awareness of customer are top level obstructions. Inadequate government legal enforcement is found bottom level obstructions.

Table 5: Various Levels of obstructions to Implement GSCM in Bangladeshi Industries

| S. N. | Level No. | Factors importance for implementing GSCM |
|-------|-----------------|---|
| 1 | 1 st | Market contest and insecurity Inadequate knowledge for implementing Green practices Cost Implications Inadequate awareness of customer |
| 2 | 2 nd | Inadequate Supplier willingness for changing towards GSCM |
| 3 | 3 rd | Inadequate Technology Advancement Adoption Inadequate Organization support Inadequate technical knowledge and skills of Human Resources |
| 4 | 4 th | Inadequate IT implementation |
| 5 | 5 th | Inadequate Top and Middle management support |
| 6 | 6 th | Inadequate government legal enforcement |

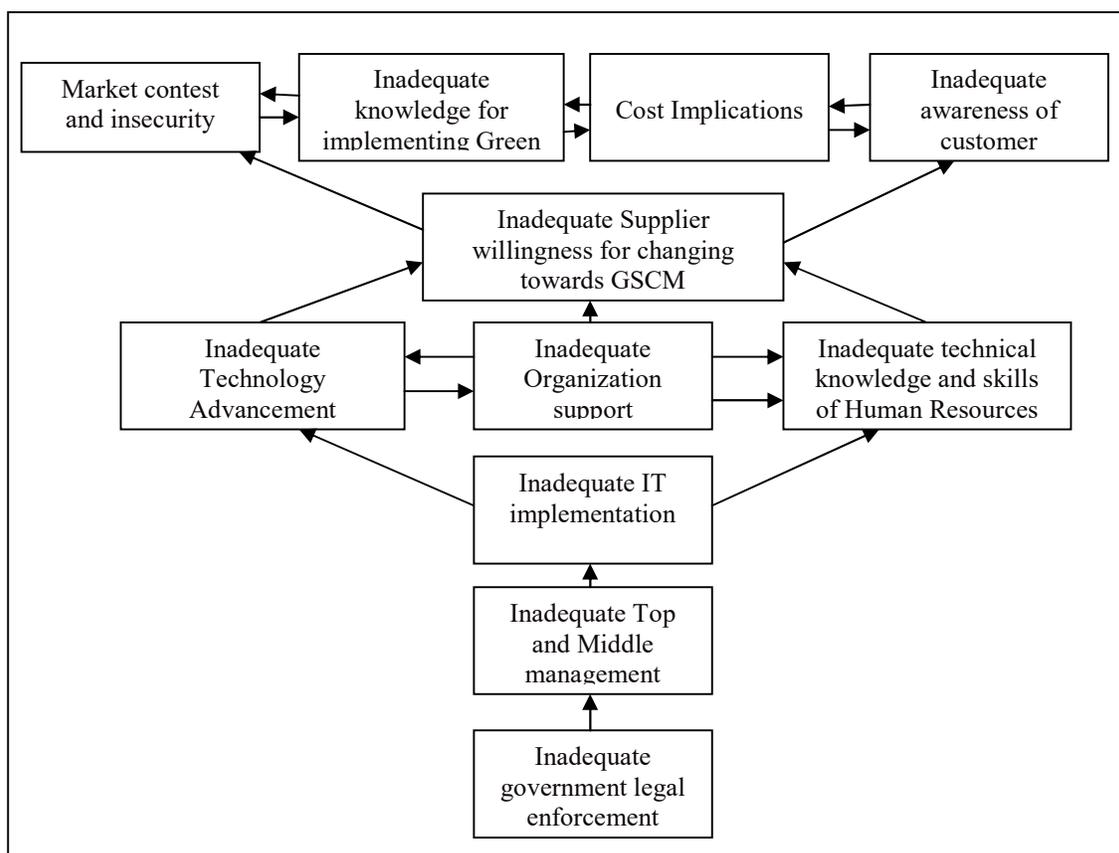


Figure 3: ISM BASED Model for obstructions to Implement GSCM in Bangladeshi Industries

4.3 Proposed Solution for Solving Limitation

Organizations may lower their cost by reducing waste, also reducing their compliance costs. Implementation of government policies towards green practices will lead to more committed top management. IT enablement will also help in fast and effective communication among members of supply chain to achieve competent SCM. ISO 14001: 2004 (environment management system) should be promoted by Bangladesh government. Innovative green practices may be motivated with Government support systems, Top management commitment, Technology advancement adoption, Organization encouragement, Quality of human resources and IT enablement. Innovative green practices involve hazardous solid waste disposal, energy conservation, reusing and recycling materials. Design for environment is the consideration of recyclable and non harmful materials in design phase. Product should safe disposal after

successful end of the life. Use of lean or flexible manufacturing will help in continuous improvement and elimination of waste in all forms.

5. CONCLUSION

Green supply Chain Management (GSCM) has been identified as an approach for improving performance of the processes and products according to the requirements of environmental regulations. Eleven obstructions to implement GSCM in Bangladeshi industry have been identified. Interpretive Structural Modeling (ISM) methodology has been used for finding contextual relationships among various obstructions to implement GSCM in Bangladeshi industry. A Model has been developed from ISM methodology. Removal of these obstructions will be help in implementing GSCM in Bangladeshi industry. Methodological developments and application for GSCM research are also promising areas for future studies.

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