Structural Framework for Evaluating Drivers and Barriers to Green Supply Chain Management in Chemical Industry

SHOHANUZZAMAN SHOHAN

DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING
BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY
DHAKA-1000, BANGLADESH
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SHOHANUZZAMAN SHOHAN

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CERTIFICATE OF APPROVAL

The thesis titled **"Structural Framework for Evaluating Drivers and Barriers to Green Supply Chain Management in Chemical Industry"** submitted by Shohanuzzaman Shohan, Student No: 0416082004 P has been accepted as satisfactory in partial fulfillment of the requirements for the degree of Master of Science in Industrial & Production Engineering on June 04, 2018.

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It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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Shohanuzzaman Shohan

To the Almighty

To my family

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First of all, I am grateful to the almighty Allah, the beneficial, the merciful for granting me to bring this research work into light.

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ABSTRACT

Green supply chain management (GSCM) is managing the supply chain of an organization with an emphasis on environmental considerations and impacts of the supply chain activities. GSCM has become one of successful business strategies in modern business environment for improving performance of the whole supply chain, including the environmental performance. The chemical industry of Bangladesh is expanding rapidly and implementation of GSCM is essential in this sector to sustain global competition. Considering the importance of GSCM in modern business ecosystem, this thesis proposes two structural frameworks that aimed to enhance the probability of successful implementation of GSCM in the chemical industry of Bangladesh. One framework evaluates the contextual relationships among the drivers of GSCM in the chemical industry while the other framework captures the interrelationships among the barriers to GSCM.

To develop the frameworks, the identification of the drivers and the barriers to GSCM in the chemical industry of Bangladesh is crucial. In total, eight drivers and eight barriers were finalized through a survey of related literature and by taking expert inputs via the Delphi methodology. The Delphi rounds were conducted among a number of supply chain professionals belonging to a diverse range of chemical companies in Bangladesh. The structural frameworks for both the drivers and the barriers were developed using total interpretive structural modeling (TISM) technique. The driving power and the dependence for all the drivers and the barriers were determined with the help of Matriced' Impacts Croise's Multiplication Appliquée a UN Classement (MICMAC) analysis. The structural frameworks were validated using an expert panel of supply chain analysts. The findings indicate that the most significant driver was supplier pressure and willingness and the most significant barrier was high cost. The outcomes of this research are expected to help industrial managers to understand the critical areas where they should focus on to implement GSCM in the chemical industry.

Comment [M1]: The abstract was damn weak. I have rewritten it.

Comment [M2]: I have put the acronym. If anybody reads the abstract only, how will he know it?

Comment [M3]: If anybody reads the abstract only, how will he know it?

Comment [M4]: What were the findings! It is missing! Significant drivers and barriers!!!!!!!

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LIST OF ABBREVIATIONS

GSCM	Green Supply Chain Management
ISM	Interpretive Structural Modeling
MICMAC	Matriced' Impacts Croise's Multiplication Appliquée a UN Classement
TISM	Total Interpretive Structural Modeling
SEM	Structural Equation Modeling

CHAPTER 1
INTRODUCTION

1.1 Overview

Over the past few years, green supply chain management (GSCM) is gaining popularity among academics and practitioners. Leading companies around the world are continuously searching for ways which can be profitable for the companies and environment-friendly for their supply chain activities. In the 21st century, business organizations and their logistics divisions are constantly facing challenges of implementing greener culture. One of their biggest concerns is how the GSCM strategies can be incorporated into their supply chain and logistics activities (Somsuk & Laosirihongthong, 2017). Some examples of GSCM practices would be developing eco-friendly products, implementing reverse logistics, reduce carbon emission and reducing the hazardous waste (Sachdeva et al., 2018). Increasingly, companies are recognizing that the implementation of GSCM is very crucial and also provides the opportunity to create a lasting impact on organizational performance (Diabat & Govindan, 2011). The concept of GSCM also offers a hope in preserving the damage to environment (Sheetal et al., 2018).

Business organizations are facing pressure due to the awareness of consumers who are concerned about environmental protection. Along with rapid changes in global manufacturing scenario, environmental and social issues are becoming more important in managing any business (Jayant & Azhar, 2014). GSCM can be defined as a process and performance improving tools that also provide considerations to the environment (Hsu & Hu, 2008).

Gilbert (2001) defined the GSCM as the process of meeting logistics demand with consideration of environment aspects, and keeping a long term relationship with the suppliers. As competition intensified in the 1990s, the increased awareness of green practices has triggered firms to act in an ethically and socially responsible manner in their supply chains (Diabat & Govindan, 2011). At the beginning of 1995, GSCM has attracted considerable scholarly interest; GSCM received the highest attention in 2010 (Luthra et al., 2014). With time, firms have realized it's importance, and they have started to incorporate the GSCM in supply chain operations (Beamon, 1999).

The chemical industry is expanding rapidly in Bangladesh. The average growth rate of the industry in Bangladesh is around 6-10%. Chemical, pharmaceutical, food and allied industries have a major share of these numbers (Ahaduzzaman et al., 2017). Chlor-Alkali Plant and its chlorinated product and hydrogen peroxide plants are basically the chemical industry's main focus in Bangladesh. Caustic soda (NaOH), chlorine (Cl_2), hydrochloric acid (HCl), sodium hypochlorite (NaOCl), stable bleaching power (SBP), chlorinated paraffin wax (CPW) and hydrogen peroxide (H_2O_2) are the main products that are being produced in these plants (Salahuddin, 2011). Chemical industries of Bangladesh can produce a maximum of 800 metric tons per day of hydrochloric acid and a minimum of 42 metric tons per day of liquid chlorine. Most of the companies are trying to increase their production capacity to fulfill local customer demands of basic chemical consumption (Ahaduzzaman et al., 2017).

One example of the chemical industry is the textile industry. The textile industry requires different types of chemicals in each step of processing activities. Therefore, chemicals play a vital role in the textile industry (Kiron et al, 2013) . The chemical industry produces chemicals locally and a large number of chemical components are being imported globally from several countries. As a result, their impact on the environment comes naturally. To reduce the hazardous effect of the components and to dispose of the wastage produced by these industries, implementation of the GSCM system is essential. To improve the environmental performance of any organization, GSCM is one of the best strategies for meeting the challenge to reduce hazardous waste and to make eco-friendly products at the same time.

The research on how to successfully implement the GSCM in industries is seen in the literature in the context of developed countries. However, there is a lack of research in

implementing the GSCM system in industries in Bangladesh, especially in the chemical industry context where several hazardous chemicals are used. Identifying the barriers, which oppose the implementation of GSCM, and the drivers, which advance the process of implementing GSCM, in the chemical industry is crucial. In this research, we have proposed structural framework the drivers and another framework for barriers to implementing GSCM in the chemical industry of Bangladesh.

1.2 Objectives of the Study

The objectives of this research are:

- To identify drivers and barriers to implementing GSCM in the chemical industry of Bangladesh.
- To develop a total interpretive structure model (TISM) model by examining the relationships among various drivers of GSCM for the chemical industry of Bangladesh.
- To develop another TISM by examining the relationships among various barriers to GSCM for the chemical industry of Bangladesh.
- To provide insights of the relationships among the drivers and the barriers of GSCM and its implications in the chemical industry of Bangladesh.

In brief, the objective of this research is to develop structural frameworks for evaluating drivers and barriers to GSCM in the chemical industry of Bangladesh. Recognizing the interdependence of drivers and barriers, and the contextual relationships among barriers could lead to supply chain cost savings. The outcome of this research would help practicing managers to take appropriate measures for proper utilization of resources for greening their supply chain initiatives.

1.3 Outline of the Methodology

The research methodology is outlined as follows:

- Drivers and barriers associated with the implementation of GSCM in the chemical industry of Bangladesh have been identified using literature reviews and feedbacks from industry experts.
- The contextual relationships among green supply chain drivers as well as among green supply chain barriers have been examined based on their driving and dependence power.
- The level of several drivers and barriers have been determined by partitioning the reachability matrix.
- A directed graph (digraph) has been developed for the drivers and barriers by arranging all the drivers and barriers in their respected levels.
- Directed links have been drawn as per the relation revealed in the reachability matrix. The final digraph has been converted into a binary interaction matrix.
- Two structural frameworks, one for the drivers and the other for the barriers, have been developed for both drivers and barriers, using TISM.
- MICMAC ((Matriced' Impacts Croise's Multiplication Appliquée a UN Classement) analysis has been conducted to illustrate the hierarchical relationships among the drivers and barriers associated with the implementation of GSCM in the chemical industry of Bangladesh.
- The structural frameworks were validated using an expert panel of supply chain analysts. After removing the insignificant links, the final framework for the drivers and the final framework for the barriers were constructed.

1.4 Organization of the Thesis

This thesis has been organized into seven chapters, along with a list of references and appendices. They are as follows:

Chapter 1 is entitled as “INTRODUCTION”, which describes the motivation and background of this research for implementing GSCM in the chemical industry of Bangladesh. The research objectives and the outline of the methodology followed in this thesis are also depicted there.

Theoretical background on GSCM has been discussed in Chapter 2 titled as "LITERATURE REVIEW". Previous studies focusing on identifying drivers and barriers to GSCM using ISM and TISM tool are also briefly discussed in this chapter. An overview of the chemical industry of Bangladesh is also presented in Chapter 2.

Chapter 3 includes the methodology followed for conducting the research. The procedure is summarized in a flowchart. The information gathering process using Delphi method has been discussed in details. Then, the TISM methodology used for developing the frameworks of drivers and barriers is also described in this chapter. At last, the MICMAC analysis is discussed. MICMAC analysis is used in this research to identify the driving power and the dependence of the drivers and the barriers. At last, the validation process of the TISM model is discussed.

The next portion of this thesis deals with developing a structural framework indicating the relationships among various drivers of GSCM, which is illustrated in Chapter 4, named as "FRAMEWORK OF DRIVERS OF GREEN SUPPLY CHAIN MANAGEMENT". MICMAC analysis is also conducted to illustrate the hierarchical relationships among the drivers. After validation of the initial structural framework, the final framework for the drivers of GSCM is constructed.

In Chapter 5, which is called "FRAMEWORK OF BARRIERS TO GREEN SUPPLY CHAIN MANAGEMENT", the selected barriers to implementing GSCM are defined. The relationships among the barriers are identified using a TISM model. Then, the structural framework is developed for the barriers to the GSCM. The MICMAC analysis is done later to identify the driving power and the dependence among the barriers. The validation process removes the insignificant links, and finally the final framework for the barriers is constructed.

Chapter 6, termed as "RESULT AND DISCUSSION", discusses the different results and findings from the formulated structural frameworks and the MICMAC analysis. The discussion and implications of the structural frameworks for both the drivers and the barriers are also presented in this chapter.

Chapter 7 titled as "CONCLUSION, MANAGERIAL IMPLICATIONS & RECOMMENDATION" briefly summarizes the research conducted in this thesis, the

findings and the managerial implications of this research. Recommendations for the future research are also presented.

The "References" enlist all the relevant references used in this research. The "Appendix" at the end of this thesis gives the survey questionnaires used to collect data through Delphi method and provides pairwise comparison database used to construct the reachability matrix in the TISM model development. The "Appendix" also includes the TISM model validation questionnaire set for both the drivers and the barriers.

CHAPTER 2
LITERATURE REVIEW

Over the years, a number of research have been reported in the literature on how to implement GSCM in several industries. The most crucial parts for implementing GSCM are identifying drivers and barriers. Descriptive research on GSCM help to find drivers and barriers to GSCM in an industrial context. This chapter gives the theoretical understanding of drivers, barriers, and other materials required to build structural frameworks of GSCM in the chemical industry of Bangladesh.

2.1 Introduction

Leading industries worldwide are trying to implement GSCM culture in every aspect of their day to day activities. The successful implementation of GSCM not only provides a leading place of their products in the minds of customers but also completes the organizations' social and ethical responsibility. In the literature, the research on GSCM is conducted using various tools. Interpretive structural modeling (ISM) and total interpretive structural modeling (TISM) are popular tools, among others; ISM and TISM can collaborate expert opinions and previous research at the same time. These tools also provide a great deal of information to top management with less complexity. Between ISM & TISM, TISM provides a unique advantage compared to the ISM tool. The Delphi method has been a dependable system to gather expert opinions by questionnaire set in the literature.

2.2 Green Supply Chain Management

Green supply chain aims at confining the wastes within the industrial system in order to conserve energy and prevent the dissipation of dangerous materials into the environment (Jayant & Azhar, 2014).

Balaji et al. (2014) has defined GSCM as creating a sustainable supply chain system where the input is converted into output, and the output can be reclaimed and reused and the whole process is environment friendly. According to Rao & Holt (2005), the greening of supply chains can make an impact in improving the competitive edge and in flourishing the economic development of industries.

Vachon & Klassen (2006) found out that manufacturing organizations engaged in green project partnership with their suppliers and customers can develop organizational capabilities that will be reflected not only in environmental performance but also in other performance dimensions such as cost and quality. Seman & Aslinda (2012) opined that it is very important to integrate the GSCM guidelines in the whole supply chain of the industry to achieve the maximum advantage from it. If implemented successfully, GSCM would result in more profit.

Jaggernath & Khan (2015) showed that many organizations still do not wish to implement GSCM culture in their industries, even though the implementation of the GSCM culture has been proven successful. It is important to identify drivers and barriers to GSCM implementation and motivate industries to implement GSCM culture (Niemann et al., 2016).

Zhu et al. (2005) investigated China's textile, automobile, power generating, chemical/petroleum, electrical and electronic industries. They have proposed some ways to implement GSCM. First, the managerial authorities should be willing to accept the guidelines to GSCM implementation. Second step is collaborating with the suppliers and the customers in the supply chain and introducing them with the GSCM guidelines. The third step is to design the product and production procedure eco-friendly which would be reusable and easy to recycle. The fourth step is to sell the extra or unused resources and the recycled products to gain profit from the GSCM implementation.

Zhu et al. (2008) divided the Chinese external supply chain system into two parts for indicating which business strategy should be adopted to collaborate with the suppliers and the customers. The business strategies they mentioned are green purchasing and cooperation with customers. Here the green purchasing means that the organization should require environmental certifications from the suppliers who deliver the raw materials. Cooperation with customers refers to communicating with customers with their environmental concern by conducting green production and packaging. The authors classified the internal environmental management system in two classes: organizational learning system and support from the management. Their studies showed that the organization's internal characteristics could improve the possibility of implementing GSCM. In another research, Zhu et al. (2007) found that the implementation of GSCM was relatively more successful in the electrical industry rather than any other industry.

Mathiyazhagan et al. (2014) tried to identify the important pressures, barriers and drivers for GSCM adoption in Indian automotive sector context from the available literature. Balon et al. (2016) also did similar research in the Indian automotive industry. Their study mainly focused on implementing the GSCM guidelines in the automotive sector, especially at the firm level for the manufacturing processes. They identified the barriers of GSCM in the automotive industry and concluded that the interrelation of the barriers could be used in favor of the industry for successful implementation of GSCM.

Holt & Ghobadian (2009) examined the amount and property of greening the supply chain (SC) in the manufacturing sector of United Kingdom. They discovered that the greatest pressure was coming from the legislation and internal drivers for improving environmental considerations. The least pressure was from the society and the customers.

Chin et al. (2015) reviewed the existing literature on the relationship between GSCM, environmental collaboration and sustainability performance, and then proposed a plausible theoretical model to show the relationship among these three. The research proved to be helpful to the manufacturing organizations in maintaining an environmentally sound relationship with their suppliers and helped both parties in achieving sustainability.

Sarkis et al. (2011) categorized and reviewed recent GSCM literature under nine broad organizational theories, with a special emphasis on investigation of adoption, diffusion and outcomes of GSCM practices.

Subrata (2014) reviewed the impact of GSCM on industry performances by taking a closer look at the most used processes and practices. The author linked the GSCM practices with firm's performances and provided guidelines for future research. Lee (2008) researched on drivers for the participation of small and medium-sized suppliers in green supply chain initiatives. The research showed that the customer requirements put pressure to the suppliers in maintaining the environmental standards. The author also discussed the government's important role in implementing the GSCM.

2.3 Research on Green Supply Chain Management Drivers and Barriers

The drivers of the GSCM indicates the factors that would speed up the GSCM implementation process. The barriers of the GSCM refers to the factors that would hinder the progress of GSCM implementation. Huang et al (2017) explored how the GSCM implementation is affected by the internal and external factors. The also noted that the environmental considerations should be integrated into the corporate culture as the need of GSCM is intensifying. Dhull & Narwal (2016) has reviewed the literature on drivers and barriers for the implementation of GSCM. The authors listed their findings which provided insights into the drivers and barriers to GSCM. They also classified the drivers and barriers of GSCM in six sub streams i.e. internal, external, customers, competition, market and suppliers.

Pascasarjana & Terbuka (2013) listed a total of 20 barriers and a total of 16 drivers which they identified through extensive literature review and expert opinions. Jayant & Azhar (2014) used the ISM tool to identify the most influential barriers from a list of barriers and conducted MICMAC analysis on the barriers. Parmar & Shah (2016) conducted research in the field of manufacturing organization. They classified the barriers into mainly five clusters namely strategic, organizational, cultural, individual and technological barriers.

Faisal (2015) analyzed barriers to GSCM in the pharmaceutical industry. The research focused on the evaluation of the barriers to implementing GSCM culture in the pharmaceutical companies of Karachi.

2.3.1 Drivers of Green Supply Chain Management

After reviewing the related literature, the following drivers are found to be potential drivers of GSCM in the chemical industry.

2.3.1.1 Employees Motivation, Health and Safety

The employee motivation plays an essential role in GSCM practices. Mutual understanding of the employees of great vision in different sections can lead to the easy implementation of the GSCM practices. Firm specific capabilities such as professional knowledge, cross-departmental communication and environmental management system enable companies to implement environmental management (Chen et al., 2012). For the employees to be motivated, the focus should be given to their health and safety related issues (Kuo Jui et al., 2011).

2.3.1.2 Customer Awareness, Pressure & Support

Customers are one of the most crucial drivers in GSCM. Knowledge of green initiatives can make the customers more concerned in choosing environment friendly products in their day to day needs. As a result, the industry would be forced to ensure GSCM practices in their industry to increase their brand value and be in the leading place of the market. Customer pressure enforces the top management to include the GSCM vision in their company profile (Balasubramanian, 2012).

2.3.1.3 Green Image, Global Marketing & Competitiveness

The recent trends in the global markets can always be a great driver which forces the companies to adapt the green initiatives and improving their green image in this competitive international market. Developed countries are already focusing on the requirement of several certification programs in chemical industries (Huang et al., 2017). Many

organizations involved in exports have started adopting green practices in their supply chain as part of the competition with foreign domestic players (Faisal, 2015).

2.3.1.4 Demand for Environment Friendly Products

Customers are becoming more educated and conscious about the environmental degradation and want the product they buy to be environment friendly (Faisal, 2015). Demand for environment friendly products is certainly a driver of GSCM (Dhull & Narwal, 2016; Niemann et al., 2016).

2.3.1.5 Social & Environmental Responsibility

By reducing the hazardous waste and appropriate disposal planning of the non-usable waste, the environmental responsibility can be completed. Not only accepting GSCM practices, but also advertising its philosophy to the sourcing organization, the retailers and the customers would be a start in fulfilling the social responsibility of any organization or industry (Dawei et al., 2015; Guo Ciang et al., 2012).

2.3.1.6 Organizational Support

Top management's support and vision are significant while implementing the GSCM in the industry (Zhu, Sarkis, & Lai, 2008). Adopting appropriate environmental management system mainly depend on the top level management (Ramus & Steger, 2000). The top managers of the organization must be aligned with the GCSM philosophy for the process to work. Even with social and environmental responsibility and personal motivation, green practice cannot be achieved without organizational support (Muduli et al., 2013; Niemann et al., 2016).

2.3.1.7 Competitors

As companies always try to be on the top of the market, this corporate competition flourishes the implementation of GSCM. If some of the companies begin the GSCM practices, other will follow them to keep up in the market. Christmann & Taylor (2001) found that the competitive pressure of the organization made them imitate another organization's

environmental management structure which faced less obstacle from the compliance. Under high competitive pressure, organizations were also forced to imitate the entire business model of other organization (Dhull & Narwal, 2016; G. C. Wu et al., 2012).

2.3.1.8 Suppliers Pressure & Willingness

The pressure from the suppliers can prove to be an important driver in GSCM practice. (Zhu et al., 2005) did an investigation in China's textile, automobile, power generating, chemical/petroleum, electrical and electronic industries. The authors suggested that supplier's pressure and willingness provide a significant push in the inplementation of GSCM.

2.3.1.9 Government Rules & Legislation

Shivani & Jain (2014) discussed in details about the importance of government's specific rules and guidelines in implementing GSCM. The government rules in the any sector can pressurize the top management to think in advance and take necessary steps for implementing GSCM culture (Rao & Holt, 2005).

2.3.1.10 Economic Benefits or Cost Reduction Benefits

The GSCM is given more attention recently due to its cost reduction and improved process quality characteristics (Mathiyazhagan et al., 2014). If the GSCM is successfully implemented in the industry, the economic benefit can be achieved as well as the satisfaction of the stakeholders (Zhu et al., 2005).

2.3.1.11 Society or Public Pressure

The public pressure or the society can be an influential driver in GSCM initiative (Huang et al., 2017). In many cases, organizations implement GSCM only when they are forced to comply with regulations or pressures from other social and political organizations (Subrata Mitra, 2014).

2.3.1.12 Environmental Concerns

Awareness of environmental and social concerns that drive businesses and supply chains toward improved sustainability has increased in the last few decades (Somsuk & Laosirihongthong, 2017). Jaegler & Burlat (2012) conducted research on the effectiveness of supply chain, and it was noted that the environmental concerns can work as a reactive strategy in implementing the environmental concern of the organization.

2.3.2 Barriers to Green Supply Chain Management

This section identifies barriers to GSCM from the extant literature. The literature reveals the following barriers to GSCM practices in the chemical industry.

2.3.2.1 Lack of Government Support

Providing strict guidelines to GSCM practices and providing rewards for the best GSCM guideline followers industry would motivate the top management of organizations to implement GSCM in every aspect of the industry (Walker et al., 2008). In developing countries, often lack of supportive laws and guidelines has been considered a major barrier to the implementation of GSCM (Muduli et al., 2013). As seen in India, the government authorities often change, and as a result of the guidelines also changed with them. Specific guidelines and regulations are essential for internal collaboration and maintaining a minimum safety standard in the organization (Chandramowli, Transue, & Felder, 2011).

2.3.2.2 High Cost

To successfully implement the GSCM in industries, several technological changes can be necessary which requires high investment (Lee, 2008). Investors also think about the rate of return and the financial recovery of the investment. Implementing advanced technology and saving the cost of the investment in a professional way have been a big challenge in the industries (Balon et al., 2016).

2.3.2.3 Lack of Adoption of Advancement in Technology

Holt & Ghobadian (2009) has emphasized the importance of implementing advanced technology for ensuring GSCM practices in the industry. Lack of adoption of advancement in technology is one of significant barriers to successful GSCM implementation. The integration of information technology in the industrial activities could also make the GSCM practices much easier (Pascasarjana & Terbuka, 2013).

2.3.2.4 Cost of Disposal of Hazardous Products

Often implementation of the reverse logistics procedure has faced challenges due to economic constraints (Mathiyazhagan et al., 2014). Hazardous products are one of main concerns of the chemical industry. Due to the addition of cost and lack of knowledge of reverse logistics, implementation of GSCM becomes problematic.

2.3.2.5 Lack of Top Management Support

Management should make necessary plans beforehand, to implement the use of greener resources. (Faisal, 2015). The top management must be on-board with the GSCM implementation (Balon et al., 2016). Lack of top management support is a critical barrier to the successful implementation of GSCM. Top management often prioritizes the investment in the activities which would bring visible short-term profit. Management should provide continuous visible support for the successful implementation of GSCM (Agarwal et al., 2007). Monczka et al. (2015) stated that top management is additionally dominant in firms that recognize guidelines as a major threat or whose consumers are already aware of the eco-friendly products.

2.3.2.6 Lack of Training

Training of the workforce is crucial before implementing GSCM or making any other large changes in the industry. Training the workforce is required to increase the performance level of the employees, which is very important for successful implementation of GSCM and making it profitable at the same time (Mudgal et al., 2010). Lack of training also results in resisting the enhancement of overall performance of GSCM Practices (Balasubramanian, 2012).

2.3.2.7 Lack of Ethical Standards and Corporate Social Responsibility

The organizations should have a vision of not only making profits but also serving the environment due to their ethical and social responsibility (Balon et al., 2016; Dhull & Narwal, 2016; Seuring & Müller, 2008). Corporate social responsibility (CSR) indicates that corporate organizations are willing to follow the guidelines of compliance and also willing to invest money for the social consequences that are the result of actions taken by management (Sanjay Sharma, 2000).

2.3.2.8 Lack of Recycling and Reuse Effort of Organization

Recycling and reuse efforts often are the main concern of reverse logistics. If the guidelines of reverse logistics are designed and maintained systematically, upholding the profitability and satisfaction is possible (Diabat & Govindan, 2011). Due to the lack of knowledge, the reverse logistics cannot be implemented properly in the industry (Balon et al., 2016). The basic barrier to the implementation of GSCM is the lack of willingness to change. Human nature avoids changes, and GSCM needs a change in the way of thinking practices (Mudgal et al., 2010).

2.3.2.9 Lack of Knowledge and Experience among Suppliers

Pascasarjana & Terbuka (2013) have listed the lack of knowledge and experience among the suppliers as a major barrier in the process of implementing GSCM. Suppliers always play crucial role in maintaining the sustainability in the organization (Zhu et al., 2005). If the suppliers are aware of the importance of GSCM, implementation of environment friendly procedure in the organization would be much reactive.

2.3.2.10 Lack of Technical Expertise

Perron (2014) has identified the lack of technical expertise as a major barrier to GSCM. The research is focused on improving the environmental performance in Canadian SMEs. Revell & Rutherfoord (2003) have also identified the lack of expertise a critical barrier in implementing environmental concerns in small firms.

2.3.2.11 Lack of Environmental Awareness to the Supplier

Jayant & Azhar (2014) have selected the lack of environmental awareness to the suppliers as a prime barrier to implanting the GSCM in an organization. If the suppliers are not economically aware, the resources of the organization may not be GSCM culture friendly (Gibbon, 1997).

2.3.2.12 Low Return from Investment

Almost no return or low return from the investment in GSCM implementation can be a significant barrier (Dhull & Narwal, 2016). When the customers prefer low cost product and GSCM adds additional cost to the existing product, the top management lose their interest (Walker et al., 2008).

2.4 Total Interpretive Structural Modeling

Total interpretive structural modeling (TISM) tool is an advanced qualitative tool that can transform theoretical and unclear models into well defined, visible models. It is a superior version of previously used interpretive structure modeling (ISM) tool. Sushil (2012) highlighted the use of the digraph as a result of the interpretive matrix and the interpretation of the links in the ISM model, which completes the TISM model formulation. Srivastava & Sushil (2013) employed the TISM tool to model strategic performance. Their research showed how the questions like how, why and what can be answered in a model easily.

Sandbhor & Botre (2014) identified 10 barriers to productivity and used TISM tool to analyze them. Yadav (2014) conducted research in the Indian telecom service providing industry

using the TISM tool. He also developed a robust performance management model with the assistance of TISM tool.

Agarwal et al. (2007) detected nine drivers of organizational excellence and their research was motivated by human body mechanism. The interdependence among the drivers was detected using the TISM tool. Jena et al. (2017) highlighted how the TISM model is better in terms of understanding compared to the conventional ISM tool. Rajesh (2017) identified some technical capabilities of a firm using the TISM model for enhancing supply chain resilience. The author used five supply chain analysts to validate his findings.

2.5 Green Supply Chain Management in the Chemical Industry

Foerstl et al. (2010) conducted research on sustainable supplier management in the chemical industry. They explored how purchasing and supply management (PSM) function identifies and assesses the supplier's sustainability risk.

Patil (2014) reviewed of green chemical technologies for sustainable developments in chemical process industry (CPI). They reviewed the trend towards sustainability and green technologies in the CPI. They concluded that CPI must encourage sustainable development by investing in green technologies and ensure increased adherence to safety, health and environmental standards (Patil, 2014).

Giraud et al. (2014) developed a survey report on implementing green chemistry in the chemical manufacturing industry. According to their research, the identification and development of process metrics and the collaborative effort of the organization's employees can result in green chemical production system a cost effective and risk free option.

Rola (2017) explored the barriers faced by the chemical industry in greening their supply chain. The study represented the opinions of the industry experts on whether GSCM implementation was an expensive non effective plan or a strategy for a long run.

Zhang (2017) investigated some basic problems occurred in the development process of green chemistry and chemical engineering. He concluded that focus on green manufacturing

methods, and paying attention to the training of talents in the field of expertise could be a solution to the basic problems in the field of chemical engineering.

Cardoso et al. (2018) identified sustainable practices used by chemical industries of the triple bottom line. The final report of the investigation showed that sustainability is present but not completely obeying the sustainability tripod concept.

Closs et al. (2005) measured the chemical industry performance through enhanced railcar utilization method. The findings included the importance of establishing and adhering to policies regarding supply chain practices.

Hong et al. (2008) identified the key characteristics of supply chains in the chemical industry, which warrant management approaches that differ from those of other industries. The research also provided a brief overview of research work that has been done to address supply chain operation problems.

Schwemmer & Kübler (2016) provided basic data and interpretations on the chemical logistics sector in Germany. The research also proposed the implementation of GSCM in the chemical industry of Germany.

2.6 Delphi Method

Delphi method can be defined as a communication tool which is normally used to collect valuable information from the experts in any sector. A predetermined set of questions are asked to the panel of experts for two or more rounds until the required result is achieved.

The Delphi method has been proven as a popular tool in information systems research for identifying and prioritizing issues for managerial decision-making. Okoli & Pawlowski (2004) conducted extensive research on Delphi method as a research tool. The research provided specific guidelines on how to select the appropriate experts from industry.

Erffmeyer et al. (1986) attempted to establish empirically the point of stability in a six-round Delphi. The research provided empirical support for the classical four round Delphi by showing that the most accurate results were gathered after the forth iteration.

Azevedo et al. (2012) proposed the use of Delphi technique for the assessment of supply chain resilience in the automotive industry. They also focused on the links between the supplier and the manufacturer. Markmann et al (2013) conducted a Delphi-based risk analysis for identifying and assessing future challenges for supply chain security.

Somsuk & Laosirihongthong (2017) proposed a framework on prioritization of applicable drivers for GSCM implementation toward sustainability in Thailand. The applicable drivers and their priorities were gathered by several techniques and fuzzy Delphi technique was one of them.

CHAPTER 3
RESEARCH METHODOLOGY

This chapter discusses the step by step procedure that was followed to conduct this research. To identify the drivers and the barriers associated with the implementation of GSCM in the chemical industry, industry experts were interviewed. After identifying the drivers and barriers with the help of expert opinions and literature reviews, TISM technique was used to develop the framework. The MICMAC analysis was also conducted to illustrate the hierarchical relationships among the drivers and the barriers associated with the implementation of GSCM.

3.1 Introduction

Identification of the drivers and barriers to GSCM implementation in the chemical industry has been the core objective of this research. Like any other qualitative research, the expert opinions were given significant attention during the data gathering process (Sheetal et al. 2018). The industry experts were contacted again to identify the contextual relationship among the elements in the TISM model later on. The research conducted in this thesis identifies the driving elements which are stable and drives other elements. After analyzing the structural framework developed here and focusing on the driving elements, successful implementation of GSCM may be possible.

The research methodology is outlined as follows:

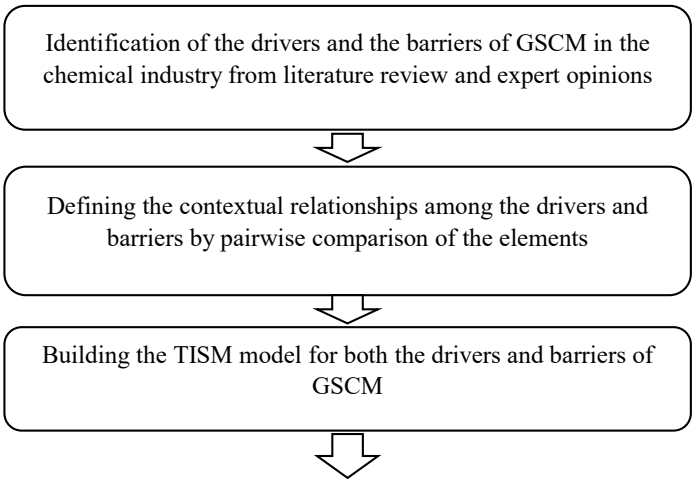
- Drivers and barriers associated with the implementation of GSCM in the chemical industry of Bangladesh were identified using literature reviews and interview with industry experts.
- The contextual relationships among green supply chain drivers and among green supply chain barriers were examined based on their driving and dependence power.
- The level of several drivers and barriers was determined by partitioning the reachability matrix.
- A directed graph (digraph) was developed for the drivers and barriers by arranging all the drivers and the barriers in their respected levels.
- Directed links were drawn as per the relation revealed in the reachability matrix. The final digraph was converted into a binary interaction matrix.
- Two structural frameworks, one for the drivers and the other for the barriers, were developed, using TISM.
- MICMAC ((Matriced' Impacts Croise's Multiplication Appliquée a UN Classement) analysis was conducted to illustrate the hierarchical relationships among the drivers and barriers associated with the implementation of GSCM in the chemical industry of Bangladesh.
- Both of the frameworks were validated using a panel of experts. Based on the rating of the experts, the weak interpretation links were removed from the initially developed frameworks.

The research is conducted using TISM approach rather than traditional Interpretive Structural Modeling (ISM) approach as the TISM approach provides several advantages over the ISM. The TISM approach is more interpretive in nature as it shows how the drivers or the barriers are interconnected and the reason behind their connection. Also, TISM approach shows the complicated systems in a simpler way compared to the ISM. The digraph obtained from TISM, is a unique characteristic of the TISM approach which will be discussed later in this chapter.

The structural framework was developed for both the drivers and the barriers using the TISM approach. Later, the MICMAC analysis was performed to identify the elements that are actually the accountable drivers and barriers and thus focusing on those, the other dependent drivers and barriers can be easily identified and necessary steps can be taken by the managerial level for implementing GSCM in the chemical industry. The research methodology adopted in this study is shown in Figure 3.1.

3.2 Identification of the Drivers and the Barriers of GSCM

To identify the drivers and barriers to GSCM in the chemical industry, a review of literature was conducted. At first, the potential drivers and the barriers were listed in a questionnaire survey form, which was sent to the industry experts upon their permission.



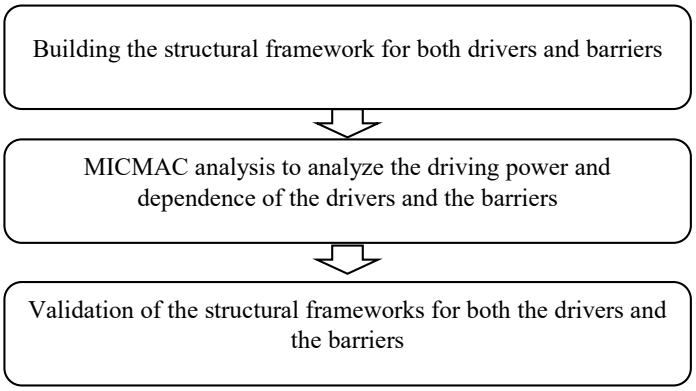


Figure 3.1: Overview of the research methodology

The experts were selected based on purposive sampling technique (Niemann et al., 2016). The requirements that were set for the expert selection process were having an extensive knowledge of what is GSCM, having at least seven years of experience in industry job and most important one as being involved with procurement, manufacturing, distribution and storage of the chemical components. A total of 9 companies were contacted in which the experts meet the pre-requirement of the purposive sampling technique. The purposive sampling is based on theory and assumes that cases are not chosen randomly (Ayodeji et al., 2015). Purposive sampling technique is commonly used in qualitative studies. It requires the researcher to select subjects based on study purpose with each participant providing unique and rich information of value for the study (Suen et al., 2014). In this thesis, the five companies were selected because they had experience with GSCM implementation and were known to the author for their experience in the chemical sector.

All of the experts were provided with the questionnaire as shown in Appendix 1, which includes all the drivers and barriers. All the listed drivers and barriers on the questionnaire were provided with a numbering option which has a range of 1 to 5, number 5 being the highest and number 1 being the lowest. This numbering system is also called Likert scale (Balon et al., 2016; Huang et al., 2017). Among the 9 companies, 14 experts from 5 companies agreed to participate in the Delphi process. Even though there is no strict rule on the number of expert required for Delphi method, 10-18 people are recommended (Okoli & Pawlowski, 2004; Somsuk & Laosirihongthong, 2017).

The data were gathered from the experts in over a two-month period. The experts were interviewed, contacted by phones and emails numerous time to gather the accurate data. In the Delphi method, after selecting the most crucial 8 drivers and 8 barriers from the ranking based on the first survey, the experts were again interviewed with the shorted list and their feedback was taken. They were contacted again for constructing the knowledge database for the pairwise comparison table and for their opinions on the interconnection of the drivers and barriers in the structural framework.

After interviewing the industry experts, 8 drivers and 8 barriers were selected which were more significant according to the experts scoring in the Delphi method. A total of 14 experts were interviewed in various companies. On the first round of the Delphi study, 4 drivers were selected by the experts for the chemical industry. After 2nd and 3rd round, the experts were unified about another 4 drivers. So, in total 8 drivers were selected. For the barriers, the first Delphi round provided 3 barriers. The 2nd round provided 5 barriers, upon which all the experts were unified. The drivers and the barriers with average score of 3.5 or above (75 percent) were selected for further research (Rajesh, 2017). Table 3.1 shows the selected drivers and Table 3.2 shows the selected barriers to the chemical industry. The affiliation of the experts are mentioned in Appendix 2. All of the experts expressed their opinions for both drivers and barriers.

Table 3.1: Selected drivers of GSCM in the chemical industry

Serial No.	Drivers
1.	Employees motivation, health and safety
2.	Customer awareness, pressure & support
3.	Green image, global marketing & competitiveness
4.	Demand for environment friendly products
5.	Social & environmental responsibility
6.	Organizational support
7.	Competitors

8	Supplier's pressure & willingness

Table 3.2: Selected barriers to GSCM in the chemical industry

Serial No.	Barriers
1.	Lack of government support
2.	High cost
3.	Lack of adoption of advancement in technology
4.	Cost of disposal of hazardous products
5.	Lack of top management support
6.	Lack of training
7.	Lack of ethical standards and corporate social responsibility
8	Lack of recycling and reuse effort of organization

The score and ranking of the drivers can be viewed in Table 3.3. The score and ranking of the barriers can be observed in Table 3.4.

Table 3.3: Ranking of the drivers

Experts / **Drivers**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	Ave--rage	Rank
Government rules & legislation	1	2	2	1	1	1	5	4	5	4	3	1	3	5	38	2.71	10
Economic benefits or cost	3	5	4	4	1	1	1	4	5	1	4	4	5	3	45	3.21	9

reduction benefits																	
Social & environmental responsibility	2	4	5	5	5	4	4	1	3	3	5	4	3	4	52	3.71	5
Society or public pressure	1	1	3	4	4	1	4	1	1	2	5	4	3	3	37	2.64	11
Green image, global marketing & competitiveness	1	4	4	5	5	5	5	1	5	4	3	4	4	3	53	3.78	3
Suppliers pressure & willingness	1	4	4	5	5	3	3	4	1	3	3	4	5	4	49	3.50	8
Employees motivation, health and safety	5	5	4	5	5	5	3	5	5	3	5	4	3	4	61	4.35	1
Customer awareness, pressure & support	3	4	5	4	4	4	5	4	5	4	5	4	2	5	58	4.14	2

Table 3.3: Ranking of the drivers (Continued)

Experts / **Drivers**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	Ave--rage	Rank
Competitors	2	3	3	4	5	5	5	4	1	3	4	3	4	3	49	3.50	7
Demand for environment friendly products	2	5	3	3	1	3	4	5	4	4	5	5	4	5	53	3.78	4

Organizational support	5	5	2	4	3	3	3	4	5	2	5	4	3	2	50	3.57	6
Environmental concerns & legislature	1	1	3	3	1	1	1	1	5	3	5	5	2	4	36	2.57	12

Table 3.4: Ranking of the barriers

Experts / **Barriers**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	Ave--rage	Rank
High cost	5	3	4	4	5	1	3	4	3	3	5	4	4	5	53	3.78	2
Lack of adoption of advancement in technology	1	4	4	5	5	4	3	3	3	4	5	4	4	4	53	3.78	3
Lack of training	1	4	2	3	4	4	4	5	4	3	5	5	2	4	50	3.57	6

Table 3.4: Ranking of the barriers (Continued)

Experts / **Barriers**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	Ave--rage	Rank
Lack of knowledge and experience among	3	2	4	1	1	3	4	2	5	3	5	5	2	4	44	3.14	11

suppliers																	
Lack of government support	5	4	1	5	4	5	5	5	4	3	5	4	3	5	58	4.14	1
Lack of ethical standards and corporate social responsibility	1	1	3	4	3	5	4	1	4	3	5	5	5	5	49	3.50	7
Lack of top management support	1	3	4	3	4	4	4	2	5	4	5	4	4	4	51	3.64	5
Lack of recycling and reuse effort of organization	3	2	5	5	1	4	4	3	4	1	5	5	3	4	49	3.50	8
Cost of disposal of hazardous products	3	2	5	4	4	4	4	5	4	1	4	4	4	4	52	3.71	4

Table 3.4: Ranking of the barriers (Continued)

Experts / **Barriers**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	Ave--rage	Rank
Lack of technical expertise	3	3	3	3	4	3	4	4	5	4	4	1	2	4	47	3.35	9
Lack of	1	4	4	1	3	1	3	3	3	4	5	4	5	5	46	3.28	10

environmental awareness to the supplier																	
Low return from investment	2	1	1	1	1	1	1	2	3	4	5	3	3	4	32	2.28	12

3.3 Developing the TISM model

The TISM model development included several steps. All the steps can be shown with a schematic diagram as shown in Figure 3.2.

Step 1: Identification and Definition of the Elements (the Drivers & the Barriers)

In the beginning, the drivers and the barriers were identified from the literature reviews of the previous studies. Taking expert's feedback was the second step in finalizing the element. From the literature review, both the drivers and barriers to GSCM applicable in the chemical industry of Bangladesh were identified. Then, the elements were verified by industry experts using Delphi method. The Delphi method questionnaire format can be found in Appendix 1.

Step 2: Determination of Contextual Relationship

The contextual relationships between different drivers and barriers were also identified. For each driver and barrier, how it would enhance or affect another driver or barrier respectively was determined.

Step 3: Define Interpretation for Contextual Relationship

Why any element would be connected to or be affected by another element is described in this step. Complex systems can be easily translated in TISM for this particular feature.

Step 4: Interpretive Logic of Pair-Wise Comparison

Each element is individually compared to all other elements for gathering an interpretive logic database which will later be converted into a reachability matrix. As there are two possible directional links i-j or j-i, a total number of pair-wise comparison for *n* identified elements would be $(n\times (n-1))$.

Eventually, there will be $(n\times (n-1))$ numbers of rows in the knowledge base for performing study (Sheetal et al., 2018). The eight drivers and the eight barriers produced 8×7 or 56 rows of knowledge base separately. The interpretive logic database is used to develop the structural framework for both the drivers and the barriers. The pairwise comparison questionnaire is available in Appendix 3 and Appendix 4.

Step 5: Development of Reachability Matrix

The data gathered in the pairwise comparison was transferred into reachability matrix by converting the "Yes" answer into 1 and the "No" answer into 0. The transivity rule was also checked for the reachability matrix. If an element "i" is directly linked to element "j", and the element "j" is directly connected to element "k", it can be said that the element "i" is transitively connected with element "k", when the element "i" is not directly connected to element "k". The transitive entry is mentioned in the matrix.

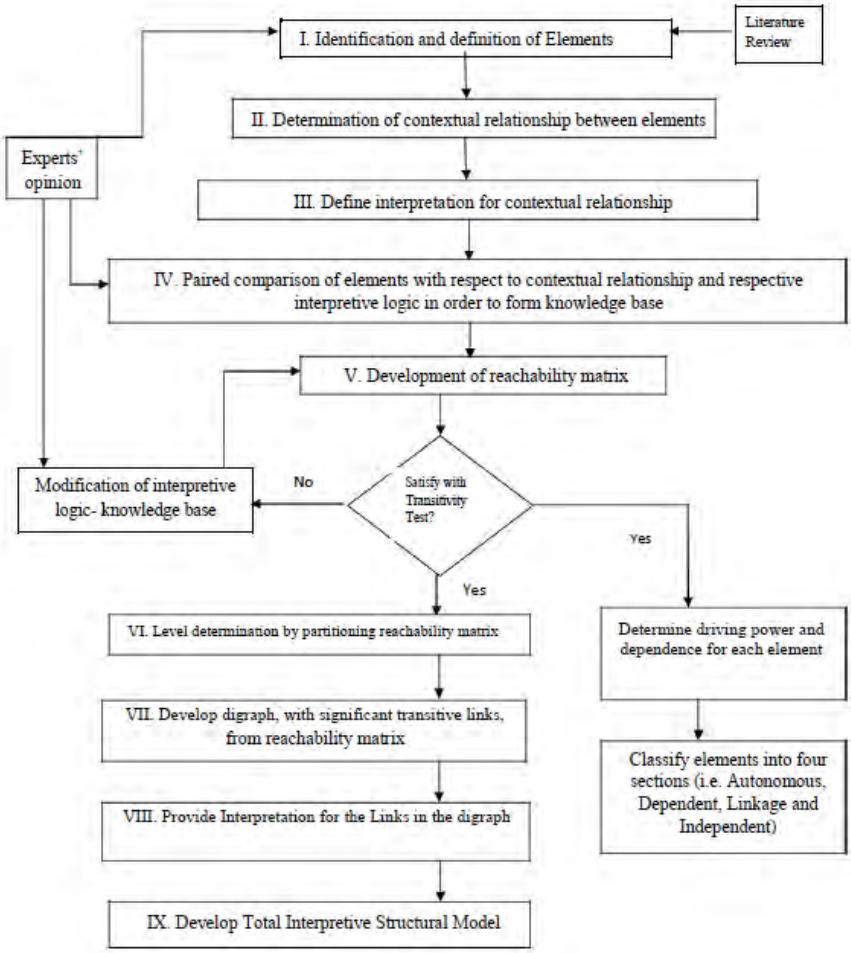


Figure 3.2: Steps of TISM model development (modified from Jena et al., 2017)

Step 6: Level Determination by Partitioning Reachability Matrix

In this step, the reachability set and the antecedent set of the drivers and the barriers were identified which will later be discussed in details in the following chapters. The reachability set includes the drivers and barriers, on those it has an influence on. Similarly, the antecedent set consists of drivers and barriers which have influence over this particular element. The

elements, for which the reachability set and intersection set are same, will hold the top level position in the TISM hierarchy.

Step 7: Develop Digraph with Transitive Link and Reachability Matrix

Digraph which is also called directed graph for drivers and barriers are constructed by identifying the levels of each driver and barrier after several iterations and by showing directed links between the drivers and the barriers. The direct links are shown using the solid line and the transitive links are shown using the dotted line. Only those transitive relationships are retained in the digraph whose interpretation is crucial. Their significance were measured by the expert opinions and if the collective significance of the transitivity link were more than 50%, they were collected.

Step 8: Provide Interpretation for the Links in Digraph

The final digraph is converted into an interpretation table where the interpretation for every link is provided. The interpretation table will describe how the elements are connected and how they will enhance or affect each other.

Step 9: Total Interpretive Structural Model (The Initial Framework)

TISM for the identified elements is developed with the help of digraph and interpretation table. The connections between the elements in the digraph are described in the interpretation table. Using both the digraph and the interpretation table, it is easy to identify the relationships between various drivers and barriers available and on which the managerial body should focus on. In this way, the proposed hierarchy-based model assists to comprehend the driving and dependent elements unambiguously (Sheetal et al., 2018).

3.4 MICMAC Analysis

MICMAC (Cross-impact Matrix Multiplication Applied to Classification) analysis was conducted to illustrate the hierarchical relationships among the drivers and barriers associated with the implementation of GSCM in the chemical industry. The main purpose of this analysis was to identify the elements which are responsible for enforcing GSCM in the

industry, or which are restricting the GSCM implementation. The driving power and the dependence powers of the elements are identified and the elements are classified into 4 clusters:

Cluster A: Autonomous Element
Cluster B: Dependent Element
Cluster C: Linkage Element
Cluster D: Independent Element

The detailed calculation of the MICMAC analysis of the drivers and the barriers will be conducted in Chapter 4 and Chapter 5 respectively.

3.5 Validation of the Frameworks for the Drivers and the Barriers

The initially constructed diagraphs are validated using an expert panel of ten academics who has extensive knowledge of supply chain. All the experts have concept of GSCM and all of them contributed in the validation process of both the drivers and the barriers. The prominent relations of the drivers' framework and the barriers' framework are rated on a scale of one to five signifying the importance of the relation. The value of "1" indicates a not so important influential relation and the value of "5" indicates most important relation exists. Average score for each relation was obtained and those relation satisfying average score of three (60 percent) or above were retained in the structural framework and the others were excluded from the final framework (Rajesh, 2017). The experts were selected on the criteria of having teaching experience in the supply chain for at least 3 years, taken supply chain courses at the undergraduate level and have a research interest in GSCM. The validation questionnaire presented to the academic experts are presented in Appendix 5 and Appendix 6. The name and affiliation of the academic experts are listed in Appendix 7. The feedback from the experts are summarized in Appendix 8 and Appendix 9. The final framework for the drivers is indicated in Chapter 4 and the final framework for the barriers is indicated in Chapter 5.

CHAPTER 4
FRAMEWORK OF DRIVERS OF GREEN SUPPLY CHAIN MANAGEMENT

The chapter focuses on describing the drivers of green supply chain management, and explains how they are used as the information source in TISM technique. After identifying the contextual relationships of the drivers, their associated values are entered in an initial reachability matrix. After completing the transitivity test, the final reachability matrix is created which ensures the partitioning of the drivers at different levels. After necessary iterations, five level of the drivers were developed which were used to complete the digraph, the most important feature of the TISM technique. At last, the MICMAC analysis is done to identify the driving power and the dependence of the drivers.

4.1 Introduction

Identification of the drivers of GSCM is the basic step of developing the structural framework. A number of papers were reviewed to gather information about the most relevant drivers of the GSCM implementation. After listing the probable drivers of GSCM, industry experts were consulted to identify the actual drivers which have an impact on the chemical industry of Bangladesh. Based on the expert opinions, eight drivers were selected which were later used to construct the framework.

The drivers are: employee's motivation, health and safety, customer awareness, pressure and support, green image, global marketing and competitiveness, demand for environmentally friendly products, social and environmental responsibility, organizational support, competitors and supplier's pressure and willingness. The later sections describe how these drivers enhance the possibility of GSCM implementation and how the expert opinions are used to construct the framework.

4.2 Drivers of Green Supply Chain Management in Chemical Industry

This section provides a short description of the selected drivers of GSCM in the chemical industry of Bangladesh.

4.2.1 Employees Motivation, Health and Safety

Lack of employees motivation towards implementing the GSCM, even though the top management is willing to take necessary steps, can lead to an unsuccessful attempt at GSCM implementation. As the chemical industry works with a lot of hazardous components and there is always safety related risks involved, knowledge regarding the GSCM practice and the advantage it contains will motivate them. If the employees realize that the GSCM practice also ensures their well-being and safety in work place, the motivation will be increased with time.

4.2.2 Customer Awareness, Pressure & Support

If customers support the industry for starting GSCM practices, the top management would be motivated to ensure GSCM in all aspects of their business.

4.2.3 Green Image, Global Marketing & Competitiveness

The green culture in global marketing is also affecting the chemical industry of Bangladesh. If the green image brings a more profitable change in the industry, companies will certainly try to embrace it by implementing GSCM practices.

4.2.4 Demand for Environment Friendly Products

Due to the social awareness in every stage of a supply chain, demand for environment products are working as a driver of implementing GSCM in the industry.

4.2.5 Social & Environmental Responsibility

Every organization has a social and environmental responsibility of accepting greener practice. Chemical companies produce extremely hazardous and dangerous components which are difficult to dispose and reuse. Therefore, accepting the social & environmental responsibility would be a significant driver towards implementing GSCM.

4.2.6 Organizational Support

The organizational restructuring for implementing new business strategies and manufacturing process is one of the main considerations during the GSCM implementation. There are some internal organizational resources which can help the organization in achieving the goal of GSCM implementation.

4.2.7 Competitors

Competitors are always an important driver in any industry. Corporate willingness to invest in implementation of GSCM could be increased by the competitor's greener activities.

4.2.8 Suppliers Pressure & Willingness

The pressure from suppliers can prove to be an important driver in GSCM practices. If the GSCM is to be applied successfully in industry, the suppliers' willingness is also essential. Similarly, pressures from the suppliers can also be fruitful in the implementation of GSCM.

4.3 Determining the Contextual Relationship

The industry experts were consulted for identifying the contextual relationship among the drivers. All the questions were basically yes or no type questions.

If the answer was yes, an explanation was provided by the expert on how a driver was affecting or enhancing the other one.

4.4 Interpretation of the Relationship and Pairwise Comparison

The interpretation among the drivers was used to construct the database of pairwise comparison. Each driver was compared with the other for checking how it would be enhanced, or it will enhance the other. There are 8 drivers in total and as a result there were 8*7 or 56 rows of pairwise comparison describing how each is being affected or enhanced. The result of the interpretation of the contextual relationship database is listed in Appendix 3.

4.5 Reachability Matrix and Transitivity Test

The pairwise comparison was developed into an initial reachability matrix and after transitivity test it was developed into a final reachability matrix. For the "Yes" or "No" answer, the value of 1 or 0 was taken, respectively. The transitivity test was also done to identify the indirect relationships between the drivers. After the transitivity test, the driver's which passed the test, their values were changed into 1 from 0 and was also given a (*) in the upper right side for easy identification. The initial reachability matrix is illustrated in Table 4.1. After the transitivity test, the final reachability matrix is determined and the final reachability matrix is shown in Table 4.2.

Table 4.1: Initial reachability matrix

	Driver 1	Driver 2	Driver 3	Driver 4	Driver 5	Driver 6	Driver 7	Driver 8
Driver 1	1	0	1	0	1	1	0	0
Driver 2	0	1	1	1	1	1	0	0
Driver 3	0	0	1	0	1	1	1	0
Driver 4	0	0	0	1	1	1	0	0
Driver 5	0	1	0	1	1	1	0	0
Driver 6	1	0	0	0	1	1	0	0
Driver 7	0	0	1	1	0	0	1	0
Driver 8	0	0	0	0	1	0	0	1

Table 4.2: Final reachability matrix

	Driver 1	Driver 2	Driver 3	Driver 4	Driver 5	Driver 6	Driver 7	Driver 8
Driver 1	1	1*	1	1*	1	1	1*	0
Driver 2	1*	1	1	1	1	1	1*	0
Driver 3	1*	0	1	1*	1	1	1	0
Driver 4	1*	1*	0	1	1	1	0	0
Driver 5	1*	1	1*	1	1	1	0	0
Driver 6	1	0	0	0	1	1	0	0
Driver 7	0	0	1	1	1*	1*	1	0

Driver 8	0	1*	0	1*	1	1*	0	1

4.6 Level Determination

The level of the final reachability matrix was determined after a total of 5 iterations. With each iteration, the least data holding interaction set was selected as the highest level and is placed on the top place of the digraph (Sheetal et al., 2018). The iteration is shown in Table 4.3.

Table 4.3: Level determination of the drivers

Iteration 1

Driver	Reachability Set	Antecedent Set	Intersection	Level
1	1,2,3,4,5,6,7	1,2,3,4,5,6	1,2,3,4,5,6	
2	1,2,3,4,5,6,7	1,2,4,5,8	1,2,4,5	
3	1,3,4,5,6,7	1,2,3,5,7	1,3,5,7	
4	1,2,4,5,6	1,2,3,4,5,7,8	1,2,3,4,5	
5	1,2,3,4,5,6	1,2,3,4,5,6,7,8	1,2,3,4,5,6	
6	1,5,6	1,2,3,4,5,6,7,8	1,5,6	
7	3,4,5,6,7	1,2,3,7	3,7	
8	2,4,5,6,8	8	8	I

Iteration 2

Driver	Reachability Set	Antecedent Set	Intersection	Level
1	1,2,3,4,5,6,7	1,2,3,4,5,6	1,2,3,4,5,6	
2	1,2,3,4,5,6,7	1,2,4,5	1,2,4,5	
3	1,3,4,5,6,7	1,2,3,5,7	1,3,5,7	
4	1,2,4,5,6	1,2,3,4,5,7	1,2,3,4,5	
5	1,2,3,4,5,6	1,2,3,4,5,6,7	1,2,3,4,5,6	
6	1,5,6	1,2,3,4,5,6,7	1,5,6	

7	3,4,5,6,7	1,2,3,7	3,7	II

Iteration 3

Driver	Reachability Set	Antecedent Set	Intersection	Level
1	1,2,4,5,6	1,2,4,5,6	1,2,4,5,6	
2	1,2,4,5,6	1,2,4,5	1,2,4,5	
3	1,4,5,6	1,2,5	1,5	III
4	1,2,4,5,6	1,2,4,5	1,2,4,5	
5	1,2,4,5,6	1,2,4,5,6	1,2,4,5,6	
6	1,5,6	1,2,4,5,6	1,5,6	

Iteration 4

Driver	Reachability Set	Antecedent Set	Intersection	Level
1	2,4,6	2,4,6	2,4,6	
2	2,4,6	2,4	2,4	
4	2,4,6	2,4	2,4	
5	2,4,6	2,4,6	2,4,6	
6	6	2,4,6	6	IV

Iteration 5

Driver	Reachability Set	Antecedent Set	Intersection	Level
1	2,4	2,4	2,4	V
2	2,4	2,4	2,4	
4	2,4	2,4	2,4	
5	2,4	2,4	2,4	

4.7 Framework Development

The initial framework is developed from the results of the TISM iteration which shows both of the direct and indirect links. The initial framework is represented in Figure 4.1.

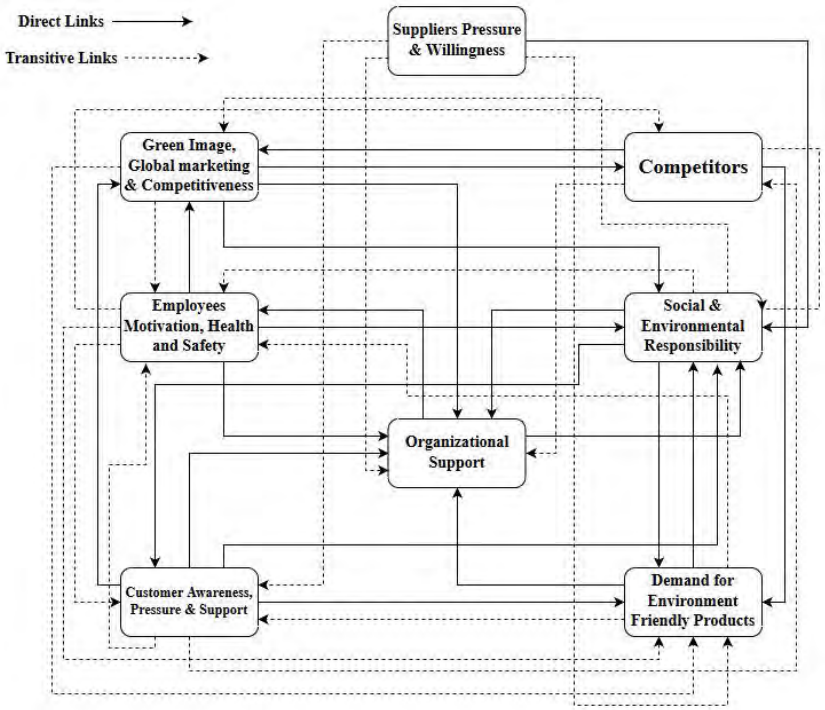


Figure 4.1: Initial structural framework for the drivers of GSCM

4.8 Interpretation of the Links in the Framework

After constructing the framework with digraph, the following interpretation table was developed which describes the links in the digraph and the interpretation of each link. The transitive links were ignored as their average percentage of captured responses are below 50%. As a result the were proved to be insignificant (Jena et al., 2017; Sheetal et al., 2018).

Table 4.4: Interpretation table constructed from the digraph

Driver Links in Digraph	Interpretation
D1-D3	Motivated employee's enhanced performance would result in the competitive position of the company in the local and global market.
D1-D5	Improved employee motivation and safety would result in increased social & environmental responsibility.
D1-D6	The organization as a whole would provide more support to GSCM if employees are motivated.
D2-D3	Customer pressure would make the industry more focuses on implementing GSCM.
D2-D4	Customer awareness would directly result in a demand for more environment friendly product.
D2-D5	If the customers are aware, organizations would be more motivated to show social and environmental responsibility for improving brand value.
D2-D6	When customers demand green product, top management and whole organization will be forced to implement GSCM.
D3-D5	When the competitors are accepting the GSCM culture, any organization would want to accept it to be in the competition.
D3-D6	The whole organization will support GSCM if global market and competitors accept it.
D3-D7	The competitors will also be encouraged to accept GSCM due to global competitiveness.
D4-D5	Organization's pressure improves employees social 7 environmental responsibility.

D4-D6	Customers demand for the greener product will influence organizational responsibility and force them to accept the GSCM practice.
D5-D2	Social & environmental responsibility will motivate the customer to demand greener product.

Table 4.4: Interpretation table constructed from the digraph (Continued)

Driver Links in Digraph	Interpretation
D5-D4	Social & environmental responsibility of person motivates demand for the environmentally friendly product.
D5-D6	Organization's social & environmental responsibility would motivate organizations top management to influence GSCM.
D6-D1	Organizations overall mission would increase employee motivation, health and safety.
D6-D5	Organization's pressure improves employee's social & environmental responsibility.
D7-D3	Implementing GSCM among competitors would increase the possibility of GSCM culture globally.
D7-D4	When Competitors produce a greener product, the industry is forced to accept the similar strategy.
D8-D5	Supplier pressure will motivate employees to improve social & environmental responsibility.

4.9 Developing the Structural Framework for the Drivers of GSCM

The structural framework for the drivers of GSCM is developed with the help of the digraph and the interpretation table. The framework can be easily realized at the managerial level and how the drivers can affect the whole GSCM implementation in chemical industry can also be understood. The MICMAC analysis is done in the following section to analyze the driving power and dependence of the drivers.

4.10 MICMAC Analysis

MICMAC analysis has been selected to identify the interdependence of the barriers in this research. The main purpose of this analysis is to identify the elements which are responsible for enforcing GSCM in the industry or restrict the GSCM implementation. The driving power and the dependence powers of the elements are identified and the elements are classified in 4 clusters: Cluster A (Autonomous Driver), Cluster B (Dependent Driver), Cluster C (Linkage Driver) and Cluster D (Independent Driver). The following table describes the total driving power and the dependence power of the drivers of GSCM in the chemical industry. The driving power is determined by summarizing the "1" in the row for a driver from the final reachability matrix. The dependence is determined by summarizing the "1" in the column for a driver from the final reachability matrix.

Table 4.5: Final reachability matrix with driving power and dependence

	Driver 1	**Driver 2**	**Driver 3**	**Driver 4**	**Driver 5**	**Driver 6**	**Driver 7**	**Driver 8**	**Driving Power**
Driver 1	1	1*	1	1*	1	1	1*	0	**7**
Driver 2	1*	1	1	1	1	1	1*	0	**7**
Driver 3	1*	0	1	1*	1	1	1	0	**6**
Driver 4	1*	1*	0	1	1	1	0	0	**5**
Driver 5	1*	1	1*	1	1	1	0	0	**6**
Driver 6	1	0	0	0	1	1	0	0	**3**
Driver 7	0	0	1	1	1*	1*	1	0	**5**
Driver 8	0	1*	0	1*	1	1*	0	1	**5**
Dependence	**6**	**5**	**5**	**7**	**8**	**8**	**4**	**1**	

4.10.1 Cluster A: Autonomous Driver

There drivers are comparatively very weak in driving power as well as dependence. The drivers in this cluster hardly influence other drivers. As shown in the table, there are no drivers who fall into this category.

4.10.2 Cluster B: Dependent Driver

These drivers have strong dependence over other drivers but the driving power of the elements in this cluster are not that strong. driver 6 (organizational support) is in this cluster.

Table 4.6: MICMAC Analysis of the drivers of GSCM

Driving Power									
	8								
	7					Driver 2	Driver 1		
	6			D		Driver 3		C	Driver 5
	5	Driver 8			Driver 7			Driver 4	
	4								
	3			A				B	Driver 6
	2								
	1								
		1	2	3	4	5	6	7	8
		Dependence							

4.10.3 Cluster C: Linkage Driver

The drivers in this section have strong driving power as well as strong dependence. The elements in this section have a tendency to be unstable and they have a significant impact on the other drivers too. Driver 1 (employees motivation, health and safety), driver 2 (customer awareness, pressure & support), driver 3 (green image, global marketing & competitiveness), driver 4 (demand for environmentally friendly products) & driver 5 (social & environmental responsibility) all are in this cluster.

4.10.4 Cluster D: Independent Driver

Strong driving power and low dependence are the main properties of this section. These are the key drivers who have a very strong driving power over others. There are two drivers: driver 7 (competitors) and driver 8 (supplier's pressure & willingness) are in this cluster.

4.11 Validation of the Structural Framework for Drivers of GSCM

Table 4.7 shows the validation of the interpreted links of the drivers. The average score from ten experts were calculated and the links satisfying an average score of three (60 percent) or above were retained in the final structural framework for the drivers of GSCM in the chemical industry of Bangladesh.

Table 4.7: Validation of the structural framework for drivers of GSCM

Driver Links in Digraph	Interpretation	Average Score from experts	Accept/ Reject
D1-D3	Motivated employee's enhanced performance would result in the competitive position of the company in the local and global market.	4.5	Accept
D1-D5	Improved employee motivation and safety would result in increased social & environmental responsibility.	4.2	Accept
D1-D6	The organization as a whole would provide more support to GSCM if employees are motivated.	4	Accept
D2-D3	Customer pressure would make the industry more focuses on implementing GSCM.	4.5	Accept
D2-D4	Customer awareness would directly result in a demand for more environment friendly product.	4.4	Accept
D2-D5	If the customers are aware, organizations would be more motivated to show social and environmental responsibility for improving brand value.	4.1	Accept
D2-D6	When customers demand green product, top management and whole organization will be forced to implement GSCM.	4.4	Accept
D3-D5	When the competitors are accepting the GSCM culture, any organization would want to accept it to be in the competition.	4.0	Accept

D3-D6	Whole organization will support GSCM if global market and competitors accept it.	4.0	Accept
D3-D7	The competitors will also be encouraged to accept GSCM due to global competitiveness.	4.2	Accept

Table 4.7: Validation of the structural framework for drivers of GSCM (Continued)

Driver Links in Digraph	**Interpretation**	**Average Score from experts**	**Accept/ Reject**
D4-D5	Organization's pressure improves employees social 7 environmental responsibility.	3.5	Accept
D4-D6	Customers demand for the greener product will influence organizational responsibility and force them to accept the GSCM practice.	4.2	Accept
D5-D2	Social & environmental responsibility will motivate the customer to demand greener product.	3.7	Accept
D5-D4	Social & environmental responsibility of person motivates demand for the environmentally friendly product.	3.9	Accept
D5-D6	Organization's social & environmental responsibility would motivate organizations top management to influence GSCM.	4.1	Accept
D6-D1	Organizations overall mission would increase employee motivation, health and safety.	4.1	Accept
D6-D5	Organization's pressure improves employee's social & environmental responsibility.	3.6	Accept
D7-D3	Implementing GSCM among competitors would increase the possibility of GSCM culture globally.	4.4	Accept
D7-D4	When Competitors produce a greener product, the industry is forced to accept the similar strategy.	3.8	Accept
D8-D5	Supplier pressure will motivate employees to improve social & environmental responsibility.	3.8	Accept

Figure 4.2 represents the final structural framework of the drivers of GSCM in the chemical industries of Bangladesh. According to the experts' opinion, there were no rejected relation. All the links from the initial framework is accepted in the final framework.

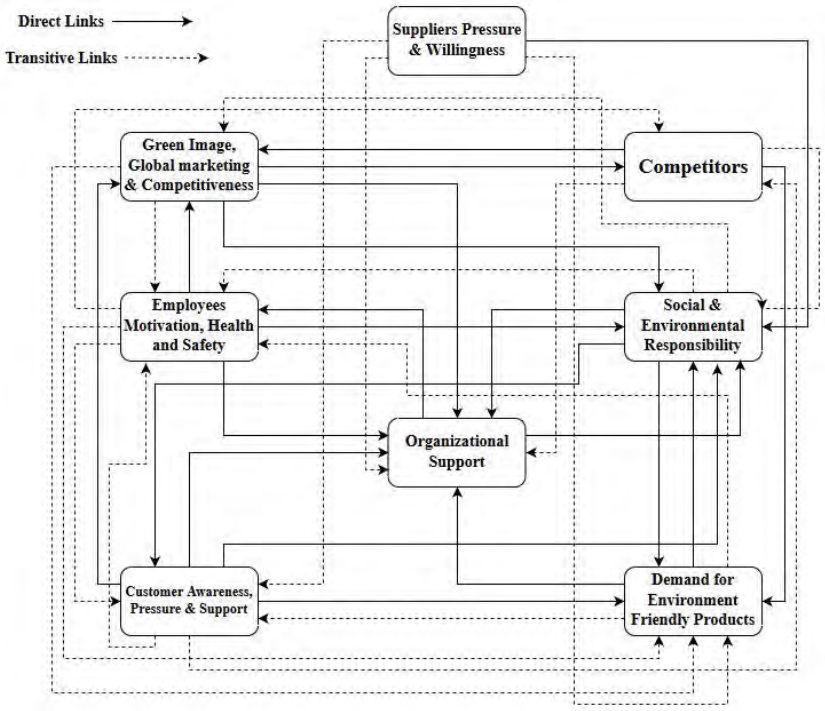


Figure 4.2: Final structural framework for the drivers of GSCM

4.12 Conclusion

As it can be observed from the constructed model and the MICMAC analysis, most of the drivers here are in Cluster C and it can be said that all of them are unpredictable in nature. Driver 1 (employees motivation, health and safety), driver 2 (customer awareness, pressure & support), driver 3 (green image, global marketing & competitiveness), driver 4 (demand for environmentally friendly products) & driver 5 (social & environmental responsibility) all have high dependence and driving power. But driver 7 (competitors) and driver 8 (suppliers pressure & willingness) shows real promise as GSCM driver as them do not depend on the others and focusing on them can prove to be beneficial in the long run. No values in the Cluster A also indicates that there is no driver which should be given less attention and all of the drivers are closely impacted by the other one.

CHAPTER 5
FRAMEWORK OF BARRIERS TO GREEN SUPPLY CHAIN MANAGEMENT

This chapter briefly discusses the selected barriers to GSCM and develops the framework of barriers to GSCM. The chapter also describes how the barriers can hamper the successful implementation of GSCM in the chemical industry. The identified and selected barriers are used as the information source in TISM technique. Then, the GSCM framework for the barriers is constructed, and MICMAC analysis is done. The significance of the output from this analysis is described in details in the following chapter.

5.1 Introduction

To develop the framework for barriers to GSCM, identification of the barriers is the first step. Previous researches were reviewed to gather information about the most relevant barriers to the GSCM implementation. After listing the significant barriers to GSCM in the chemical industry around the world, industry experts were consulted to identify the actual barriers which have impacts on the chemical industry of Bangladesh. Based on the expert opinions, eight barriers were selected which were later used to construct the framework. The selected barriers are lack of government support, high cost, lack of adoption of advancement in technology, cost of disposal of hazardous products, lack of top management support, lack of training, lack of ethical standards and corporate social responsibility and lack of recycling and reuse effort of the organization.

The latter sections describe how these barriers decrease the possibility of GSCM implementation and how the expert opinions are used to construct the framework. After identifying contextual relationships among the barriers, their associated values are entered in an initial reachability matrix. After completing the transitivity test, the final reachability matrix is created which ensures the partitioning of the barriers at different levels. After two iterations, two levels of the barriers were developed which was used to complete the digraph, the most important feature of the TISM technique.

At last, the MICMAC analysis was done at last to identify the driving power and the dependence of the barriers.

5.2 Barriers to GSCM in Chemical Industry

This section briefly describes the barrier used to develop the structural framework to GSCM.

5.2.1 Lack of Government Support

Lack of supporting laws and guidance from the government is one of the most crucial barriers to GSCM culture.

5.2.2 High Cost

Sometimes implementing GSCM requires a financial investment in the initial process. As investing financial resources in GSCM implementation may seem non-profitable investment in the short term, top management may not be willing to make the transaction.

5.2.3 Lack of Adoption of Advancement in Technology

Often, existing technology is not built with consideration of the environment. As a result, the existing technology does not comply with GSCM practice. To successfully integrate the GSCM culture in every aspect of the industry-wide activities, changing the older established activities are necessary.

5.2.4 Cost of Disposal of Hazardous Products

The costs associated with the disposal of hazardous by-products and waste sometimes demotivates the companies in the industry in disposition and adaptation of reverse logistics.

5.2.5 Lack of Top Management Support

If the top management does not authorize GSCM, use of greener resources for the activities in the chemical industry is impossible.

5.2.6 Lack of Training

Lack of appropriate knowledge in GSCM practice is a result of lack of training the employees about the importance and advantages of following the guidelines to GSCM practice. Training of the workforce is very crucial before implementing GSCM or making any other large changes in the industry.

5.2.7 Lack of Ethical Standards and Corporate Social Responsibility

The ethical standards of the organization sometimes become irrelevant compared to the associated cost and hassle of GSCM implementation. Thus, lack of strong ethical standards become one of the crucial barriers to GSCM practice in the chemical industry.

5.2.8 Lack of Recycling and Reuse Effort of Organization

The recycling and reuse efforts require certain changes in the industry-wide activities and not only the top management but also the employees are sometimes reluctant to change the way they are used to work.

5.3 Determining the Contextual Relationship

The contextual relationship among the barriers was determined using the Delphi session with the industry experts. The questions were Yes/No type questions where if the answer is yes, an explanation was given on how a barrier would influence or enhance another barrier.

5.4 Interpretation of the Relationship and Pairwise Comparison

This unique characteristics of the TISM method explain in expert opinions that how the barriers affect each other. There are a total of 56 rows of pairwise comparison describing how a barrier would affect the others. The interpretation of the contextual relationship database is given in Appendix 4.

5.5 Reachability Matrix and Transitivity Test

A reachability matrix was developed using the results gathered from the pairwise comparison, just as described in the methodology. For the "Yes" or "No" answer, the value of 1 or 0 was taken, respectively. The transitivity test was also done to identify the indirect relationships among the barriers. Table 5.1 shows the initial reachability matrix and Table 5.2 shows the final reachability matrix.

Table 5.1: Initial reachability matrix

	Barrier 1	**Barrier 2**	**Barrier 3**	**Barrier 4**	**Barrier 5**	**Barrier 6**	**Barrier 7**	**Barrier 8**
Barrier 1	1	0	0	1	0	0	0	1
Barrier 2	0	1	1	0	1	0	0	1
Barrier 3	0	0	1	0	0	0	0	1
Barrier 4	1	0	0	1	1	0	0	0
Barrier 5	0	0	1	0	1	1	0	1
Barrier 6	0	0	0	0	0	1	0	1
Barrier 7	1	0	0	0	1	0	1	1
Barrier 8	0	0	0	0	0	0	0	1

After the transitivity test, the final reachability matrix is determined. The transitivity values are marked with (*) beside them after changing the value from 0 to 1.

Table 5.2: Final reachability matrix

	Barrier 1	**Barrier 2**	**Barrier 3**	**Barrier 4**	**Barrier 5**	**Barrier 6**	**Barrier 7**	**Barrier 8**
Barrier 1	1	0	1*	1	1*	0	0	1
Barrier 2	0	1	1	0	1	0	0	1
Barrier 3	0	0	1	0	0	0	0	1
Barrier 4	1	0	1*	1	1	1*	0	1*
Barrier 5	0	0	1	0	1	1	0	1
Barrier 6	0	0	0	0	0	1	0	1
Barrier 7	1	0	1*	1*	1	1*	1	1
Barrier 8	0	0	0	0	0	0	0	1

5.6 Level Determination

The level of the final reachability matrix was determined after 2 iterations. The least number of values in the intersection set is selected as the highest level and the corresponding driver is placed at the top level in the digraph. The iteration is shown in Table 5.3.

Table 5.3: Level determination of the barriers

Iteration 1

Barrier	Reachability Set	Antecedent Set	Intersection	Level
1	1,4,8	1,4,7	1,4	
2	2,3,5,8	2	2	**I**
3	3,8	2,3,5	3	**I**
4	1,4,5	1,4	1,4	
5	3,5,6,8	2,4,5,7	5	**I**
6	6,8	5,6	6	**I**
7	1,5,7,8	7	7	**I**
8	8	1,2,3,5,6,7,8	8	**I**

Iteration 2

Barrier	Reachability Set	Antecedent Set	Intersection	Level
1	1,4	1,4	1,4	**II**
4	1,4	1,4	1,4	

5.7 Framework Development

The initial framework was developed from the results of the TISM iteration, which shows both of the direct and indirect links. The digraph is shown in Figure 5.1.

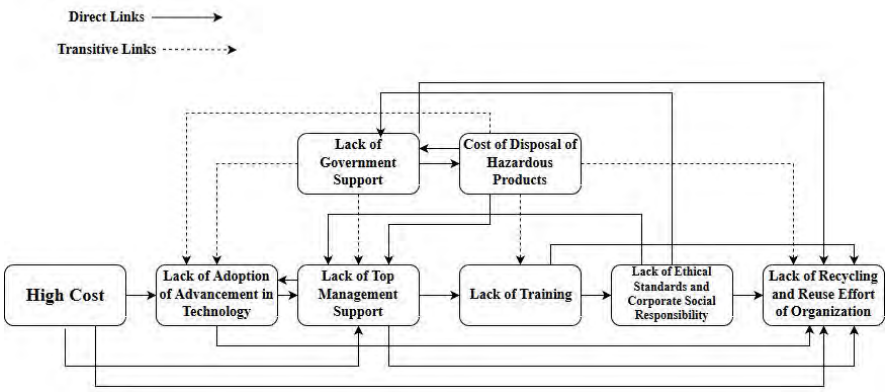


Figure 5.1: Initial structured framework for the barriers of GSCM

5.8 Interpretation of the Links in the Framework

After constructing the Framework using digraph, the interpretation Table 5.4 was developed which describes the links in the digraph and the interpretation of each link. The transitive links were ignored as their average percentage of captured responses were below 50%. As a result, they were proved to be insignificant (Jena et al., 2017; Sheetal et al., 2018).

Table 5.4: Interpretation table constructed from the digraph

Barrier Links in Digraph	Interpretation
B1-B4	Lack of government support for creating disposal place, cost of disposal will enhance.
B1-B8	Without government specific guidelines, the organizations will lack the willingness to implement recycling and reuse.
B2-B3	The high cost of implementation encourages organization not to buy new technology.
B2-B5	Top management would hesitate to invest high cost on GSCM implementation.

Table 5.4: Interpretation table constructed from the digraph (Continued)

Barrier Links in Digraph	Interpretation
B2-B8	The high cost will demotivate the recycle and reuse policy of the industry.
B3-B8	Sometimes advance technology increases the recycling and reuse effort.
B4-B5	If the disposal cost is high, the top management would be demotivated to do it.
B5-B6	Lack of top management support increases lack of training effort of the employees.
B5-B8	Lack of top management support will increase the Lack of recycling and reuse effort of the organization.
B6-B8	Lack of training will increase lack of recycling and reuse effort of the organization.
B7-B8	Lack of ethical standards and corporate social responsibility will increase lack of recycling and reuse effort of the organization.
B4-B1	Cost of disposal of hazardous products often increases lack of government support.
B7-B1	Lack of ethical standards and corporate social responsibility can enhance lack of government support.
B5-B3	Lack of top management support can increase lack of adoption of advance technology.
B7-B5	Lack of ethical standards and corporate social responsibility will decrease the support from top management.

5.9 Developing the Structural Framework for the Barriers to GSCM

After the construction of the digraph and the interpretation table, the structural framework for the barriers to the GSCM is complete. The digraph along with the interpretation table can easily interpret the relationship among different barriers and show how they can affect the whole GSCM implementation in the chemical industry. To illustrate the hierarchical

relationships among the barriers associated with the implementation of GSCM, MICMAC analysis was conducted latter in this chapter.

5.10 MICMAC Analysis

MICMAC analysis was conducted to illustrate the hierarchical relationships among the barriers and barriers associated with the implementation of GSCM in the chemical industry. The main purpose of this analysis is to identify the elements which are responsible for enforcing GSCM in the industry or restrict the GSCM implementation. The driving power and the dependence powers of the elements are identified and the elements are classified in 4 clusters: Cluster A (Autonomous Barrier), Cluster B (Dependent Barrier), Cluster C (Linkage Barrier) and Cluster D (Independent Barrier). Table 5.5 describes the total driving power and the dependence power of the barriers of GSCM in the chemical industry. The driving power is determined by summarizing the "1" in the row for a barrier from the final reachability matrix. The dependence is determined by summarizing the "1" in the column for a barrier from the final reachability matrix.

Table 5.5: Final reachability matrix with driving power and dependence

	Barrier 1	**Barrier 2**	**Barrier 3**	**Barrier 4**	**Barrier 5**	**Barrier 6**	**Barrier 7**	**Barrier 8**	**Driving Power**
Barrier 1	1	0	1*	1	1*	0	0	1	**6**
Barrier 2	0	1	1	0	1	0	0	1	**4**
Barrier 3	0	0	1	0	0	0	0	1	**2**
Barrier 4	1	0	1*	1	1	1*	0	1*	**6**
Barrier 5	0	0	1	0	1	1	0	1	**4**
Barrier 6	0	0	0	0	0	1	0	1	**2**
Barrier 7	1	0	1*	1*	1	1*	1	1	**7**
Barrier 8	0	0	0	0	0	0	0	1	**1**
Dependence	**3**	**1**	**6**	**3**	**5**	**4**	**1**	**8**	

5.10.1 Cluster A: Autonomous Barrier

These barriers are comparatively very weak in driving power as well as dependence. Normally, the barriers in cluster A are detached from the other barriers thus would hardly link

with other barriers which are strong. As shown in the table, barrier 2 (high cost) and barrier 6 (lack of training) are in this cluster.

5.10.2 Cluster B: Dependent Barrier

These barriers have a strong dependence on the other barriers but the driving power of the elements in this cluster are not that strong. Barrier 3 (lack of adoption of advancement in technology), barrier 5 (lack of top management support) and barrier 8 (lack of recycling and reuse effort of organization) are in this cluster.

5.10.3 Cluster C: Linkage Barrier

The barriers in this section have strong driving power as well as strong dependence power. The elements in this section tend to be unstable and they have a significant impact on the other barriers too. As seen in Table 5.6, there is no barrier in this cluster.

Table 5.6: MICMAC analysis of the barriers of GSCM

Driving Power									
	8								
	7	Barrier 7							
	6			D Barrier 1, Barrier 4			C		
	5								
	4	Barrier 2				Barrier 5			
	3			A			Barrier 3	B	
	2				Barrier 6				
	1								Barrier 8
		1	2	3	4	5	6	7	8
	Dependence								

5.10.4 Cluster D: Independent Barrier

Strong driving power and low dependence are the main properties of the barriers fall in this cluster. These are the key barriers which have a very strong driving power over others. There are three barriers: barrier 1 (lack of government support), barrier 4 (cost of disposal of hazardous products) and barrier 7 (lack of ethical standards and corporate social responsibility) are in this cluster.

5.11 Validation of the Structural Framework for Barriers of GSCM

Table 5.7 shows the validation of the interpreted links of the barriers. The average score from ten experts were calculated and the links satisfying an average score of three (60 percent) or above were included in the final structural framework for the barriers to GSCM in the chemical industry of Bangladesh.

Table 5.7: Validation of the structural framework of barriers to GSCM

Barrier Links in Digraph	Interpretation	Average Score from experts	Accept/ Reject
B1-B4	Lack of government support for creating disposal place, cost of disposal will enhance.	4.2	Accept
B1-B8	Without government specific guidelines, the organizations will lack the willingness to implement recycling and reuse.	4.3	Accept
B2-B3	The high cost of implementation encourages organization not to buy new technology.	4.3	Accept
B2-B5	Top management would hesitate to invest high cost on GSCM implementation.	4.2	Accept
B2-B8	The high cost will demotivate the recycle and reuse policy of the industry.	4.3	Accept
B3-B8	Sometimes advance technology increases the recycling and reuse effort.	4.2	Accept
B4-B5	If the disposal cost is high, the top management would be demotivated to do it.	4.3	Accept
B5-B6	Lack of top management support increases lack of training effort of the employees.	4.3	Accept

Table 5.7: Validation of the structural framework of barriers to GSCM (Continued)

Barrier Links in Digraph	Interpretation	Average Score from experts	Accept/ Reject
B5-B8	Lack of top management support will increase the Lack of recycling and reuse effort of the organization.	4.4	Accept
B6-B8	Lack of training will increase lack of recycling and reuse effort of the organization.	4.4	Accept
B7-B8	Lack of ethical standards and corporate social responsibility will increase lack of recycling and reuse effort of the organization.	4.4	Accept
B4-B1	Cost of disposal of hazardous products often increases lack of government support.	3.3	Accept
B7-B1	Lack of ethical standards and corporate social responsibility can enhance lack of government support.	3.8	Accept
B5-B3	Lack of top management support can increase lack of adoption of advance technology.	4.4	Accept
B7-B5	Lack of ethical standards and corporate social responsibility will decrease the support from top management.	4.0	Accept

Figure 5.2 represents the final structural framework of the barriers to GSCM in the chemical industries of Bangladesh. According to the experts' opinion, there were no rejected relation. All the links from the initial framework is accepted in the final framework.

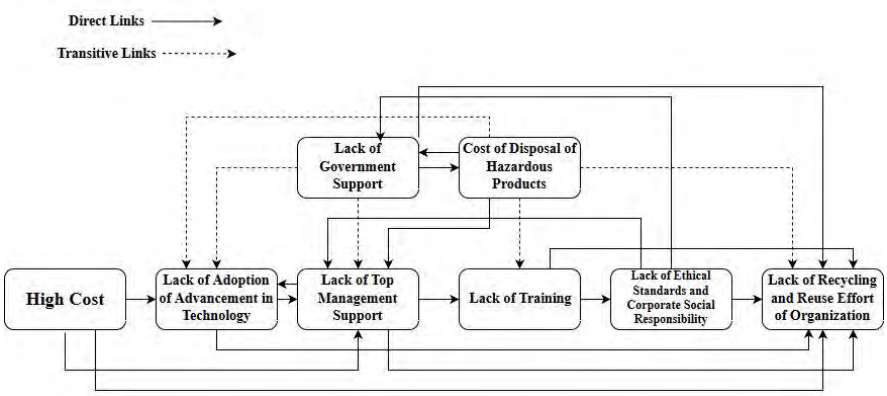


Figure 5.2: Final structural framework for the barriers to GSCM

5.12 Conclusion

The structural framework for the barriers and the MICMAC analysis makes the interpretation of the chapter easy for the managerial authorities. As seen from the first level of the digraph and the Cluster D, barrier 1 (lack of government support) and barrier 4 (cost of disposal of hazardous products) should be the focus of attention as both of them have high driving power and focusing on them could result in solving the other barriers as well.

CHAPTER 6
RESULT and DISCUSSION

This chapter discusses in details about the links among the drivers and the links among the barriers to implementing GSCM in the chemical industry and interprets the output of MICMAC analysis.

6.1 Discussion of the Framework for Drivers of GSCM

The main objective of the research was to develop structural frameworks for the drivers and the barriers to GSCM and provide meaningful information to the top management of any organization in the chemical industry so that successful implementation of the GSCM system is possible.

From the structural framework for the barriers, it can be observed that significant influential relationships exist among the drivers of GSCM. Driver 6 (organizational support) is being directly influenced by driver 1 (employees motivation, health and safety), driver 2 (customer awareness, pressure and support), driver 3 (green image, global marketing and competitiveness), driver 4 (demand for environment friendly products) and driver 5 (social and environmental responsibility). Driver 7 (competitors) and driver 8 (suppliers pressure and willingness) is also influencing driver 6 in a transitive relation. Hence, it can be easily interpreted that focus on any other driver would eventually influence driver 6 and no extra efforts need to be taken to improve driver 6 at the beginning. The result is comparable with the output in the MICMAC analysis, where the driver has a dependence of eight (8) and is placed in Cluster B.

The framework also reveals that driver 8 (supplier's pressure and willingness) bears a strong influence on driver 5 (social and environmental responsibility). Increasing the supplier pressure and willingness to implement GSCM in the organization would definitely increase the social and environmental responsibility of the management. Driver 8 also indirectly influences driver 2 (customer awareness, pressure and support), driver 4 (demand for environment friendly products) and driver 6 (organizational support) which indicates that there is a transitive link present between them. No other driver is influencing driver 8 which

indicates that suppliers' pressure and willingness is independent of the influence of other factors on the driver framework.

Another notable observation can be made from the framework is that driver 1 (employees motivation, health and safety), driver 2 (customer awareness, pressure and support), driver 3 (green image, global marketing and competitiveness), driver 4 (demand for environment friendly products) and driver 5 (social and environmental responsibility) all are directly and indirectly connected with each other, and as a result, the drivers show high dependence and driving power. The study reveals that the management should provide great concern on all these drivers. Neglecting any one of these drivers could result in a delay of successful GSCM implementation.

From the Cluster A of the MICMAC analysis for the drivers, it can be seen that there are no autonomous drivers of GSCM. As interpretation can be made from the table, the driving power and the dependence of the drivers in this section would be comparatively weak. Therefore, it is reasonable to assume that if there were drivers in this Cluster, they would not be significant as a driver of GSCM in comparison to others. From the Cluster B we can see that only driver 6 (organizational support) is available in this section. As the properties of this Cluster include low driving power and high dependence, it can be concluded that the organizational support driver is high in dependence with low driving power. The driver is also in the fourth level in the structural framework for drivers, and has seven direct links with other drivers where it is being affected by five drivers directly.

The properties of Cluster C indicates that all the drivers of this section have high driving power as well as high dependence power. Driver 1 (employees motivation, health and safety), driver 2 (customer awareness, pressure and support), driver 3 (green image, global marketing and competitiveness), driver 4 (demand for environment friendly products) and driver 5 (social and environmental responsibility) are in this Cluster. All of these drivers have high driving power and dependence. The independent element or Cluster D acts as the key driver among all the drivers as the elements in this section would have high driving power and low dependence. Driver 7 (competitors) and driver 8 (suppliers pressure and willingness) are the two drivers in this Cluster. The managerial level should take strategic action for improving the effects of the drivers which will ultimately make the GSCM implementation successful.

From Figure 4.1 of the initial structural framework, it is apparent that driver 2 (customer awareness, pressure and support) and driver 4 (demand for environment friendly products) form the lowest level of the TISM model. Both the drivers are in level 5 in the structural framework. They both are in Cluster C which indicates that both of the drivers have high driving power and dependence. Driver 8 (suppliers pressure and willingness) is at the highest level of the framework and it has a high driving power and very low dependence in the MICMAC analysis output.

It can be inferred from the framework that special consideration should be given to driver 7 (competitors), driver 8 (suppliers pressure and willingness), driver 2 (customer awareness, pressure and support) and driver 4 (demand for environment friendly products) as they all are in Cluster C and Cluster D. All of these drivers in Cluster C and Cluster D has high driving power. Therefore, activities to make these drivers effective will consequently result in the implementation of GSCM in the chemical industry.

The validation of the structural framework removed several links of the initial structural framework of Figure 4.1 and finalized the structural framework for drivers in Figure 4.2. According to the supply chain analysts, the relationship between 2 (customer awareness, pressure and support) and driver 5 (social and environmental responsibility) is strong. It can also be inferred that all the interpretation made by the industry experts are accepted by the academic experts in the validation process.

The validation process also reveals that the academic experts approves the impact of driver 6 (organizational support) on driver 5 (social and environmental responsibility). Table 4.7 reveals that supply chain academics accepts the idea of one company accepting greener production system just because it's competitors does so. As a result, the direct link between driver 7 (competitors) and driver 4 (demand for environment friendly products) was included in the final structural framework for barriers in Figure 4.2.

The direct link between driver 8 (suppliers pressure and willingness) and driver 5 (social and environmental responsibility) was also approved by supply chain analysts. According to them, supplier pressure would motivate employees to improve social and environmental responsibility.

6.2 Discussion of the Framework for Barriers to GSCM

After constructing the framework for the drivers, another objective of this research was to develop a structural framework for the barriers to GSCM in the chemical industry. Following similar methods of constructing the framework for the drivers, the framework for the barriers was also developed. The barriers were identified at first and then the TISM tool was used to achieve the digraph and ultimately the framework was constructed. Similar to the case of the drivers, MICMAC analysis was also conducted to identify the driving power and the dependence of the barriers. Both the framework and the result of the MICMAC analysis would be fruitful for the managers to execute necessary steps in order to implement GSCM.

The initial structural framework for barriers to GSCM reveals that barrier 1 (lack of government support) and barrier 4 (cost of disposal of hazardous products) are on the top level in the barriers hierarchy and they directly influence each other. They should be given special attention while implementing GSCM. The MICMAC analysis also provides similar output comparable to the structural framework for barriers, which reveals that both of them has high driving power but lower dependence. Lack of government support is only being influenced by barrier 7 (lack of ethical standards and corporate social responsibility) which is a major concern for the GSCM implementation.

The lack of ethical standards and social responsibility makes the government unconcerned about the environmental factors and the adverse effect of not implementing GSCM. Barrier 4 (cost of disposal of hazardous products) is only being influenced by barrier 1 (lack of government support) which is understandable because the disposal cost can increase significantly if the government is unwilling to support GSCM strategy and does not provide with the necessary guidelines and equipment.

The framework also reveals that except barrier 1 (lack of government support) and barrier 4 (cost of disposal of hazardous products), all the other barriers are in the lower level (level 2). Barrier 8 (lack of recycling and reuse effort of organization) does not influence any other barrier which means the organization can deal with them later, after they have dealt with barrier 1, barrier 4 and barrier 7 (lack of ethical standards and corporate social responsibility).

From the MICMAC analysis, it can be observed that there are two barriers in Cluster A: barrier 2 (high cost) and barrier 6 (lack of training). As they are in Cluster A, both of their driving power and dependence are weak. They will not have any significant impact on the other barriers. Managerial bodies can focus on these barriers after working on the barriers with high driving power and high dependence.

There are three barriers in Cluster B: barrier 3 (lack of adoption of advancement in technology), barrier 5 (lack of top management support) and barrier 8 (lack of recycling and reuse effort of organization). All of these barriers have high dependence but their driving power is far lower compared to the barriers in Cluster D. There are three barriers in Cluster D: barrier 1 (lack of government support), barrier 4 (cost of disposal of hazardous products) and barrier 7 (lack of ethical standards and corporate social responsibility). All of them have high driving power which means the top managers should focus on taking necessary steps for mitigating the barriers in this Cluster. There are no barriers enlisted in Cluster C which indicates that there is no unstable barrier in the framework with unstable properties.

The initial structural framework shows six drivers in level two and two drivers in level one. Barrier 1 (lack of government support) and barrier 4 (cost of disposal of hazardous products) hold the same level in Cluster D as well as in the framework (level 1). Special attention must be given to them for mitigating these drivers and as a result the dependent drivers will also be mitigated. The managerial level should also give critical attention to barrier 7 (lack of ethical standards and corporate social responsibility) as it is in Cluster D and has the highest driving power among all the barriers.

The final framework for the barriers of GSCM in the chemical industry of Bangladesh in Figure 5.2 reveals that, according to supply chain analysts, barrier 4 (cost of disposal of hazardous products) influences barrier 1 (lack of government support). The Table 5.7 indicates that cost of disposal of hazardous products is a reason of lack of government support. Most often, lack of government support is a result of lack of information among administrative bodies, political instability of the country and frequent change in the governing power which results in frequent change in guideline providing authorities.

CHAPTER 7
CONCLUSION, MANAGERIAL IMPLICATIONS and RECOMMENDATION

This chapter briefly summarizes the research conducted, the findings and the managerial implications of this research. Recommendations for the future research are also presented.

7.1 Conclusion

This thesis aimed to develop structural frameworks of the drivers and the barriers to GSCM in the chemical industry of Bangladesh. The chemical industry of Bangladesh is expanding rapidly and implementation of GSCM is essential in this sector. The contribution of this research lies in identifying the drivers and the barriers to GSCM, and constructs the structural frameworks of drivers and barriers to GSCM in the chemical industry. The identification of drivers and barriers was done from a review of relevant literature and consultation with the industry experts using Delphi method.

Employee motivation, health and safety, customer awareness, pressure and support, green image, global marketing and competitiveness, demand for environmentally friendly products, social and environmental responsibility, organizational support, competitors and supplier's pressure and willingness were found to be the significant drivers of GSCM in the chemical industry. Lack of government support, high cost, lack of adoption of advancement in technology, cost of disposal of hazardous products, lack of top management support, lack of training, lack of ethical standards and corporate social responsibility, lack of recycling and reuse effort of organizations were found to be signifiant barriers of GSCM in the chemical industry.

The structural frameworks for both the drivers and the barriers were developed using the TISM qualitative tool. Both the frameworks reveals that the drivers and the barriers both have influential elements that influence each other. The driving power and the dependence of all the drivers and the barriers were determined and subsequently categorized into four clusters with the help of MICMAC analysis.

After analyzing the structural framework for drivers and conducting the MICMAC analysis, competitors, suppliers pressure and willingness, customer awareness, pressure and support and demand for environmentally friendly products were found to be the crucial drivers which top management of any organization in the chemical industry should focus on. Similarly, the framework for the barriers and the MICMAC analysis revealed that lack of government support, cost of disposal of hazardous products and lack of ethical standards and corporate social responsibility were the critical barriers which should be mitigated with a high priority.

7.2 Managerial Implications

The outcomes of this research can help the top management of any organization in the chemical industry to understand the critical areas where they should focus on to implement GSCM. Focusing on the crucial drivers and barriers to GSCM would increase the probability of successful implementation of GSCM in the chemical industry. By mitigating the barriers and taking necessary steps to extend the effects of the drivers, a paradigm shift is possible in the chemical industry.

The direct links and the transitive links between the drivers and the barriers will provide more information to the top management about how the drivers and the barriers interconnect among themselves as well as how their dependence can be used in management's advantage. There are numerous complex tools available which can provide similar data but may seem very tough to extract the necessary information to the managerial authorities. With the help of the TISM tool, the constructed framework and the interpretation of the links provide very complex information in a very simple manner which can be anticipated by anyone with minimum experience. The methodology described here can be used for any new driver or barrier as well to identify the driving power and dependence of the driver or the barrier in the updated framework.

7.3 Recommendations

The represented framework for the drivers and the barriers were constructed using the total interpretive structural modeling (TISM) technique. There are other tools which can be used to conduct the same research such as fuzzy TISM to check the validity of the TISM model. Structural Equation Modeling (SEM) technique can be used to validate the theoretical model

proposed here. In this research eight drivers and eight barriers were taken according to the expert opinions. Future research can include more drivers and barriers for conducting the experiment. MICMAC analysis tool was used in this research to identify the driving power and the dependence of the drivers and the barriers. Another analysis tool such as fuzzy MICMAC analysis tool can be employed in the future for conducting similar research. The research has been conducted focusing on the chemical industry of Bangladesh. The research methodologies can also be applied to any industry to identify the drivers and the barriers to implementing GSCM in that sector.

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APPENDIX

Appendix 1: Delphi Method Questionnaire

Designation:
Company:
Years of Experience:

We are trying to identify the barriers (factors which will oppose) and drivers (factors which will accelerate) of Green Supply Chain Management (GSCM) in Bangladeshi Industries, especially those that deal with chemical components in several activities (procurement, transportation, storage, usage & disposal)

[This is an editable PDF, just click on the scores and save is. Then please send it back]

Drivers of Green Supply Chain Management (GSCM)

01. Do you think government rules & legislation is a driver for implementing GSCM?

☐ Yes ☐ No

How much would you score government rules & legislation as a driver of GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

02. Do you think economic benefits or cost reduction benefits is a driver for implementing GSCM?

☐ Yes ☐ No

How much would you score economic benefits or cost reduction benefits as a driver of GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

03. Do you think social & environmental responsibility is a driver for implementing GSCM?

☐ Yes ☐ No

How much would you score social & environmental responsibility as a driver of GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

04. Do you think society or public pressure is a driver for implementing GSCM?

☐ Yes ☐ No

How much would you score society or public pressure as a driver of GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

05. Do you think green image, global marketing & competitiveness is a driver for implementing GSCM?

☐ Yes ☐ No

How much would you score green image, global marketing & competitiveness as a driver of GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

06. Do you think suppliers pressure & willingness is a driver for implementing GSCM?

☐ Yes ☐ No

How much would you score suppliers pressure & willingness as a driver of GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

07. Do you think employees motivation, health and safety is a driver for implementing GSCM?

☐ Yes ☐ No

How much would you score employees motivation, health and safety as a driver of GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

08. Do you think customer awareness, pressure & support is a driver for implementing GSCM?

☐ Yes ☐ No

How much would you score customer awareness, pressure & support as a driver of GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

09. Do you think competitors is a driver for implementing GSCM?

☐ Yes ☐ No

How much would you score competitors as a driver of GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

10. Do you think demand for environment friendly products is a driver for implementing GSCM?

☐ Yes ☐ No

How much would you score demand for environment friendly products as a driver of GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Do you think organizational support is a driver for implementing GSCM?

☐ Yes ☐ No

How much would you score organizational support as a driver of GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

12. Do you think environmental concerns & legislature is a driver for implementing GSCM?

☐ Yes ☐ No

How much would you score environmental concerns & legislature as a driver of GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Barriers to Green Supply Chain Management (GSCM)

01. Do you think high cost is a barrier to implementing GSCM?

☐ Yes ☐ No

How much would you score high cost as a barrier to GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

02. Do you think lack of adoption of advancement in technology is a barrier to implementing GSCM?

☐ Yes ☐ No

How much would you score lack of adoption of advancement in technology as a barrier to GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

03. Do you think lack of training is a barrier to implementing GSCM?

☐ Yes ☐ No

How much would you score lack of training as a barrier to GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

04. Do you think lack of knowledge and experience among suppliers is a barrier to implementing GSCM?

☐ Yes ☐ No

How much would you score lack of knowledge and experience among suppliers as a barrier to GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

05. Do you think lack of government support is a barrier to implementing GSCM?

☐ Yes ☐ No

How much would you score lack of government support as a barrier to GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

06. Do you think lack of ethical standards and corporate social responsibility is a barrier to implementing GSCM?

☐ Yes ☐ No

How much would you score lack of ethical standards and corporate social responsibility as a barrier to GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

07. Do you think lack of top management support is a barrier to implementing GSCM?

☐ Yes ☐ No

How much would you score lack of top management support as a barrier to GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

08. Do you think lack of recycling and reuse effort of organization is a barrier to implementing GSCM?

☐ Yes ☐ No

How much would you score lack of recycling and reuse effort of organization as a barrier to GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

09. Do you think cost of disposal of hazardous products is a barrier to implementing

GSCM?

☐ Yes ☐ No

How much would you score cost of disposal of hazardous products as a barrier to GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

10. Do you think lack of technical expertise is a barrier to implementing Green Supply Chain Management?

☐ Yes ☐ No

How much would you score lack of technical expertise as a barrier to Green Supply Chain Management?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Do you think lack of environmental awareness to the supplier is a barrier to implementing GSCM?

☐ Yes ☐ No

How much would you score lack of environmental awareness to the supplier as a barrier to GSCM?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

12. Do you think low return from investment is a barrier to implementing GSCM?

☐ Yes ☐ No

How much would you score low return from investment as a barrier to Green Supply Chain Management?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Appendix 2: Industry Experts

Companies	Experts	Affiliation
Kohinoor Chemicals	Expert 1	Vice President
	Expert 2	Manager, Procurement
	Expert 3	Deputy Manager, Procurement
RAK Paints	Expert 4	Supply Chain Manager
	Expert 5	Assistant Manager, Supply Chain
	Expert 6	Deputy Manager, Supply Chain
	Expert 7	Deputy Manager, Supply Chain
Walton R & D (Chemical Division)	Expert 8	Additional Director, SCM
	Expert 9	Additional Director, SCM
	Expert 10	Senior Assistant Manager, SCM
Reedisha Knitex Ltd.	Expert 11	Senior Vice President
Rahimafroz Battery	Expert 12	Senior Executive, Supply Chain
	Expert 13	Executive, Chemical Maintenance
	Expert 14	Executive, Supply Chain

Appendix 3: Pairwise comparison database for drivers

In implementing green supply chain in management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Do you think employees motivation, health and safety	would influence/ enhance	customer awareness, pressure & support	as a driver of GSCM?	No	
Do you think employees motivation, health and safety	would influence/ enhance	green image, global marketing & competitiveness	as a driver of GSCM?	Yes	Motivated employee's enhanced performance would result in the competitive position of the company in the local & global market
Do you think employees motivation, health and safety	would influence/ enhance	demand for environment friendly products	as a driver of GSCM?	No	
Do you think employees motivation, health and safety	would influence/ enhance	social & environmental responsibility	as a driver of GSCM?	Yes	Improved employee motivation and safety would result in increased social & environmental

					responsibility
Appendix 3 (Continued)					
In implementing green supply chain in management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Do you think employees motivation, health and safety	would influence/ enhance	organizational support	as a driver of GSCM?	Yes	The organization as a whole would provide more support to GSCM is employees are motivated
Do you think employees motivation, health and safety	would influence/ enhance	competitors	as a driver of GSCM?	No	
Do you think employees motivation, health and safety	would influence/ enhance	suppliers pressure& willingness	as a driver of GSCM?	No	
Do you think customer awareness, pressure & support	would influence/ enhance	green image, global marketing & competitiveness	as a driver of GSCM?	Yes	Customer pressure would make the industry more focuses on implementing GSCM
Do you think customer awareness, pressure & support	would influence/ enhance	demand for environment friendly products	as a driver of GSCM?	Yes	Customer awareness would directly result in a demand for more environment friendly product.

Appendix 3 (Continued)					
In implementing green supply chain in management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Do you think customer awareness, pressure & support	would influence/ enhance	social & environmental responsibility	as a driver of GSCM?	Yes	If the customers are aware, organizations would be more motivated to show social and environmental responsibility for improving brand value
Do you think customer awareness, pressure & support	would influence/ enhance	organizational support	as a driver of GSCM?	Yes	When customers demand green product, top management and whole organization will be forced to implement GSCM
Do you think customer awareness, pressure & support	would influence/ enhance	competitors	as a driver of GSCM?	No	
Do you think customer	would influence/	suppliers pressure & willingness	as a driver of	No	

awareness, pressure & support	enhance		GSCM?		
Appendix 3 (Continued)					
In implementing green supply chain in management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Do you think green image, global marketing & competitiveness	would influence/ enhance	demand for environment friendly products	as a driver of GSCM?	No	
Do you think green image, global marketing & competitiveness	would influence/ enhance	social & environmental responsibility	as a driver of GSCM?	Yes	When the competitors are accepting GSCM culture, any organization would want to accept it, to be in the competition
Do you think green image, global marketing & competitiveness	would influence/ enhance	organizational support	as a driver of GSCM?	Yes	Whole organization will support GSCM if global market and competitors accept it
Do you think green image, global marketing & competitiveness	would influence/ enhance	competitors	as a driver of GSCM?	Yes	The competitors will also be encouraged to accept GSCM due to global

					competitiveness
Appendix 3 (Continued)					
In implementing green supply chain in management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Do you think green image, global marketing & competitiveness	would influence/ enhance	suppliers pressure& willingness	as a driver of GSCM?	No	
Do you think demand for environment friendly products	would influence/ enhance	social & environmental responsibility	as a driver of GSCM?	Yes	Social responsibility of organization will be motivated by aware customers demand
Do you think demand for environment friendly products	would influence/ enhance	organizational support	as a driver of GSCM?	Yes	Customers demand for greener product will influence organizational responsibility and force them to accept GSCM practice
Do you think demand for environment friendly products	would influence/ enhance	competitors	as a driver of GSCM?	No	
Do you think demand for environment friendly products	would influence/ enhance	suppliers pressure & willingness	as a driver of GSCM?	No	

Appendix 3 (Continued)					
In implementing green supply chain in management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Do you think demand for environment friendly products	would influence/ enhance	organizational support	as a driver of GSCM?	Yes	Organization's social & environmental responsibility would motivate organizations' top management to influence GSCM
Do you think social & environmental responsibility	would influence/ enhance	competitors	as a driver of GSCM?	No	
Do you think social & environmental responsibility	would influence/ enhance	suppliers pressure & willingness	as a driver of GSCM?	No	
Do you think organizational support	would influence/ enhance	competitors	as a driver of GSCM?	No	
Do you think organizational support	would influence/ enhance	suppliers pressure & willingness	as a driver of GSCM?	No	

Appendix 3 (Continued)					
In implementing green supply chain in management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Do you think competitors	would influence/ enhance	suppliers pressure & willingness	as a driver of GSCM?	No	
Customer awareness, pressure & support	would influence/ enhance	employees motivation, health and safety	as a driver of GSCM?	No	
Green Image, global marketing & competitiveness	would influence/ enhance	employees motivation, health and safety	as a driver of GSCM?	No	
Demand for environment friendly products	would influence/ enhance	employees motivation, health and safety	as a driver of GSCM?	No	
Social & environmental responsibility	would influence/ enhance	employees motivation, health and safety	as a driver of GSCM?	No	
Organizational support	would influence/ enhance	employees motivation, health and safety	as a driver of GSCM?	Yes	Organizations overall mission would increase employee motivation. health and safety

Competitors	would influence/ enhance	employees motivation, health and safety	as a driver of GSCM?	No	
Appendix 3 (Continued)					
In implementing green supply chain in management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Suppliers pressure & willingness	would influence/ enhance	employees motivation, health and safety	as a driver of GSCM?	No	
Green Image, global marketing & competitiveness	would influence/ enhance	customer awareness, pressure & support	as a driver of GSCM?	No	
Demand for environment friendly products	would influence/ enhance	customer awareness, pressure & support	as a driver of GSCM?	No	
Social & environmental responsibility	would influence/ enhance	customer awareness, pressure & support	as a driver of GSCM?	Yes	Social & environmental responsibility will motivate the customer to demand for greener product
Organizational support	would influence/ enhance	customer awareness, pressure & support	as a driver of GSCM?	No	
Competitors	would influence/ enhance	customer awareness, pressure & support	as a driver of GSCM?	No	

Suppliers pressure & willingness	would influence/ enhance	customer awareness, pressure & support	as a driver of GSCM?	No	
Appendix 3 (Continued)					
In implementing green supply chain in management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Demand for environment friendly products	would influence/ enhance	green image, global marketing & competitiveness	as a driver of GSCM?	No	
Social & environmental responsibility	would influence/ enhance	green image, global marketing & competitiveness	as a driver of GSCM?	No	
Organizational support	would influence/ enhance	green image, global marketing & competitiveness	as a driver of GSCM?	No	
Competitors	would influence/ enhance	green image, global marketing & competitiveness	as a driver of GSCM?	Yes	Implementing GSCM among competitors would increase possibility of GSCM culture globally
Suppliers pressure & willingness	would influence/ enhance	green image, global marketing & competitiveness	as a driver of GSCM?	No	
Social & environmental responsibility	would influence/ enhance	demand for environment friendly products	as a driver of GSCM?	Yes	Social & environmental responsibility of person motivates demand for environment

					friendly product
Appendix 3 (Continued)					
In implementing green supply chain in management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Organizational support	would influence/ enhance	demand for environment friendly products	as a driver of GSCM?	No	
Competitors	would influence/ enhance	demand for environment friendly products	as a driver of GSCM?	Yes	When competitors produce greener product, the industry is forces to produce greener product
Suppliers pressure & willingness	would influence/ enhance	demand for environment friendly products	as a driver of GSCM?	No	
Organizational support	would influence/ enhance	social & environmental responsibility	as a driver of GSCM?	No	Organization's pressure improves employees social & environmental responsibility
Competitors	would influence/ enhance	social & environmental responsibility	as a driver of GSCM?	No	
Suppliers pressure & willingness	would influence/ enhance	social & environmental responsibility	as a driver of GSCM?	Yes	Supplier pressure will motivate employees to improve social & environmental

					responsibility
Appendix 3 (Continued)					
In implementing green supply chain in management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Competitors	would influence/ enhance	organizational support	as a driver of GSCM?	No	
Suppliers pressure & willingness	would influence/ enhance	organizational support	as a driver of GSCM?	No	
Suppliers pressure & willingness	would influence/ enhance	competitors	as a driver of GSCM?	No	

Appendix 4: Pairwise comparison database for barriers

In implementing green supply chain management (GSCM) in chemical industry		(with respect to implementing GSCM)		Yes/ No	In what way ?(If YES)
Do you think lack of government support	would affect	high cost	as a barrier to GSCM?	No	
Do you think lack of government support	would affect	lack of adoption of advancement in technology	as a barrier to GSCM?	No	
Do you think lack of government support	would affect	cost of disposal of hazardous products	as a barrier to GSCM?	Yes	Cost of disposal will enhance for lack of government support for creating disposal place
Do you think lack of government support	would affect	lack of top management support	as a barrier to GSCM?	No	
Do you think lack of government support	would affect	lack of training	as a barrier to GSCM?	No	
Do you think lack of government support	would affect	lack of ethical standards and corporate social responsibility	as a barrier to GSCM?	No	
Do you think lack of government support	would affect	lack of recycling and reuse effort of	as a	Yes	Without government specific guidelines, the

		organization	barrier to GSCM?		organizations will lack the willingness to implement recycling and reuse
Appendix 4 (Continued)					
In implementing green supply chain management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Do you think the high cost	would affect	lack of adoption of advancement in technology	as a barrier to GSCM?	Yes	High cost of implementation encourages organization not to buy new technology
Do you think the high cost	would affect	cost of disposal of hazardous products	as a barrier to GSCM?	No	
Do you think the high cost	would affect	lack of top management support	as a barrier to GSCM?	Yes	Top management would hesitate to invest high cost on GSCM implementation
Do you think the high cost	would affect	lack of training	as a barrier to GSCM?	No	
Do you think the high cost	would affect	lack of ethical standards and corporate social responsibility	as a barrier to GSCM?	No	
Do you think the high cost	would affect	lack of recycling and reuse effort of the organization	as a barrier to GSCM?	Yes	The high cost will demotivate the recycle and reuse policy of the industry
Do you think lack of adoption of advancement in technology	would affect	cost of disposal of hazardous products	as a	No	

			barrier to GSCM?		
Appendix 4 (Continued)					
In implementing green supply chain management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Do you think lack of adoption of advancement in technology	would affect	lack of top management support	as a barrier to GSCM?	No	
Do you think lack of adoption of advancement in technology	would affect	lack of training	as a barrier to GSCM?	No	
Do you think lack of adoption of advancement in technology	would affect	lack of ethical standards and corporate social responsibility	as a barrier to GSCM?	No	
Do you think lack of adoption of advancement in technology	would affect	lack of recycling and reuse effort of organization	as a barrier to GSCM?	Yes	Sometimes advance technology increases the recycling and reuse effort.
Do you think cost of disposal of hazardous products	would affect	lack of top management support	as a barrier to GSCM?	Yes	If the disposal cost is high, the top management would be demotivated to do it.
Do you think cost of	would	lack of training	as a	No	

disposal of hazardous products	affect		barrier to GSCM?		
Appendix 4 (Continued)					
In implementing green supply chain management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Do you think cost of disposal of hazardous products	would affect	lack of ethical standards and corporate social responsibility	as a barrier to GSCM?	No	
Do you think cost of disposal of hazardous products	would affect	lack of recycling and reuse effort of the organization	as a barrier to GSCM?	No	
Do you think lack of top management support	would affect	lack of training	as a barrier to GSCM?	Yes	Lack of top management support increases lack of training effort of the employees.
Do you think lack of top management support	would affect	lack of ethical standards and corporate social responsibility	as a barrier to GSCM?	No	
Do you think lack of top management support	would affect	lack of recycling and reuse effort of the organization	as a barrier to GSCM?	Yes	Lack of top management support will increase the lack of recycling and reuse effort of the organization.
Do you think lack of training	would affect	lack of ethical standards and	as a	No	

		corporate social responsibility	barrier to GSCM?		
Appendix 4 (Continued)					
In implementing green supply chain management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Do you think lack of training	would affect	lack of recycling and reuse effort of the organization	as a barrier to GSCM?	Yes	Lack of training will increase lack of recycling and reuse effort of organization.
Do you think lack of ethical standards and corporate social responsibility	would affect	lack of recycling and reuse effort of the organization	as a barrier to GSCM?	Yes	Lack of ethical standards and corporate social responsibility will increase lack of recycling and reuse effort of the organization.
High cost	would affect	lack of government support	as a barrier to GSCM?	No	
Lack of adoption of advancement in technology	would affect	lack of government support	as a barrier to GSCM?	No	
Cost of disposal of hazardous products	would affect	lack of government support	as a barrier to GSCM?	Yes	Cost of disposal of hazardous products often increase lack of government support

Lack of top management support	would affect	lack of government support	as a barrier to GSCM?	No	
Appendix 4 (Continued)					
In implementing green supply chain management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Lack of training	would affect	lack of government support	as a barrier to GSCM?	No	
Lack of ethical standards and corporate social responsibility	would affect	lack of government support	as a barrier to GSCM?	Yes	Lack of ethical standards and corporate social responsibility can enhance lack of government support
Lack of recycling and reuse effort of the organization	would affect	lack of government support	as a barrier to GSCM?	No	
Lack of adoption of advancement in technology	would affect	high cost	as a barrier to GSCM?	No	
Cost of disposal of hazardous products	would affect	high cost	as a barrier to GSCM?	No	
Lack of top management support	would affect	high cost	as a barrier to GSCM?	No	
Lack of training	would affect	high cost	as a barrier to GSCM?	No	

Lack of ethical standards and corporate social responsibility	would affect	high cost	as a barrier to GSCM?	No	
Appendix 4 (Continued)					
In implementing green supply chain management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Lack of recycling and reuse effort of the organization	would affect	high cost	as a barrier to GSCM?	No	
Cost of disposal of hazardous products	would affect	lack of adoption of advancement in technology	as a barrier to GSCM?	No	
Lack of top management support	would affect	lack of adoption of advancement in technology	as a barrier to GSCM?	Yes	Lack of top management support can increase lack of adoption of advance technology
Lack of training	would affect	lack of adoption of advancement in technology	as a barrier to GSCM?	No	
Lack of ethical standards and corporate social responsibility	would affect	lack of adoption of advancement in technology	as a barrier to GSCM?	No	
Lack of recycling and reuse effort of the organization	would affect	lack of adoption of advancement in technology	as a barrier to GSCM?	No	

Lack of top management support	would affect	cost of disposal of hazardous products	as a barrier to GSCM?	No	
Appendix 4 (Continued)					
In implementing green supply chain management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Lack of training	would affect	cost of disposal of hazardous products	as a barrier to GSCM?	No	
Lack of ethical standards and corporate social responsibility	would affect	cost of disposal of hazardous products	as a barrier to GSCM?	No	
Lack of recycling and reuse effort of the organization	would affect	cost of disposal of hazardous products	as a barrier to GSCM?	No	
Lack of training	would affect	lack of top management support	as a barrier to GSCM?	No	
Lack of ethical standards and corporate social responsibility	would affect	lack of top management support	as a barrier to GSCM?	Yes	Lack of ethical standards and corporate social responsibility will decrease the support from top management

Lack of recycling and reuse effort of the organization	would affect	lack of top management support	as a barrier to GSCM?	No	
Appendix 4 (Continued)					
In implementing green supply chain management (GSCM) in chemical industry		**(with respect to implementing GSCM)**		**Yes/ No**	**In what way ?(If YES)**
Lack of ethical standards and corporate social responsibility	would affect	lack of training	as a barrier to GSCM?	No	
Lack of recycling and reuse effort of the organization	would affect	lack of training	as a barrier to GSCM?	No	
Lack of recycling and reuse effort of the organization	would affect	lack of ethical standards and corporate social responsibility	as a barrier to GSCM?	No	

Appendix 5: Questionnaire set for the validation of TISM drivers

Driver Links in Digraph	Interpretation	How much would you score between 1 to 5 (5 being the highest)
D1-D3	Motivated employee's enhanced performance would result in the competitive position of the company in the local & global market.	
D1-D5	Improved employee motivation and safety would result in increased social & environmental responsibility.	
D1-D6	The organization as a whole would provide more support to GSCM if employees are motivated.	
D2-D3	Customer pressure would make the industry more focuses on implementing GSCM.	
D2-D4	Customer awareness would directly result in a demand for more environment friendly product.	
D2-D5	If the customers are aware, organizations would be more motivated to show social and environmental responsibility for improving brand value.	
D2-D6	When customers demand green product, top management and whole organization will be forced to implement GSCM.	
D3-D5	When the competitors are accepting the GSCM culture, any organization would want to accept it, to be in the competition.	

D3-D6	Whole organization will support GSCM if global market and competitors accept it.	
D3-D7	The competitors will also be encouraged to accept GSCM due to global competitiveness.	

Appendix 5 (Continued)

Driver Links in Digraph	**Interpretation**	**How much would you score between 1 to 5 (5 being the highest)**
D4-D5	Organization's pressure improves employee's social & environmental responsibility.	
D4-D6	Customers demand for the greener product will influence organizational responsibility and force them to accept the GSCM practice.	
D5-D2	Social & environmental responsibility will motivate the customer to demand greener product.	
D5-D4	Social & environmental responsibility of person motivates demand for the environment friendly product.	
D5-D6	Organization's social & environmental responsibility would motivate organizations top management to influence GSCM.	
D6-D1	Organizations overall mission would increase employee motivation, health and safety.	
D6-D5	Organization's pressure improves employee's social & environmental responsibility.	
D7-D3	Implementing GSCM among competitors would increase the possibility of GSCM culture globally.	
D7-D4	When Competitors produce a greener product, the industry is forced to accept the similar strategy.	

D8-D5	Supplier pressure will motivate employees to improve social & environmental responsibility.	

Appendix 6: Questionnaire set for the validation of TISM barriers

Barrier Links in Digraph	Interpretation	How much would you score between 1 to 5 (5 being the highest)
B1-B4	Lack of government support for creating disposal place, cost of disposal will enhance.	
B1-B8	Without government specific guidelines, the organizations will lack the willingness to implement recycling and reuse.	
B2-B3	The high cost of implementation encourages organization not to buy new technology.	
B2-B5	Top management would hesitate to invest high cost on GSCM implementation.	
B2-B8	The high cost will demotivate the recycle and reuse policy of the industry.	
B3-B8	Sometimes advance technology increases the recycling and reuse effort.	
B4-B5	If the disposal cost is high, the top management would be demotivated to do it.	
B5-B6	Lack of top management support increases lack of training effort of the employees.	
B5-B8	Lack of top management support will increase the lack of recycling and reuse effort of the organization.	
B6-B8	Lack of training will increase lack of recycling and reuse effort of the organization.	

B7-B8	Lack of ethical standards and corporate social responsibility will increase lack of recycling and reuse effort of the organization.	

Appendix 6 (Continued)

Barrier Links in Digraph	**Interpretation**	**How much would you score between 1 to 5 (5 being the highest)**
B4-B1	Cost of disposal of hazardous products often increases lack of government support.	
B7-B1	Lack of ethical standards and corporate social responsibility can enhance lack of government support.	
B5-B3	Lack of top management support can increase lack of adoption of advance technology.	
B7-B5	Lack of ethical standards and corporate social responsibility will decrease the support from top management.	

Appendix 7: Academic Experts

Name	Affiliation	Organization
Expert 1	Assistant Professor, Industrial & Production Engineering Department	Rajshahi University of Engineering & Technology
Expert 2	Assistant Professor, Industrial & Production Engineering Department	Ahsanullah University of Engineering & Technology
Expert 3	Assistant Professor, Industrial & Production Engineering Department	Khulna University of Engineering & Technology
Expert 4	Assistant Professor, Industrial & Production Engineering Department	Dhaka University of Engineering & Technology
Expert 5	Assistant Professor, Industrial & Production Engineering Department	Khulna University of Engineering & Technology
Expert 6	Assistant Professor, Industrial & Production Engineering Department	Dhaka University of Engineering & Technology
Expert 7	Assistant Professor, Industrial & Production Engineering Department	Bangladesh University of Engineering & Technology
Expert 8	Assistant Professor, Industrial & Production Engineering Department	Bangladesh University of Engineering & Technology
Expert 9	Assistant Professor, Industrial & Production Engineering Department	Dhaka University of Engineering & Technology
Expert 10	Associate Professor, Industrial & Production Engineering Department	Bangladesh University of Engineering & Technology

Appendix 8: Validation of the initial structural framework for the drivers

Expert / Interpretation	1	2	3	4	5	6	7	8	9	10	Total	Avg.
Motivated employee's enhanced performance would result in the competitive position of the company in the local and global market.	4	5	3	4	5	5	5	4	5	5	45	4.5
Improved employee motivation and safety would result in increased social & environmental responsibility.	4	3	4	3	5	5	5	4	5	4	42	4.2
The organization as a whole would provide more support to GSCM if employees are motivated.	4	4	4	3	4	5	5	2	5	4	40	4.0
Customer pressure would make the industry more focuses on implementing GSCM.	5	4	3	5	4	5	5	5	4	5	45	4.5
Customer awareness would directly result in a demand for more environment friendly product.	5	5	5	5	4	5	4	2	5	4	44	4.4
If the customers are aware, organizations would be more motivated to show social and environmental responsibility for improving brand value.	5	4	4	4	4	5	4	3	4	4	41	4.1
When customers demand green product, top management and whole organization will be forced to implement GSCM.	5	4	5	5	4	5	4	3	5	4	44	4.4

Appendix 8 (Continued)

Expert / Interpretation	1	2	3	4	5	6	7	8	9	10	Total	Avg.
When the competitors are accepting the GSCM culture, any organization would want to accept it to be in the competition.	4	3	5	5	4	5	4	3	5	2	40	4.0
Whole organization will support GSCM if global market and competitors accept it.	5	3	4	4	4	5	4	2	5	4	40	4.0
The competitors will also be encouraged to accept GSCM due to global competitiveness.	4	4	5	4	4	5	3	4	5	4	42	4.2
Organization's pressure improves employees' social & environmental responsibility.	4	4	4	4	3	3	3	2	4	4	35	3.5
Customers demand for the greener product will influence organizational responsibility and force them to accept the GSCM practice.	5	4	5	5	4	5	3	3	5	3	42	4.2
Social & environmental responsibility will motivate the customer to demand greener product.	4	3	3	4	4	5	3	3	5	3	37	3.7
Social & environmental responsibility of person motivates demand for the environmentally friendly product.	4	4	4	4	3	5	4	3	5	3	39	3.9
Organization's social & environmental responsibility would motivate organizations top management to influence GSCM.	4	5	5	4	4	4	3	3	5	4	41	4.1

Appendix 8 (Continued)

Expert / Interpretation	1	2	3	4	5	6	7	8	9	10	Total	Avg.
Organizations overall mission would increase employee motivation, health and safety.	4	4	4	4	5	4	4	3	5	4	41	4.1
Organization's pressure improves employee's social & environmental responsibility.	4	2	5	4	3	3	3	4	4	4	36	3.6
Implementing GSCM among competitors would increase the possibility of GSCM culture globally.	4	4	5	5	4	5	4	4	5	4	44	4.4
When Competitors produce a greener product, the industry is forced to accept the similar strategy.	5	2	5	5	3	5	4	2	5	2	38	3.8
Supplier pressure will motivate employees to improve social & environmental responsibility.	4	4	3	4	4	3	4	4	4	4	38	3.8

Appendix 9: Validation of the initial structural framework for the barriers

Expert / Interpretation	1	2	3	4	5	6	7	8	9	10	Total	Avg.
Lack of government support for creating disposal place, cost of disposal will enhance.	5	4	5	5	4	4	4	2	5	4	42	4.2
Without government specific guidelines, the organizations will lack the willingness to implement recycling and reuse.	5	4	4	5	4	5	4	3	4	5	43	4.3
The high cost of implementation encourages organization not to buy new technology.	5	4	4	5	4	4	4	4	4	5	43	4.3
Top management would hesitate to invest high cost on GSCM implementation.	5	4	5	5	4	4	4	2	4	5	42	4.2
The high cost will demotivate the recycle and reuse policy of the industry.	5	4	4	5	5	4	3	4	5	4	43	4.3
Sometimes advance technology increases the recycling and reuse effort.	4	4	5	3	5	5	4	3	5	4	42	4.2
If the disposal cost is high, the top management would be demotivated to do it.	5	5	5	5	4	4	4	3	4	4	43	4.3
Lack of top management support increases lack of training effort of the employees.	4	4	5	4	5	5	3	4	5	4	43	4.3
Lack of top management support will increase the Lack of recycling and reuse effort of the organization.	4	4	5	5	5	5	4	3	5	4	44	4.4

Appendix 9 (Continued)

Expert / Interpretation	1	2	3	4	5	6	7	8	9	10	Total	Avg.
Lack of training will increase lack of recycling and reuse effort of the organization.	4	4	5	4	5	5	4	3	5	5	44	4.4
Lack of ethical standards and corporate social responsibility will increase lack of recycling and reuse effort of the organization.	4	4	5	5	4	5	3	4	5	5	44	4.4
Cost of disposal of hazardous products often increases lack of government support.	4	1	4	4	4	2	4	3	5	2	33	3.3
Lack of ethical standards and corporate social responsibility can enhance lack of government support.	4	3	4	4	4	5	4	3	5	2	38	3.8
Lack of top management support can increase lack of adoption of advance technology.	5	4	5	4	5	5	4	3	5	4	44	4.4
Lack of ethical standards and corporate social responsibility will decrease the support from top management.	4	3	4	4	4	5	4	3	5	4	40	4.0