DEVELOPING A GSCM MODEL FOR THE INDIAN RUBBER GOODS MANUFACTURING SECTOR

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DEDICATIONS

To my dear Mom, Dad

"For your unconditional love and prayers"

To my Grandma

"You would have been the happiest person in the world to see me where I am today. May your soul rest in peace"

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Surajit Bag

Date: 15.5.2014

DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the University or any other institute of higher learning, except where due knowledge has been made in the text.

Surajit Bag

Date: 15.5.2014

THESIS COMPLETION CERTIFICATE

This is to certify that the thesis entitled "Developing a Green Supply Chain Management model for the Indian rubber goods manufacturing sector" submitted by Surajit Bag to University of Petroleum & Energy Studies for the award of the Degree of Doctor of Philosophy is a bona fide record of the research work carried out by him under our supervision and guidance. The content of the thesis, in full or parts have not been submitted to any other Institute or University for the award of any other degree or diploma.

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CONTENTS

EXECUTIVE SUMMARY

Industrial processes are highly energy intensive and account for significant green house gas emissions. Major portion of this energy is supplied by fossil fuels and thereby depletion of natural resources is occurring at an accelerating rate with time. Studies suggest that demand for manufacturing products is likely to double by the year 2050. If these green house gases emissions remain unchecked, then it will create a catastrophic effect by 2050. Reducing emissions require a focused and sustained effort by the business world. This has led to the evolution of green supply chain management. In the recent years green supply chain management (GSCM) has gained popularity both in academics as well in industry and is reflected in the special issues of journals and themes of conferences. GSCM is aimed to achieve sustainability by manufacturers globally and is gaining huge popularity.

The rubber products manufacturing sector plays a pivotal role in Indian Economy and considered to be one of the key players in global rubber business.

With around 6000 units comprising 30 large scale, 300 medium scale and around 5600 SSI/tiny sector units, manufacturing 35000 rubber products, employing four hundred thousand people, including around 22000 technically qualified support personnel, with a turnover of Rs.200 billions and contributing Rs.40 billions to

the National Exchequer through taxes, duties and other levies, the Indian Rubber Industry plays a core sector role in the Indian national economy. The industry has certain distinct advantages due to indigenous availability of the basic raw materials, like natural rubber, synthetic rubber, reclaim rubber, carbon black, rubber chemicals, fatty acids, rayon and nylon yarn and a large domestic market.

The wide range of rubber products manufactured by the Indian rubber industry are auto tyres, auto tubes, automobile parts, footwear, belting, hoses, cycle tyres and tubes, cables and wires, camelback, battery boxes, latex products and pharmaceutical goods.

With the saturation in rubber consumption in Western countries and the shift in consumption of rubber to the Asia Pacific region, the focal points for this decade for development will be India. The industry is expected to grow at over 8% p.a. in the coming decade.

But there are certain disadvantages which is hindering the growth rate of this sector. The environmental impact due to wide operations is a burning issue among the rubber technologists. The rubber chemicals and ingredients used in the manufacturing process create nuisance during the entire product life cycle. During the rubber product manufacturing operations workers are exposed to these hazards through inhalation and skin absorption. Therefore risk of cancer and other adverse health effects are high among rubber products workers, DHHS (NIOSH).

CPCB has categorized this sector in the high polluting (red) category. Rubber products manufacturing leads to GHG emission and heavy solid waste generation which has adverse effects on the society. Annually generated scrap rubber creates a disposal issue in every country. All these issues has created headache to the rubber association and policy makers. Throughout the rubber industry supply chain, policy makers are trying hard to reduce the level of carbon emissions.

There exists remarkable scope for expansion in future years provided GSCM is practiced by the rubber products manufacturing sector to achieve sustainability and improving the environmental image.

The objective of this study is to develop a GSCM model for the rubber goods manufacturing sector based on the results of Interpretive Structural Modeling (ISM). MICMAC analysis is applied to categorize the factors in terms of driving and dependence power. Further the GSCM model is statistically tested. Both practitioners in industry and academics might find the results useful, as it integrates natural resource based view theory and institutional theory, and addressing both internal and external perspectives of the firm.

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

AHP	Analytical Hierarchy Process
CILT	Chartered Institute of Logistics and Transport
CSR	Corporate Social Responsibility
FP	Financial Performance
GHG	Green House Gases
GSCM	Green Supply Chain Management
HRD	Human Resource Development
ISM	Interpretive Structural Modelling
ISO	International Standard Organization
MCDM	Multi Criteria Decision Making
MICMAC	Matrice d’ Impacts croises multiplication appliqué an classment
OSHA	Occupational Safety and Health Administration
SCM	Supply Chain Management
SPSS	Statistical Package for Social Sciences
SRM	Supplier Relationship Management
SSIM	Structural Self Interaction Matrix
TQM	Total Quality Management
UNFCCC	United Nations Framework Convention on Climate Change

CHAPTER 1

INTRODUCTION TO THE STUDY

1.1 Background

Global warming has become a burning issue worldwide and has led firms to adopt green supply chain management practices in order to reduce carbon footprint throughout the supply chain. It is now very clear that environmental management is a key strategic issue for organizations due to its long lasting impact on organization performance. Manufacturing sector is associated with intensive use of resources and with time the rate of material use is increasing which leads to diverse impact on environment (eg. Smith, 2012; Boltic et al., 2013; Dues et al., 2013; Giovanni and Vinzi, 2013). The contribution of the manufacturing sector to environmental degradation basically occurs during the following stages: procurement, industrial operations, product use and disposal (European Commission, 2006; Planning Commission of India, 2012). The Central Pollution Control Board have identified seventeen highly polluting industries, the majority of which are manufacturing industries (National Productivity Council, 2006).The MSMEs in India, can have a significant impact on the environment as they are generally liable to be equipped with obsolete, inefficient and polluting technologies and processes. More than70% of the total industrial pollution load of

India is attributed to MSMEs. New technologies leading to cleaner processes and operations are not being developed at a fast enough pace to address the urgent need for environmental protection. The current ecosystem does not encourage and facilitate the mainstreaming and scaling up of new technologies for widespread use mainly due to a lack of financial support, resources and government assistance. The waste management and recycling industry in India is currently vast but largely unorganized. In this space, it is necessary to mainstream the industry and ensure that the livelihoods of all people dependent on this industry are supported and upgraded (Lamming and Hampson, 1996; Linton et al., 2007; Srivastava, 2007; Carter and Rogers, 2008; Seuring and Muller, 2008; Hall et al., 2012).

Environmental dimension has become one of the critical success factor in enhancing business performance. To name a few top brands such as GE, Walmart, Coca Cola have embraced green practices as they have understood the importance of eco friendly practices.

Green organizations generally have three gears which can be used to optimize the operations- material, energy and process. The area of focus is conservation, optimized use of resources and recycling. GSCM covers several topics such as solid waste management, waste water treatment, end of product life cycle etc. With increased awareness corporate policies are being amended to conform to the international regulations. Green is a very powerful word itself and has become a global vision. Green practices is well respected and been taken care by the organizations. Generally firms compete in the market based on quality, responsiveness and cost. With passage of time different attributes have gained importance.

In the 1960s and 1970s, quality was the central point whereas in the 1980s, responsiveness time was the most important parameter considered by firms. A decade later, the main parameter was cost, while maintaining a high level of quality and speed. Throughout different approaches were taken to enhance business performance. Many of these techniques applied can be considered a craze. Concepts such as TQM, JIT or Six Sigma could all be considered fads depending on how they have been implemented by manufacturers. Quality, responsiveness time and cost are all important in manufacturing today, but presently environmental issues are so hot that it is the point of key discussion among supply chain practitioners and policy makers. This has led firms to consider environmental aspects in every phase of the supply chain. Green engineering or environmentally conscious manufacturing has attracted practitioners since it is a feasible solution to environmental problems. Green engineering originated in the early 1970s when it was realized that there were high levels of resource utilization and waste generation. This also created a challenge in front of the government. Land for waste disposal, i.e. landfill sites were a major constraint and therefore government levied heavy taxes for scrap disposal at landfills but this did not result to a permanent solution. Therefore manufacturers leaned towards green engineering which is the systems-level approach to product and process design where environmental attributes are treated as primary objectives or opportunities rather than simple constraints. It emphasizes the legitimacy of environmental objectives as consistent with the overall requirements of product quality and economy. With time, the growth of manufacturing sectors will result to production of more waste and also more energy will be utilized. Green Supply Chain is the business model that emphasizes on eliminating non-value added activities while delivering quality products at lowest cost with greater efficiency.

Manufacturing organizations has thus seen phases such as Craft production, industrial revolution, assembly lines to lean and finally the present one i.e. the Green supply chain management.

There is evidence of research supporting a relationship between GSCM practices and impact on firm performance (eg., Rao and Halt, 2005; Zhu et al., 2005; Zhu and Sarkis, 2007; Zhu et al., 2008; Eltayeb et al., 2011; Lee et al., 2012; Dues et al., 2013; Gavronski et al., 2013; Dubey and Bag., 2013; Laosirihongthong, et al., 2013; Dubey et al., 2013; Mitra, S., and Dutta, P., 2014, Kumar et al., 2012).

GSCM has attracted attention of researchers in the last decade because of its increasing importance in the business world; however wide gap exists in the existing GSCM literature and company policies (Hu, 2010). This is due to lack of a comprehensive theoretical model to support these claims without which it is difficult to take GSCM research to the ultimate level. The present research intends to bridge the gap that exists between GSCM theory and practice which finally impact the firm performance.

Developing theories related to GSCM has received focus of researchers in the earlier period (eg., Zhu and Sarkis, 2004; Rao and Holt., 2005; Zhu and Sarkis., 2007; Zhu et al., 2012; Shi et al., 2012; Schrettle et al., 2014). It is evident from the literature that in the early 2000s effort was given to build theory in context to green purchasing/ eco friendly practices and impact on firm performance (eg., Zhu and Sarkis, 2007; Linton et al., 2007; Wahid et al.,2011; Bjorlund., 2012; Kauppi., 2013) or at the macro level i.e., supplier relationship management (eg. Vachon and Klassen., 2006; Bai and Sarkis., 2010; Testa and Iraldo, 2010; Hoof and Lyon., 2013), TQM (eg. Pauli., 1997; Murovec et al., 2012; Prajogo et al., 2012; Pereira-Moliner et al., 2012; Gavronski et al., 2013); green technology (eg. Sikdar and Howell 1998; Zhang et al., 2013; Hoof and Lyon., 2013); Lean manufacturing (eg. Farish., 2009; Franchetti et al., 2009; Deif, 2011; Dues et al., 2013) and Leadership (eg. Siaminwe et al., 2005; Stone 2006; Brown and Stone

2007; Berkel 2007; Deif 2011; Dues et al., 2013; Hoof and Lyon 2013; Despeisse et al., 2012). Although there are research work both at macro and micro level, but there is deficiency of comprehensive framework which has investigated the impact of all the key GSCM factors on firm performance considering both the internal and external factors.

1.2 Need for Research

The paradigm shift of policies towards green economy is forcing companies worldwide to consider the green initiatives seriously. There is need for the companies especially manufacturing companies to take a proactive approach rather than reactive approach in this aspect. According to UNEP (2011) report, global manufacturing sector accounts for 35% of the total electricity consumed worldwide and responsible for 20% of the world's carbon dioxide emissions, which is detrimental to lives on the earth. While the above arguments indicate, that this is the high time for empirical research on green supply chain management and implementation of GSCM framework, especially for developing countries like India which is becoming one of the global manufacturing hubs next to China.

The present research is focused on the rubber goods manufacturing sector since the growth and development of rubber product manufacturing sector contribute substantially to the development of natural rubber processing industries, which, in turn, is linked directly to the living standards of large number of people, since the rubber plantation industry has become a small holder oriented industry consisting of over 9.3 lakh small holdings.

The survival of the natural rubber plantation industry in the years to come will depend on the ability of India to become a global player in export of rubber goods, (www.smallindustryindia.com). Indian companies, especially the exporters, are pressured into implementing environmental standards by their international clients (http://rubberasia.com). Automotive tyre manufacturers in the U.S. and Europe are now demanding environmentally responsive behavior from suppliers globally, including India (Mitra, 2004). With globalization and increase in number of countries becoming member of world trade organization have promoted GSCM practices in manufacturing organizations (Diabat et al., 2013).

Indian rubber goods manufacturing sector faces major challenge from environmental degradation resulting from its operations. Workers are exposed to these hazards through inhalation and skin absorption during rubber processing and product manufacturing. Risk of cancer and other adverse health effects are high among rubber products workers, (DHHS, NIOSH, 1993). CPCB has categorized this sector in the high polluting RED category due to GHG emission and solid waste generation. Throughout the supply chain this sector is trying hard to reduce the carbon emissions.

1.3 Significance of the study

What will happen if there is *sudden scarcity of oxygen* on this planet? What will happen if there is no space for *industrial waste matter disposal*? What will happen if there is *scarcity of natural resources*? What if, there lacks a *healthy environment* on this planet? Have we ever thought of it before? Surprisingly these are the few questions which have triggered the present research. All the above questions point the finger towards the sustainability issue.

The call for GSCM is to serve as a sustainable solution to the environmental degradation which is the result of not paying enough attention by manufacturers so far. The consequences are very serious in nature and have the potential to extinction of human race. Already scientists have observed its effect globally such as melting of polar ice caps and other natural calamities. Also industrial pollution has led to extinction of several animal species on this planet. There are adequate research papers available on GSCM. This reflects the popularity of the subject matter. Although the subject has gained respect from various groups but there is a wide gap between theory and practice. Literature on GSCM has covered various GSCM dimensions but there lacks a comprehensive framework.

GSCM practices are at an embryonic stage in India. The present study focuses on developing a GSCM model for the rubber goods manufacturing sector. The valid reason for selecting this particular sector has been clearly stated in subsection 1.2. Here exhaustive literature review has been conducted and systematic literature review technique has been applied to develop building blocks of the present study. Two important research gaps identified were converted into two research objectives and further two research questions. By considering all the aspects appropriate research methodology was applied. In phase one the key factors influencing GSCM practices were identified and further validated through rubber industry experts opinion. The key factors identified in phase one was used as an input in phase two for developing the ISM model. MICMAC analysis was applied to identify the driving and dependency power of the factors. Finally statistical validation of the GSCM model has been carried out and conclusions and recommendations were provided. The uniqueness of the presence study is that it has considered a highly polluting sector which can enhance business performance; subject to clear understanding of the GSCM inter-relationships. Also the presence study has considered both the internal and external GSCM dimensions. GSCM is the only path left to all of us. Let all the supply chain practitioners open up our minds and take a big leap to save Mother Earth.

1.4 Organization of thesis

The thesis is organized into the following chapters. A brief summary of each chapter is given below:

Chapter one presents the introduction of the study. The background of the study is also discussed along with motivation for research and overview of study. The last part of the chapter describes how the subsequent chapters of this dissertation are organized.

Chapter two presents the literature review related to the historical evolution of GSCM, definitions of GSCM, GSCM dimensions, impact of GSCM practices on organization performance, theories applied in SCM and GSCM research, critical success factors of GSCM, GSCM Practices, impact of GSCM on firm performance and tools and techniques used in GSCM research. The research gaps identified has helped the researcher to define the objectives of the study and develop strategies to achieve the objectives by undertaking scientific investigations.

Chapter three brief about Indian rubber industry. The major concentration is on supply chain process and waste generation details.

Chapter four presents the methodological perspectives of the research. The strategies adopted in this study are discussed. ISM methodology and MICMAC analysis is discussed in details based on which the theoretical model showing the relationships between GSCM key factors and organization performance is developed.

Chapter five presents the statistical data analysis and findings of the study. The research hypotheses are tested using linear regression analysis. For each of the statistical tools used, their justifications of use, advantages, their basic output tables and an explanation of the tables are discussed.

Chapter six presents a brief summary of the study and the conclusions drawn from the study. Also the key recommendations are provided. The research limitations and further scope of research is also discussed.

1.5 Concluding Remarks

In the present chapter, motivation behind research and background of the study is discussed. The next chapter further focuses on literature review, thus laying the foundation for the further empirical study.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

The main purpose of this chapter is to explore GSCM in depth and understand how GSCM practices within a rubber goods manufacturing sector can be a source of competitive advantage based upon review of past articles published in the journals. Literature review is considered the heart of any research study. It is found that past researchers have mostly used traditional review; however systematic literature review is a recent trend adopted by researchers for conducting literature review (eg. Pittaway et al., 2004; Van Aken., 2005; Lightfoot et al., 2013) to synthesize and organize findings. Therefore present review is done based on the technique of systematic literature review approach as recommended by Transfield et al., 2003. This eradicates the issues related to the application of correct methodology and easily helps to develop the later sections of the study. In this process researcher has adhered to the principles that are an integral part of systematic literature review.

For literature review scholarly works from databases such as Science Direct, Compendex, Ebsco, Emerald and Scopus has been utilized.

The various stages of systematic literature review (SLR) are as follows:-

Stage 1: Planning for review

- Phase 1: Need identification for literature review

Review has been done on related papers from secondary sources to understand the GSCM practices in the manufacturing sector both globally and in Indian context. The objective of conducting the review is to identify the research gaps from published literature and further develop the problem statement, research questions and research objectives for the present research.

- Phase 2: Preparation for review

In the present work literature review focuses mainly on journal articles. To set up a time span, a starting position was set at 2000. Library databases are used where a keyword search using keywords such as 'green supply chain', 'environmental supply chain', 'green purchasing', 'green manufacturing', 'green operations', 'green logistics', 'carbon and GHG emission reduction', are searched. Published literature has been utilized from 2000 onwards to go back to other papers by cross referencing. As the published literature is interlinked to a considerable degree, one paper leads to others. So, when one thread is picked up, it leads to others. As references accumulated, it is found that some of them are more vital and useful than others. Such references are considered as seminal papers which are also found to be generally referenced a number of times in subsequent literature. Thus, within the defined objective, this work integrates and takes forward the literature on GSCM since its conceptualization. The list of cited references is given at the end of the chapters.

- Phase 3: Development of a review protocol

This is a debatable area among the researchers because literature review is a never ending process. Therefore one must know where to stop and build their research work on the basis of the strings identified to reach the final destination.

Stage 2: Conducting literature review

- Phase 5: Identification of research

Earlier published papers has been reviewed related to GSCM practices in the manufacturing sector to identify the area which has been unattended by past researchers and need attention due to its relevance in the present scenario.

- Phase 6: Selection of studies

In the present section some of the relevant works related to green supply chain management has been highlighted.

Let us understand the concept of supply chain management before piercing down into green supply chain management (GSCM).

Supply chain management is gaining increasing strategic importance (Storey et al., 2006). Without a supply chain strategy a firm is simply a ship without a rudder. Global supply chains are a source of competitive strategy (Manuj and Mentzer, 2008). Widespread industrial operations emit harmful pollutants at all stages in the supply chain and degrade natural environment, thereby posing a threat to human beings and wildlife. Globally manufacturers must ensure that the operations be done as safely and responsibly as possible keeping in line with the three basic elements of sustainability. This necessitates the adoption of green supply chain management. World leading firms including IBM, Dell, HP, Sony, Toyota and Nokia have adopted GSCM as a strategic initiative.

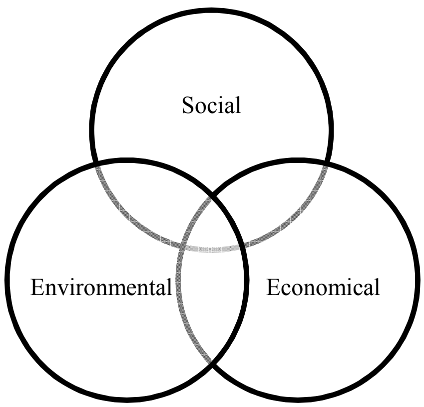
The key GSCM themes that emerged from the literature are green design, green operations, green manufacturing and reverse logistics (Guide and Srivastava 1998).

The first paper on GSCM came out in 1989 by Kelle and Silver where they developed a forecasting model for recyclable products and the first paper on green design was by (Navin Chandra, 1991).

Later various researchers extended the framework of green design (Ashley 1993; Alenby and Richards 1994; Zhang, Kuo, Lu and Huang 1997).

In reality, there are three approaches to green supply chain management i.e., environment, strategy, and logistics, Gilbert, (2001). GSCM encompasses the simultaneous adoption of environmental, economic and social principles. This is called "Triple Bottom Line" approach. According to the traditional view on green supply chain management, increased focus on the environmental initiatives would lead to cost burden on the companies and as a result, companies might lose competitiveness in the market. Many companies are being forced to take green initiatives in order comply with the various regulations of the government. There is a need for companies to view green management as an opportunity to gain technological and market leadership rather than a simple regulatory compliance.

Fig.2.1. Elements of sustainability



2.2 Evolution of Green Supply Chain Management

The evolution of supply chain management has been a gradual process. Over the last century, there have been major revolutions in the field of supply chain management which have been examined in the context of the broader evolution in the economic and technological environment.

2.2.1. The First Revolution (1910-1920): The Ford Supply Chain

The first major Revolution was staged by the Ford Motor Company where they had managed to build a tightly integrated chain. The Ford Motor Company owned every part of the chain- right from the timber to the rails. Through its tightly integrated chain, it could manage the journey from the iron ore mine to the finished automobile in 81 hours. However, as the famous saying goes, the Ford supply chain would offer any colour, as long as it was black; and any model, as long as it was model T. Ford innovated and managed to build a highly efficient, inflexible supply chain that could not handle a wide product variety and was not sustainable in the long run. General Motors on the other hand, offered a wider variety in terms of automobile models and colours. Ford's supply chain required a long time for set-up changes and, consequently, it had to work with a very high inventory in the chain.

Till the second supply chain revolution, all the automobile firms in the Detroit were integrated firms. Even traditional firms in India, like Hindustan Motors, were highly integrated firms where the bulk of the manufacturing was done in-house.

2.2.2. The Second Revolution (1960-1970): The Toyota Supply Chain

Towards the end of the first revolution, the manufacturing industry saw many changes, including a trend towards a wide product variety. To deal with these changes, firms had to restructure their supply chains to be flexible and efficient. The supply chains were required to deal with a wider product variety without holding too much inventory. The Toyota Motor Company successfully addressed all these concerns, thereby ushering in the second revolution.

The Toyota motor Company came up with ideas that allowed the final assembly and manufacturing of key components to be done in-house. The bulk of the components were sourced from a large number of suppliers who were part of the *keiretsu* system. *Keiretsu* refers to a set of companies with interlocking business relationships and shareholdings. The Toyota Motor Company had developed long term relationships with all the suppliers. These suppliers were located very close to the Toyota assembly plants. Consequently, set-up times, which traditionally used to take a couple of hours, were reduced to a couple of minutes. This combination of low set-up times and long term relationships with suppliers was the key feature that propelled the second revolution- it was a long journey from the rigidly integrated Ford supply chain. The principles followed by Toyota are more popularly known as lean production systems.

The Toyota system, involving tight linkages, did get into some problems in the later part of the century. Gradually, when Toyota and other Japanese firms tried to set up assembly in different parts of the world, they realized that they would have to take their suppliers also along with them. Further, they found that some of the suppliers in *keiretsu* had become complacent and were no longer cost competitive. With the advent of electronic data interchange (EDI), which facilitated electronic exchange of information between firms, it was possible for a firm to integrate with the suppliers without forcing them to locate their plants close to the manufacturer's plant.

In actual practice, The Toyota supply chain also had certain rigidities, such as a permanent relation with suppliers, which could become a liability over a period of time. This, in turn, led to the third revolution super headed by Dell Computers, which offered its customers the luxury of customization with loosely held supplier networks.

2.2.3. The Third Revolution (1995-2000): The Dell Supply Chain

With advances in information technology (IT), Dell Computers allowed customers to customize their computers. Dell allowed customers to configure their own PCs and track the same in their production and distribution systems. Unlike the Toyota supply chain, Dell did not believe in long-term relationships with suppliers, Dell believed in working with world-class suppliers who would maintain their technology and cost leadership in their respective fields. Dell maintained medium-term relationships with suppliers, where the suppliers were always on test. Because of advances in IT, Dell could integrate the suppliers electronically, even if they were partners only for a medium term. At Dell, the trigger for supplier orders was actual orders by customers, and not forecasts. This helped in reducing the inventory significantly, allowing them to respond to any changes in the market place. Since their suppliers were electronically integrated as they did not want rigidity in the chain, Dell did not see any advantage in locating suppliers close to their assembly plants. With increased use of IT in supply chain management, Dell developed more flexibility in the supply chain.

2.2.4. The Fourth Revolution

The Fourth Revolution (Year 2000 onwards): The fourth revolution started when organizations witnessed the ill effects of the traditional supply chain process. The results were horrible with marked impact on environment which caused irreversible damage to the environment. Apart from human beings it even posed threat to the animals and plant life on this planet. This created a concern among the policy makers, government and manufacturing associations globally and thus the concept of green supply chain emerged. Dell now allows customers to return any Dell-branded product back to the company – for free through its "no computer should go to waste" recycling program. The company has even gone so far as to establish programs that accept computers, monitors, or printers from other companies for safe disposal, as well. The main objective of the program is to take care of the safe disposal of the electronics components after its useful life. That is why green supply chain management is also called closed loop supply chain where care is taken by the manufacturer to minimize the environmental impact of the product during its entire life cycle.

The traditional supply chain was managed with the objectives to reduce cost without any focus towards environmental and social dimensions (Simpson et al., 2005; Sarkis et al., 2011). However with the passage of time institutional pressures has directed firms to design supply chain network which takes care of environmental and social dimensions as well (Srivastava, 2007; Gavronski et al., 2008; Guide and Van Wassenhove, 2009; Gunasekaran and Spalanzani, 2012). GSCM involve green design, green purchasing, green manufacturing and green distribution and transportation (Hervani et al., 2005). The environmental awareness which initiated in the 1960s, in the western part of the globe gradually spread all over the world (Sarkis, 2011; Nelson et al., 2012). However developing country like India has taken up the initiative at a much later stage. The GSCM principle was guided by a single objective, i.e, environmental performance. However in recent years firms have understood that only focusing on environmental dimension does not lead to achieve sustainability. Therefore firms have begun integrating the three important dimensions and adapting a more comprehensive performance framework, i.e., Triple Bottom Line (eg. Awaysheh and Klassen, 2010, Paulraj and De Jong, 2011; Gimenez et al., 2012; Giovanni, 2012; Hollos et al., 2012).

SSCM is the latest topic which has gained wide importance in the field of supply chain/ operations management. SSCM is defined as an efficiency of utilizing the finite resources and achieve flexibility to changeable business environment. Firms are exposed to many elements of risk and these elements are classified into economic, environmental and social element. Sustainable development encompasses the simultaneous adoption of Environmental, Economic and Social principles. This is called "Triple Bottom Line" approach.

Globally manufacturers must ensure that the operations be done as safely and responsibly as possible keeping in line with the three basic elements of sustainability. This necessitates the adoption of sustainable supply chain management. World leading firms including IBM, Dell, HP, Sony, Toyota, and Nokia have adopted SSCM as a strategic initiative. Various respected work exists in the area of sustainable supply chains (Linton et al., 2007; Longo and Mirabelli., 2008; Pereira., 2009; Azevedo et al., 2011; Gupta and Desai., 2011; Wu. and Pagell., 2011; Wang. et al., 2011; Kang et al., 2012; Barari et al., 2012; Hassisni et al., 2012; Gimenez et al., 2012; Gunasekaran and Spalanzani 2012; Dubey and Bag., 2013; Chaabane et al., 2012; Ageron et al., 2012; Liu et al., 2012; Reefke and Trocchi., 2013; Suering, S., 2013; Mirhedayatian et al., 2014; Brandenburg et al., 2014). It can be concluded that in the last two decades, supply chain management has transformed into green and sustainable supply chain management.

2.3 Definition of Green Supply Chain Management

In this section, effort has been made to define GSCM based on review of past scholarly works.

- Schrettle et al., (2014) defined GSCM as a "*tool which helps to position a company from strategic viewpoint*".
- Gunasekaran and Spalanzani, (2012) defined GSCM as *"an organizational philosophy which provides competitive edge to an organization"*.
- Ali and Govindan (2011) defined GSCM as "*an organizational philosophy to reduce environmental risks*"
- Johny (2009) defined GSCM as a *"process that added the green element to existing supply chain management and portrayed how reverse supply chain, an organization and an innovative activity reconstruct a system"*.
- Zhu et al., (2008) defined GSCM as *"adoption of eco friendly practices considering internal environmental management, green purchasing, cooperation with customers, and eco design for developing corporate and operational strategies for the firm's environmental sustainability"*.
- Seuring and Muller's (2008) defined GSCM as *" the management of material, information, and capital flows as well as cooperation among companies along the supply chain while taking goals from all three*

dimensions of sustainable development" which are derived from customer and stakeholder requirements".

- Carter and Rogers (2008) defined GSCM as an *"integration of environmental dimensions with traditional supply chain network"*.
- Srivastava (2007) defined GSCM as "*integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final products to the consumers, and end-of-life management of the product after its useful life"*.
- Vachon and Klassen (2006) defined GSCM as a "*strategy, which assists to reduce wastages in supply chain network"*.
- Kogg (2003) defined GSCM "*the set of supply chain management policies held, actions taken and relationships formed in response to concerns related to the natural environment with regard to the design, acquisition, production, distribution, use, re-use and disposal of the firm's goods and services"*.
- Sarkis (2003) defined GSCM as a *"combination of the activities of an environmental dimension and reverse logistics"*.

- Gilbert (2000) defined GSCM as an *"integration of environmental criteria with traditional supply chain network by redesigning purchasing policies and involving suppliers in the entire procurement process"*.
- Beamon (1999) defined GSCM as *"utilizing the supply chain between a central company and a cooperating company, to support the company with knowhow of eco management practices and development of clean manufacturing techniques"*.
- Narshiman and Carter (1998) defined GSCM as *"involving the procurement strategies that reduced the use of materials in addition to recycling and reuse."*
- Godfrey (1998) defined GSCM as *"organizational practices that continuously monitor the environmental impact of a supply chain and improve the performance."*

Based on the above definitions author proposes GSCM definition as "*integrating the green dimensions into the traditional supply chain management so that the product will impose reduced environmental impact during its entire life cycle. It is the set of clean and hygienic practices which starts right from the product design stage and flows through all activities of the supply chain such as procurement, manufacturing, packaging, transportation and end of life management. Firm's internal resources mediate the relationship to external forces and its adoption. It* *improves the organizational performance and is the source of competitive advantage to sustain in the turbulent business environment."*

2.4 Classification scheme for the literature on GSCM

Literature has been classified into two sections. In one section classification has been done based on theories applied in GSCM and in the next sub-section further literature has been classified based on building blocks of conceptual framework.

2.4.1 Theories applied to GSCM research

Currently there exists a gap in the GSCM literature in providing support to explain the existence and boundaries of GSCM. Only few authors (eg. Rosen et al., 2002; Maignan and McAlistar, 2003; Zhu and Sarkis, 2004; Rao and Halt, 2005; Vachon and Klassen, 2006; Zhu and Sarkis, 2007; Carter and Rogers, 2008; Delmas and Montiel, 2009; Sarkis et al., 2011; Zhu et al., 2012; Shi et al., 2012; Schrettle et al., 2014) have taken pain to provide theoretical foundations for different areas related to supply chain emphasizing on organizational theories. The theories include:

- Institutional Theory
- Resource Based View
- Complexity theory
- Transactional cost analysis

- Knowledge based view
- Strategic choice theory
- Systems theory
- Agency theory
- Network perspective
- Systems theory
- Ecological modernization theory
- Resource dependency theory
- Social network theory
- Information theory

Table 2.1: Summary of organizational theories applied to GSCM related study

Theory	***References***
Institutional Theory	Zhu et al., (2005); Tsoulfas and Pappis (2006); Sarkis et al., (2011); Singh et al., (2012); Zhu et al., (2013); Dubey and Bag., (2013)
Resource Based View	Rao and Holt., (2005); Zhu and Sarkis., (2006); Vachon and Klassen., (2007); Gold et al., (2010); Sarkis et al., (2010); Sarkis et al., (2011); Shi et al., (2012)
Complexity theory	Vachon and Klassen (2006); Choi and Krause (2006); Matos and Hall., (2007); Guide and Van Wassenhove (2009); Sarkis et al., (2011); Gunasekaran et al., (2014);

	Govindan et al., (2014)
Transactional cost economics	Rosen et al., (2002); Sheu et al., (2005); Yang et al., (2009); Delmus and Monteil, (2009); Chen et al., (2012); Barari et al., (2012); Chaabane et al., (2012); Caniels et al., (2013)
Knowledge based view	Sheu and Chen., (2012); Schrettle et al., (2014)
Strategic choice theory	Siaminwe et al., (2005); Stone (2006); Brown and Stone (2007); Berkel (2007); Deif (2011); Despeisse et al., (2012); Law and Gunasekaran, (2012); Singh et al., (2012); Dues et al., (2013); Hoof and Lyon (2013)
Systems theory	Holt and Ghobadian., (2009)
Agency theory	Bierma and Wterstraat., (1999); Vachon and Klassen (2006); Hsu and Hu (2009); Bai and Sarkis., (2010); Ku et al., (2010); Testa and Iraldo ., (2010); Hoof and Lyon., (2013)
Network perspective	Van Bommel., (2011)
Ecological modernization theory	Kassolis (2007); Zhu et al., (2010); Park et al., (2010); Sarkis et al., (2011)
Resource dependency theory	Zhu and Sarkis., (2004); Zhu et al., (2005); Carter and Rogers., (2008); Shang et al., (2010)
Social network theory	Maignan and McAlister., (2003); Seyfang., (2006); Mollenkopf et al., (2010); Wu et al., (2012)

Information theory	Jiang and Bansal., (2001); Erlandsson and Tillman., (2009); Sarkis et al., (2011)

The contributions of the various theories reflect the importance and attractiveness of the subject matter. There is hardly any study available which have integrated Institutional theory and resource based view of firm.

2.4.2 Critical Success Factors of GSCM

According to American Society for Quality "Critical success factors allow an organization to assess the success of a project, selection process, or other activities with stated goals…" Therefore it is clear that CSFs play a strategic role in successful implementation of any project. Here an effort has been made to identify GSCM critical success factors through literature review from reputable journals indexed in SCI/SSCI or Scopus. Based on systematic literature review a non-exhaustive list of CSFs as shown in the below table have been identified; which have been further classified into two broad categories. One set of CSFs have its base in operations management and other set have its base in human resource management. The first set is named as Operational dimensions and second set is named as Behavioral dimensions.

GSCM has evolved as a widely acceptable philosophy and practice for achievement of firm objectives. Here an attempt is taken to understand the key dimensions of GSCM which are important for successful implementation of GSCM.

- ***GSCM Operational Dimensions***

It refers to strategy, technology, policies adopted by firm to implement GSCM successfully. Literature proves that the GSCM operational dimensions influencing GSCM implementation. It includes Technology advancement and organization adoption, Government regulations, Green logistics, Green design, green procurement, Carbon dioxide emission, Quality management, Environmental, Social and Economic dimensions.

- ***GSCM Behavioral Dimensions***

Existing literature proves that GSCM behavioral dimensions influences GSCM implementation. It includes Environmental collaboration with suppliers, supplier relationship, Environmental image; Supplier management, Trust, Attitude and commitment, Quality, Flexibility, Waste Reduction, Clean Programs, Reducing carbon footprint, Cost of quality, Supplier flexibility, Satisfaction, Top management support, Work culture, Team work, Resistance to change, Green motivation, Green innovation, Innovative green practices, Awareness level of customers, Supplier Motivation, Organization encouragement, Quality of human resources, Organization learning.

Table 2.2: Critical success factors (CSFs) of GSCM

Key Dimensions	***CSFs***	***Author, (year)***
GSCM Operational Dimensions	Technology advancement and organization adoption, Facility technology level, Government regulations, Green logistics, Green design, green procurement, Carbon dioxide emission, Quality management, Environmental, Social and Economic dimensions.	Brandenburg et al., (2014); Reefke and Trocchi., (2013); Dubey and Bag., (2013); Suering, S., (2013); Gimenez et al., (2012); Luthra et al.(2012), Kumar and Chandrakar (2011); Dekker et al., (2012); Gunasekaran and Spalanzani (2012); Azevedo et al., (2011); Zhu and Sarkis., (2004); Lee et al., (2012)

GSCM Behavioral Dimensions	Environmental collaboration with suppliers, supplier relationship, Environmental image; Supplier management, Trust, Attitude and commitment, Quality, Flexibility, Waste Reduction, Clean Programs, Reducing carbon footprint, Customer Satisfaction, Innovativeness, Cost of quality, Supplier flexibility, Satisfaction, Top management support, Work culture, Team work, Resistance to change, Green motivation, Green innovation, Innovative green practices, Awareness level of customers, Supplier Motivation, Organization encouragement, Quality of human resources, Organization learning	Mirhedayatian et al., (2014); Muduli and Barve., (2013); Lee et al., (2012); Hassisni et al., (2012); Luthra et al.(2012); Kumar and Chandrakar (2012); Hoejmose et al., (2012); Ageron et al., (2012); Chaabane et al., (2012); Kang et al., (2012); Azevedo et al., (2011); Zhu et al., (2008); Seuring and Muller (2008); Vachon (2007); Zhu and Sarkis., (2004); Croom et al., (2000)

2.4.3. GSCM Practices

In this section effort has been taken to identify the four major activities along the supply chain network. It includes green design, green procurement, green manufacturing and green transportation.

- ***Green Design***

Green design is the first stage in greening the supply chain. Right at this stage the designs are finalized considering the environmental impact of the product from its birth to end of life. Green design involves innovation and out of the box thinking so as to develop the blue prints of the green product.

- ***Green Procurement***

The second stage i.e., green purchasing is considered an important stage in greening the supply chain. Green purchasing is defined as the purchasing of environmental friendly goods that has minimum effect on the environment. In many firms green purchasing accounts to 60% to 70% of the cost of goods sold. A purchaser always try his level best to develop a good vendor base who can support the GSCM adoption by un interrupted supply of eco-friendly material at the best price and consistent in quality parameter.

Supplier relationship management is key to the success of any green purchasing program. The firm has to tie a bond with their suppliers and motivate them to supply eco friendly and non hazardous raw material. Suppliers should be trained and educated to adopt ISO 14001. Firms which create pressure on their suppliers and review periodically to monitor progress are seen to adopt green practices successfully. Supplier collaboration results in developing eco-friendly products faster; rather only relying on the in-house R&D team. Good SRM practices create transparency and hence the costs involved in developing the eco-friendly raw material is visible and therefore chances of over spending are less. Motivating suppliers to maintain inventory at their works and issuing an open purchase order/contract so that the material is supplied in time to meet the production demand saves inventory carrying cost of firm.

(Dubey and Bag 2013) conducted a study and suggested that supplier relationship management (SRM) is a positive determinant of environmental performance outcome.

The drivers of green procurement are buying organization's environmental collaboration with suppliers which positively and significantly impact their adoption of green procurement and top management commitment also positively and significantly impacts environmental collaboration with suppliers (Yen and Yen, 2011).

(Min and Galle 1997) identified environmental factors that reshape supplier selection decisions. Selection of the right material will ensure that the input will minimize the harmful effect of the product on the environment during its life cycle.

Strategic sourcing is essential for firms practicing GSCM as multiple suppliers need to be identified for mitigating the supply risk and support GSCM program.

Wu et al., (2011) applied the fuzzy DEMATEL to GSCM performance in order to build up a cause and effect model for green supplier selection. Wu et al., proposed a framework which can be used as an analytical tool to improve the GSCM supplier selection.

- ***Green Manufacturing***

Green manufacturing is the next stage where a firm adopts green technology and best practices to ensure that the output meets the environmental standards and regulatory norms. Green technology involves usage of alternate energy and equipment by which the productivity increases with reduced solid waste generation/effluent and also reduces emission of greenhouse gases. Green manufacturing strategy is a complex area since it presents a multidimensional impact on performance. Even a simple decision to introduce clean machine requires a manager to consider the impact of the machine on environment throughout its life cycle and might need to reorganize the logistics part to take back end of life material for recycling.

Three key drivers for the adoption of green production initiatives: regulatory demands, market value creation and cost reduction programs, employees motivation, health and safety, environmental concerns and legislature, green image, global marketing and competitiveness, global climatic pressure and ecological benefits, social and environmental responsibility, government rules and regulations (eg., Baines et al., 2012; Singh et al., 2012).

Green manufacturing challenges are changes to production technologies, acceptance by customer base, buy-in of stakeholders across the operations of the manufacturer, lack of research and empirical studies, increment in overall cost or financial burden and lack of awareness in companies and lack of management commitment.

Companies are integrating various environmental policies and programs into their operations strategy and specific decisions concerning operations such as product design, process technology selection and quality management to succeed in the competitive market, (Gupta,M., 1995). Giovanni (2012) conducted a study to test causal relationships among internal and external environmental management and dimensions of triple bottom line.

The key drivers of GSCM are regulatory pressures and market pressures. In developed countries government has framed environmental policy and guidelines to provide environmental solution to the manufacturers. European Union has a policy (WEE) for disposing waste electrical and electronic equipment after the end of their life so as to reduce the harmful effects.

Cap and trade legislation for GHG emission is applicable for manufacturers across European Union, U.S and Australia. Aberdeen group survey reports that 50% of the companies are planning to redesign their entire supply chain in order to be more sustainable and 80% of them have to comply with new environmental policies. As a result companies face new challenges and need to adopt best technologies to meet their legal obligations.

Companies can earn carbon credits through one of the mechanism such as Emission trading system and carbon trading or contribution to climate change technology fund.

In an effort to reduce the green house gas emissions globally the carbon trading markets were first introduced under the Kyoto Protocol, known as the United Nations framework convention on climate change (UNFCCC).

Foreign customers demand environment friendly product and services from their suppliers globally including India. Foreign customers conduct strict environmental audit of their Indian suppliers before placing the first order as they demand environmental friendly goods, (Mitra, 2004). Green manufacturing can be used as an environmental tool to improve the environmental image with in the business arena and enhancing export sales. Suppliers and community stake holders also influence green manufacturing adoption.

To support the green manufacturing project; firm require tremendous support from the top management to highlight that the project is really important and will receive proper attention from the member of the organization. Lack of resources and financial support will lead to failure of the green manufacturing project. Firms having proper environmental policy are always ahead and the success rate of green manufacturing are high. Top management must motivate junior managers and ensure that every employee within the organization is aware of the environmental policy, Law and Gunasekaran, 2012, Zhu et al., 2005).

- ***Green Transportation and Reverse Logistics***

Green transportation is the stage where there is good scope to reduce the carbon emission. Uses of alternate fuels are generally practiced in developed countries. Selecting the right mode of transport can reduce significantly the cost and emission of green house gases in the environment. Chaabane et al, (2011), presented a comprehensive methodology to address sustainable supply chain design problems where carbon emissions and total logistics costs, including suppliers and sub-contractors selection, technology acquisition and the choice of transportation modes, are considered in the design phase. The proposed methodology provides decision makers with a multi-objective mixed-integer linear programming model to determine the trade-off between economic and environmental considerations. Case studies on reverse logistics have been developed by various researchers (Pohlen and Farris 1992; Stock 1998; Tibben and Limke 2002).

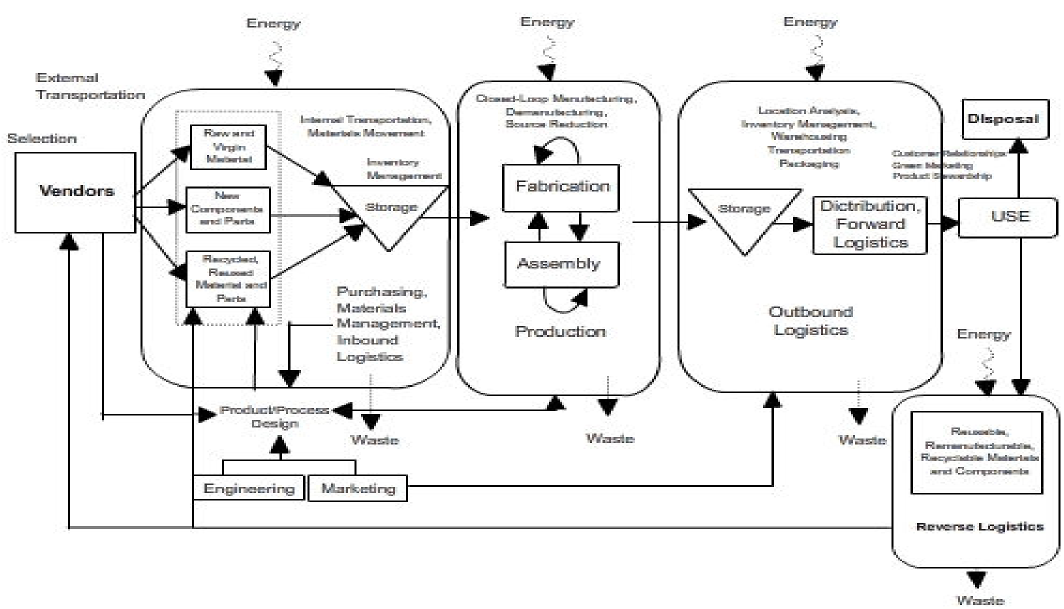
Table 2.3: GSCM Practices

GSCM Practices	***References***
Green Design	Van Hoek, (1999); Sarkis, (2003); Mabert and Venkataramanan., (1998); Zhu et al., (2006); Chien, M. K., & Shih, L. H. (2007); Zhu et al., (2007); Zhu et al., (2008); Hsu and Hu., (2008)
Green Procurement	Min and Galle., (1997); Carter et al., (2000); Zsidin and Siferd., (2001); Vachon., (2007); Zhu et al., (2008); Ambec and Lanoi., (2008); Bala et al., (2008); Salam (2008); Holt and Ghobadian., (2009); Paulraj., (2009); Tripathi and Petro., (2010); Bjorklund., (2011); Yen and Yen., (2011); Large and Thompson., (2011); Azevedo et al., (2011); Gavronski et al., (2011); Routroy and Pradhan., (2012); Dubey et al., (2013)
Green Manufacturing	Young et al., (1997); Azzone and Noci., (1998); Brown., (2008); Narula and Upadhyay., (2011); Blackhurst et al., (2012); Zailani et al., (2012); Daily et al., (2012); Wong et al., (2012); Choi et al., (2012); Digalwar et al., (2013); Nouira et al., (2014); Chen et al., (2014); Golini et al., (2014)

Green Transportation and Reverse Logistics	Lippman., (1999); Rao and Holt., (2005); Hu and Hsu., (2006); Zhu et al., (2007); Vachon (2007); Routroy., (2009); UNEP., (2011); Blackhurst et al., (2012); Blanco and Cottrill., (2013)

The table 2.3 provides deep insights in the area of green manufacturing. The above list concludes that in the last decade there are more than 80% contributions on GSCM. However most of the studies have focused on financial performance and environmental performance whereas social dimension lacks much attention.

Fig 2.2: GSCM Graph



(Source: Hervani et al. 2005)

2.4.4. Impact of GSCM on Firm Performance

The purpose of this section is to discuss the impact of GSCM practices on firm performance.

Performance measures are the reflection of the competitiveness of the firm (Short et al., 2007). The firm performance is measured from financial and non-financial perspective. From literature review, it is clearly evident that common financial measures used are return on assets (ROA), market share, Return on Investment (ROI), Operating Profit of Firm (EBIDTA), growth rates in domestic and export sales growth (Dubey,2011).

Similarly, the non-financial measures of performance include management's perception of productivity, profitability, and customer satisfaction relative to competitors. The possibility of using non-financial performance measures was suggested by Dess and Robinson (1984) if the accurate objective measures are unavailable. Subjective measures of performance have been used in several studies.

Several factors influence an organization's decision to adopt GSCM practices. Studies suggest that firms respond differently to internal and external challenges based on their internal resources. Organizational resources and capacities refer to overall level of resources and potential.

Like any management philosophy GSCM is also a subject of debate. The increasing popularity of GSCM has received many criticisms regarding its sustainability.

Organizations think that GSCM practices lead to increase in cost which may decrease profitability and is therefore a disadvantage for the firm. Major Indian manufacturing firms feel that there is lack of awareness of environmental issues which is a challenge and biggest perceived barrier to adopting GSCM is that it is not cost effective (Bhateja et al., 2011).

This has been proved wrong by recent studies on GSCM and reveals that firm can develop competitive advantage by adopting GSCM and can beat the competitors in the market. Various researchers have conducted studies to understand the impact of GSCM practices on organization performance such as (eg., Green Jr. et al., 2012a; Green Jr. et al., 2012b; Lee et al., 2012; Wu et al., 2012; Zailani et al., 2012; Hasan, M., 2013; Laosirihongthong, et al., 2013; Dubey et al., 2013; Mitra, S., and Dutta, P., 2014, Kumar et al., 2012.

The adoption of GSCM by manufacturing firms leads to enhanced environmental and economic performance which in turn positively impact operational performance which finally enhances firm performance (Green Jr et al., 2012 a).

GSCM practices lead to improvements in business performance (Dubey et al. 2013). Environmental collaboration and monitoring practices among supply chain partners are found to lead to improved environmental performance and organizational performance (Lee et al., 2012).

GSCM is the only path to achieve sustainability. In reality, there are three approaches to green supply chain i.e., environment, strategy, and logistics, (Gilbert, 2001). Linking to the definition by Srivastava (2007), it is seen that GSCM is embedded in the DNA of the product and thus all activities encompassing the life cycle of product get greened.

Chinese manufacturers have taken proactive measures in closing the supply chain loop by adopting GSCM practices. GSCM can be used as an environmental tool to improve the environmental image and gain competitiveness within the international business arena, (Zhu et al., 2008b). Greening any supply chain involves imbibing environmental principles in the design and operations of supply chain. A background of environmental principles for achieving eco efficiency and building of environmentally friendly organization system has been presented where emphasis is put on application of such principle in life cycle of product (Tsoulfas and Pappis., 2006).

It is very important for any practicing manager to understand the links between GCSM practices, environmental and economic performance for successful GSCM implementation. Environmental pressure act as a driver for successful GSCM practices. Market and regulatory pressures help organization to improve environmental pressures which are believed to influence eco design and green purchasing. Manufacturers facing higher regulatory pressure tend to implement green purchasing and investment recovery. Competitive pressure significantly improves the economic benefits from adoption of different GSCM practices (Zhu et al., 2007).

Computer parts' manufacturers in Thailand have adopted GSCM practices and Environmental Management Systems. GSCM pressures are environmental regulations and export Pressure (Seksan et al., 2010).

GSCM can be a source of competitive advantage for organizations through improvement in their environmental performance, Bacallan (2000). Green supply chain can produce a number of benefits, cost savings, reduced product life cycle costs, maximized efficiency, improved profitability (Kushwaha et.al., 2004; Singh et al., 2011; Bhateja et al., 2012).

According to the study by Lee et al., 2012 significant indirect relationship exists between GSCM practices implementation and business performance under the mediating effects of operational efficiency and relational efficiency.

An attempt has been made to classify the impact of GSCM practices on firm performance, in three broad categories which are the determinants of sustainability:

- Economic performance

- Environmental Performance
- Social Performance

The three performance dimensions and respective measures are presented in the table 2.4.

Table 2.4: GSCM performance measures

Performance Measures	***Items***	***References***
Economic perspective	Environmental cost	Hervani et al., (2005); Zhu et al., (2007);Chardine-Baumann., (2011)
	Supply chain cost	Olugu et al., (2011); Chardine (2011); Singh et al., (2011); Ageron et al., (2012)
	Cost of quality	Hervani et al., (2005); Azevedo et al., (2011); Chardine-Baumann., (2011); Ageron et al., (2012)
	Responsiveness cost	Gunasekaran et al., (2004); Azevedo et al., (2011); Ageron et al., (2012)

Environmental perspective	Environmental technology	Azevedo et al., (2011) and Deif., (2011)
	Recycling efficiency	Hervani et al., (2005); Deif., (2011)
	Eco packaging	Hervani et al., (2005); Zhu et al., (2008); Dues et al., (2011); Kim et al., (2011); Bhateja et al., (2011); Seman et al., (2012); Gangele et al., (2012); Whitelock (2012)
	Level of process management	Hervani et al., (2005); Zhu et al., (2008); Kim et al., (2011); Wang. et al., (2011); Bhateja et al., (2011); Seman et al., (2012); Gangele et al., (2012); Whitelock (2012)
	Management commitment	Hervani et al., (2005); Zhu et al., (2007); Azevedo et al., (2011)

Social perspective	Customer satisfaction	Ageron et al., (2012); Zhu et al., (2007); Markley and Davis., (2007); Pocampally et al., (2009); Gunasekaran and Spalanzani., (2012); Dues et al., (2013); Gavoronski et al., (2013)
	Employee development	Markley and Davis., (2007); Pocampally et al., (2009)

From the table 2.4 it can be included that the performance framework reflects the triple bottom line approach which is now being increasingly implemented by firms.

Table 2.5: Examples of GSCM practices

Companies	***Green Supply Chain Practices***
Wal-Mart	Focused on green packaging; Reduction in packaging costs and reduction in carbon dioxide emissions
Nestle	Eco friendly product packaging and focus on source reduction, re-use, recycling, and energy recovery
Heinken	Conservation of Natural resources and energy savings
Environmental Lubricants Mfg. Inc.	Technological up gradation to improve productivity and eco friendly manufacturing process
Bank of America	Eco-friendly operations and recycling program
General Electric's	Development of green products
Dupont	Green operations and lowering emissions of airborne carcinogens and greenhouse gases
Starbucks	Green operations, use of recycling paper cups and protecting environment
Coca-Cola	Focus on three environmental goals: water stewardship, sustainable packaging, and climate & energy protection.
Toyota	Development of hybrid vehicle. Saving natural resources
Honda	Developed fuel efficient cars
Dell	Recycling program
Hewlett Packard	Owning and operating "e-waste" recycling plants

It is clear that green supply chain has attracted attention of top global companies. GSCM practices are being used presently by these companies in some form or other. Companies are focusing mostly in reduction of natural resources, reuse of material and energy recovery program. This is really working like wonder and can potentially stop tons of green house gases in entering the atmosphere. Moreover, these companies are significantly saving costs across the supply chain. Ongoing, company-wide sustainability program has generated significant environmental and financial benefits. Commitment to reduce fuel and electricity use is a good approach to protect scare natural resources. Converting to eco friendly operations has resulted in increase in production tenfold while reducing manufacturing costs. This has also attracted more customers due to enhanced customer satisfaction.

Use of alternate source of energy such as solar panels, CNG is widely used by manufacturers. The step toward more sustainable operations has drastically lowered emissions of airborne carcinogens and greenhouse gases. Certain company has also gone a step ahead by appointing an ex-Greenpeace head as an advisor to the board. And true to its word, the company successfully reduced greenhouse gas emissions. Top companies has also partnered up with many environmental organizations, from Conservation International to the Earthwatch Institute, in efforts to do right for the communities it operates in. Wasteelimination is now in the corporate philosophy to make the operations more eco-friendly than ever.

LANXESS and China Petroleum and Chemical Industry Federation (CPCIF) joined hands to present the Green Rubber Day on December 2nd, 2013 at the China World Summit in Beijing. Among other topics, Green Rubber Day dealt with the subject of high-performance tires, also known as “green tyres”. The use of these tyres can help significantly to reduce rolling resistance, which is the friction that tires encounter when rolling. A tire’s rolling resistance is a major factor in a vehicle's fuel economy. Using a high-performance tire that has been produced with state-of-the-art rubber can decrease the fuel consumption of a car by as much as half a liter per 100 kilometers – and consequently reduce the emission of carbon dioxide by 1.2 kilograms.

2.4.5. Review of tools and techniques used in GSCM research

Several tools and techniques have been used in the past for conduction research in the area of SCM/GSCM which is listed below in table 2.6

Table 2.6: Quantitative tools and techniques applied in SCM/GSCM research

Tools and Techniques	***References***
Data Envelopment Analysis (DEA)	Mirhedayatian et al., 2014; Amirteimoori and Khosandam., 2011; Liu et al., 2000; Weber 1996

Equilibrium models	Suering, S., 2013; Dong and Zhang 2004
Multi Criteria Decision Making (MCDM)	Suering, S., 2013; Elanchezhian etal., 2010
Analytical Hierarchy Process (AHP)	Suering, S., 2013; Dryzmalski et al., 2010; Bhagwat and Sharma, 2007; Clan 2003
Simulation models	Longo and Mirabelli., 2008; Persson and Olhager., 2002
Interpretive Structural Modelling (ISM)	Hawthrone and Sage.,1975; Sage., 1977; Jedlica and Meyer., 1980; Saxena et al., 1992; Mandal and Desmukh., 1993; Kanungo et al., 1999; Ravi and Shankar., 2004; Jharkaria and Shankar., 2005; Ravi et al., 2005; Faisal et al., 2006; Thakkar et al., 2006; Singh and Kant., 2008;Subramanian et al., 2010; Diabat et al., 2012; Gorane and Kant., 2012; Khan and Haleem., 2013; Dubey et al., 2014

2.5. Decoding missing link in theories supporting GSCM practices

Natural Resource Based View-GSCM links: Firms utilize resources as inputs which are finally transformed into an output, i.e., finished products. Firms implementing GSCM practices results to creation of complex resources which are supposed to transform into enhanced environmental performance which further enhances the business performances of firm. The link between GSCM practices and RBV suggests that by adopting GSCM practices proactively, would lead to develop knowledge and management system that can improve the firm performance significantly. GSCM practices such as green purchasing, design for environment and green distribution will lead to improvement of firm performance.

Institutional theory's link to Natural Resource Based View –GSCM: Research based on institutional theory has shown that a firm's motivation to undertake GSCM practices is affected by pressures from regulators and the market (Arora and Cason, 1995). According to Scott (2008) institutional theory suggests that external forces motivate firms to undertake similar strategic actions. Under institutional theory, firms are not only profit seeking entities but also recognize the importance of achieving social legitimacy (Suchman, 1995). DiMaggio and Powell (1983) stressed the importance of coercive, normative and mimetic pressures and how these pressures lead to organizational homogeneity. Relating to decisions in adopting GSCM practices, previous research indicates that institutional pressures from regulators, market and competitors may play a particularly important role in encouraging firms to adopt similar GSCM practices.

With respect to the advancement of theory, GSCM has been explored on a more in-depth and theoretical level, by integrating NRBV and institutional theories, and addressing both internal and external perspectives of the firm.

2.6. Research Gaps

The review reveals various insights and gaps in the existing GSCM literature.

(1) Existing GSCM literature could not capture the key factors influencing GSCM practices specific to Indian rubber goods manufacturing sector.

(2) Existing GSCM literature is not capable enough to explain the underlying relationships among key factors influencing GSCM practices in Indian rubber goods manufacturing sector.

2.7. Problem Statement

Most developing countries are actively seeking various ways to achieve sustainability. Indian rubber goods manufacturing sector have not achieved popularity in GSCM practices because of not being aware of the associated enablers (Skukla et al., 2009). The present work addresses the problem which focuses on identification of key factors pertaining to successful GSCM practices in order to establish the relationship in terms of dependency and driving power of the indentified factors.

2.8 Research Objectives

Literature review has given a direction to identify the research gaps and to develop the below two specific research objectives for the present study are as follows:-

(1) To identify the key factors influencing GSCM practices in Indian rubber goods manufacturing sector.

(2) To develop a GSCM model for Indian rubber goods manufacturing sector.

2.9 Research Questions

(1) What are the key factors influencing GSCM practices in Indian rubber goods manufacturing sector?

(2) What is the GSCM model for Indian rubber goods manufacturing sector?

2.10 Concluding Remarks

The chapter on literature review presented various aspects of the study i.e. on historical evolution of GSCM, definitions of GSCM, review of theories applied to GSCM research, critical success factors of GSCM, GSCM practices and impact on firm performance from International and Indian perspective. GSCM issues and research gaps were identified through review. The next chapter covers Rubber goods manufacturing sector in India.

CHAPTER 3

INDIAN RUBBER INDUSTRY

3.1. Overview

The Indian rubber industry, which was practically non-existent and economically insignificant till independence, has developed beyond recognition over the past six decades, maintaining phenomenal growth. The industry consists of six sectors: Natural Rubber, Synthetic Rubber, Reclaim Rubber, Rubber article manufacturers, Rubber Machinery and Rubber Chemicals. The industry's current annual turnover is about Rs.250, 000 million (USD 5.5 billion). Among these, the most important are Natural Rubber producing sector and Rubber goods manufacturing sector.

The rubber products manufacturing sector can be broadly divided into three categories. The product making units are spread all over the country and they produce about 35,000 different items. The organized automobile tyre sector with 32 units accounting for about 45% of rubber consumption and 250 medium scale units accounting for 30% of rubber consumption. But the pillar of Indian rubber products manufacturing sector comprises more than 3500 small and micro scale units accounting for the balance 24% consumption. The distribution of registered rubber goods manufacturing firms across 28 wide ranges of industrial products groups showed that 7 industries, i.e., foot wear (17.90%), moulded products (13.5%), tread rubber (9.2%), foam products (6.6%), adhesives (5.20%), cycle parts (4.56%), tyre and tube (15.37%) accounted for more than 62% of the total manufacturing units. Kerala, Maharashtra, Punjab, West Bengal, Uttar Pradesh, Gujarat, Haryana and Karnataka are the states with highest rubber consumption in India.

The Indian rubber products manufacturing sector draws its strength and stability from the rapidly growing demand for the products in both domestic and overseas market. The exports are well over 85 countries including US, Russia, UK, Bangladesh, Afghanistan, Italy, Germany, France, Saudi Arabia, UAE, Canada and the African countries. The chemicals and the allied products export promotion council co-ordinates activities connected with the export of rubber products.

Rubber industry is growing at an accelerated rate globally beside the rise of automotive sector. The tyre industry consumes nearly $2/3^{rd}$ of rubber production and lead to heavy accumulation of scrap tyres annually.

The Government of India has acknowledged the automotive zone as a key area for civilizing India’s inclusive competitiveness and achieving elevated monetary expansion. The Auto policy for India was formulated amid apparition to establish internationally viable industry in India. The automotive industry is subjected to the regulation of emission of polluting GHG, waste disposal and environmental hazards.

Indian rubber industries have to employ stacks of severe norms to face future prospects. To maintain its position in the foreign market, Indian rubber industry need to apply good manufacturing practices at every phase of its operations to guarantee world class product. The different stages of its operations include mixing, extruding, moulding, curing etc.

Rubber product manufacturers need to estimate the necessities of technical parameters as well as the environmental linked rules prior to scheduling process engineering. The raw material should be as per the Raw Material Quality Plan and aligned amid recent product characteristics with environmental connected parameters such as ROHs, REACH etc.

Occupational Safety and Health Administration (OSHA) is also followed by the rubber product manufacturers.

Rubber product end users have issued stringent requirements with regard to the use of nitrosamines. In nitrosamine regulations, identification of nitrosamines, how they are formed and the latest techniques in compound preparation is essential to produce non nitrosamines generating compounds. These are the challenges for the rubber industry.

3.2. Supply Chain of Rubber Industry

The value chain of a rubber industry involves Producers, Collectors and Traders, Processors, Brokers, Manufacturers and Users:

- *Producers*: Producers are owners of the rubber land either in small holdings or estates of various sizes. On average small holders cultivate less than 2 ha blocks. Small holder producers tap the rubber trees themselves but frequently enlist non-family labor on a crop sharing basis. Producers frequently finance their consumption expenses through loan from collectors.
- *Collectors and Traders*: A number of levels of collectors and traders exist along the value chain. The main role of the collector is financing producers and other collectors down the chain and providing transport. At village level a collector may be a progressive farmer and may also be processing wet coagulate blocks or produce/sell planting material.
- *Processors*: Processors maintain semi contractual and open market relationships with collectors and farmer groups. Prices of raw material are determined based on contracts in hand, estimated dry rubber content of the material and dirt content.
- *Brokers*: Global rubber products manufacturers deal through brokers rather than directly with processors.

- *Manufacturers*: The rubber product manufacturing industry in India is basically divided into two major sectors: tyre and non tyre. Rubber products industry plays a core sector role in the Indian national economy. Indian rubber industry is well established and self-sufficient in all respects. Indian rubber industry has developed to a modern state in case of organized sector companies like tyre and some of the non-tyre units but the conditions with majority of small scale unit are far from satisfactory level. There are many renowned manufacturing units in the country such as MRF Tyre, Apollo Tyre, J.K. Tyre, Goodyear, TVS Tyre and CEAT. Northern India (Delhi, Haryana and Punjab) accounts for major rubber consumption and have maximum rubber products manufacturing unit. Other major states in the sector are Kerala, Tamil Nadu, Andhra Pradesh, Gujarat, Karnataka etc. A variety of rubber products are produced all over the country- auto and cycle tyre and tube, trade rubber, footwear. India is the world's largest manufacturer of reclaim rubber.

  Rubber product manufacturing is as diverse as the number of products manufactured. Even with the diversity, several basic common processes are described as Mixing, Milling, Extruding, Calendaring, Vulcanizing and Finishing.

The rubber product manufacturing process starts with the formation of the rubber mixture from natural rubber, synthetic rubber, carbon black, process oils and rubber chemicals. Rubber mixture changes depend upon the desired characteristics of the end products. Banbury mixture is a machine which is used to combine all the ingredients. The ingredients are weighed as per the formula and introduced into the banbury mixture hopper. Banbury Mixing results to a homogeneous mass of rubber compound which is discharged to a primary mixing mill which ultimately turns it into a long sheet. The hot tacky rubber is passed through water base “anti-tack” solution which prevents from sticking together. The rubber sheets are cooled through the application of cool air or by contact with cooling water.

After cooling the sheets of rubber compound are passed to another mill. These mills are used to warm up the rubber for further processing on extruders and calendars. Some extruders can be “cold fed” rubber sheets, making this secondary mixing mill operation unnecessary.

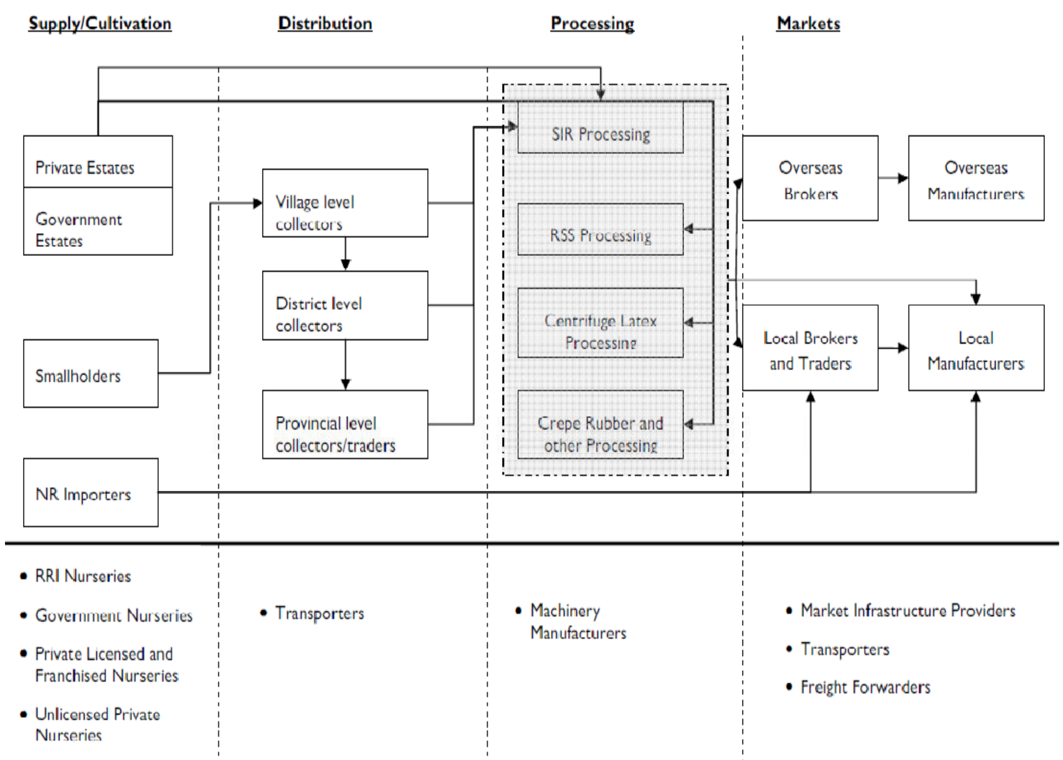
Extruders transform to the rubber compound into different shapes or profiles by forcing it through dies via a rotating screw. Extruding hits the rubber and it remains hot until it enters a water bath or spray conveyer by cooling takes place.

Calendars receive hot rubber sheets from mixing mills and squeeze them into reinforcing fibres, calendars are used to produce non-reinforced and thickness controlled sheets of rubber.

Extruders and calendars are combined with reinforcing materials to produce various rubber products.

All rubber products undergo vulcanisation. It is accomplished in heated compression moulds or steam heated pressure vessels (auto-claves). Finishing operations include trimming, grinding, printing, washing, wiping and buffing.

Fig 3.1: Rubber Industry supply chain



3.3. Water Consumption and Environmental regulations in Rubber Industry

3.3.1. Tyre and Tube Industry

Water consumption: The water usage in all possible areas of tyre and tube industry is listed as below:-

- Steam generation (Boiler)
- Non-contact cooling machinery
- Contact cooling of tread tyre
- Make-up water for anti-tack solution water based spray of green tyres
- Washing of floor machinery
- Toilets, canteen and gardening
- Waste water generation sources

The waste water is generated from the process areas includes water and steam leakages, overflows, runoff from oil storage areas, soap stone solution spillages and wash down and run off from process or storage areas. In the final operation of grinding and painting involved in tyre manufacturing process, relatively small grinding particles and run off due to over spraying of the paint may find their way to local drainage system.

In general waste water problem arising from compounding, extrusion, moulding and curing operations and tube manufacturing are very similar to that of the tyre manufacturing. Another component of waste water arises in tyre and tube industry from utility services such as

- Cooling waters
- Boiler break down
- Cooling tower
- Water treatment waste water
- Toilet and canteen

3.3.2. Moulded, extruded/calendar and fabricated products

The water usage in all possible areas of such industry is listed as below:-

- Steam generation
- Cooling water of machinery
- Contact cooling of rubber sheets and products
- Products washings
- Washings of floor and machinery
- Washing of moulds
- Make-up water for preparation of anti-tack solution, latex adhesives and rubber cement solution
- Water use in toilet and canteen

Table 3.1: Waste water Sources

Type of Industries	***Wastewater Sources***	***Contaminant***
Tyre and Tube industry	Cooling water bleed and Boiler Blow down; Floor wash down of different units (Batch wise) leakages and spills contaminating cooling water; Accidental over flow from anti-tack water tank; sanitary and other miscellaneous water; Hydraulic testing waste water leakage	Oil and grease, Rubber fines, Anti Tack agents etc.
Latex based products	Cooling water bleed and boiler Blow down; products wash water; Wash down from latex storage; compounding and transfer areas; Form wash and rinse waters; Accidental overflow water; Sanitary and other miscellaneous water ; Coagulation/coagulating Agent Tank Wash/ over flow.	Latex spills, surfactants, coagulants etc. Ball milling and washing containing chemicals including Zn Acid (Acetic/Formic) etc.
Reclaimed Rubber	Cooling water bleed and boiler blow down; Steam Condensate from auto clave; Area wash down of all processing areas; Sanitary and other miscellaneous water	Oil and grease, Soluble and insoluble organics, Rubber particles etc.

Table 3.2: Water consumption and effluent generation

Water consumption and waste water generation		
Types of Industry	***Water Consumption***	***Waste water generation***
Tyre and Tube Industry (Category)	9 to 15 liter/kg of raw material	2 to 5 liter/kg of raw material
Molded, extruded/calendared and fabricated Rubber Products	6 to 10 liter/kg of raw material	0.5 to 2 liter/kg of raw material
Latex based industries	14 to 15 liter/kg of raw material	10 to 30 liter/kg of raw material
Rubber Reclaiming Industry	1 to 2 liter/kg of raw product	0.2 to 0.4 liter/kg of product

Source: www.cpcb.nic.in

3.4 Concluding Remarks

In the present chapter Indian rubber goods manufacturing sector is discussed in detail to provide a clear picture about the industry. Supply Chain of rubber industry is also discussed to get a clear idea of the waste generation at different stages. The environmental regulations are presented for better understanding of Indian rubber goods manufacturing sector.

CHAPTER 4

RESEARCH METHODOLOGY

4.1. Overview

This section discusses on theoretical model development, the constructs, designing questionnaire, pretesting of the questionnaire, population size, sampling design and data collection technique applied.

The purpose of research methodology is to present the research design that will be used to conduct the empirical research for this study. The research design connects the broader assumptions of a study to its detailed methods of data collection, analysis, and interpretation. Research designs enable researchers to achieve the goal of answering research questions as validly, objectively, accurately, and economically as possible.

Research methodology is a way to systematically solve the research problem. It may be understood as a science of studying the way research is conducted scientifically. In it researcher define the various steps that are required in studying the research problem along with the logic behind them. It is necessary for the researcher to know not only the research methods/techniques but also the methodology. Researcher also needs to understand the assumptions underlying various techniques and need to know the criteria by which researcher can determine the appropriateness of the techniques and procedures for specific problems. The scope of research methodology is wider than that of research methods.

4.2. Research Design

A research design is the arrangement of conditions for collection and analysis for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure. In fact, the research design is the conceptual structure within which research is conducted and it certifies the blueprint for the collection, measurement and analysis of data.

Research Design can be splitted into:-

The sampling design

The Observational design

Statistical design

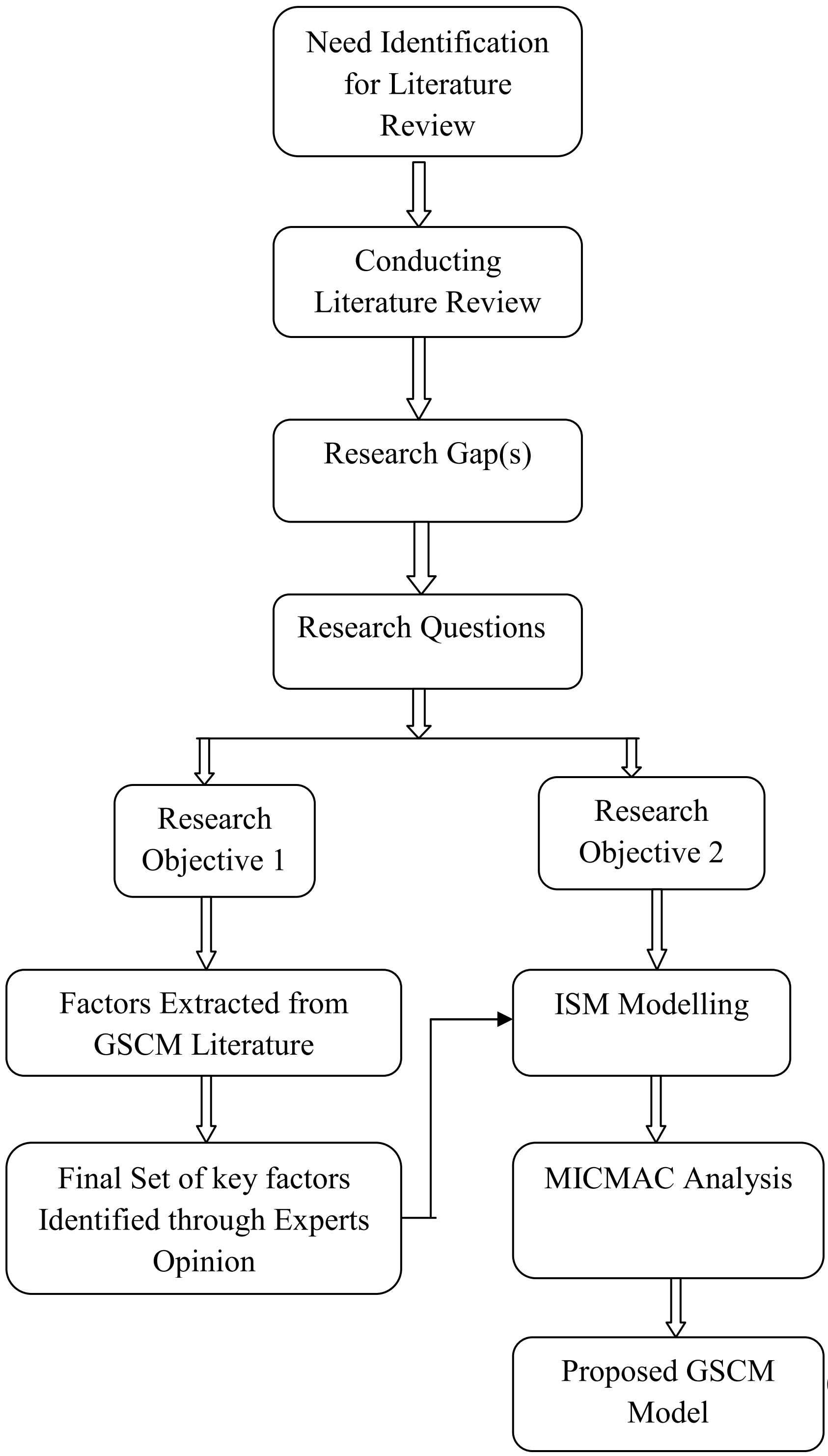
The operational design

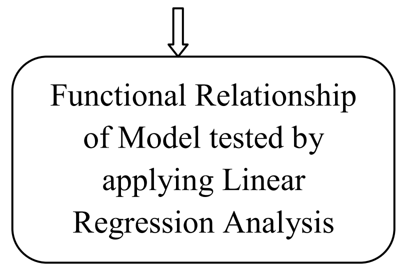
4.2.1. Research Process

Before moving to the details of research methodology and techniques applied, it seems appropriate to present a brief overview of the research process. Research process consists of series of actions or steps necessary to effectively carry out research and the desired sequencing of these steps. The flowchart in fig.4.1

illustrates the research steps.

Figure 4.1: Research Process Flow Chart





Phase I

- Based on the synthesis of literature review and experts opinion from rubber industry; the key factors influencing GSCM practices have been identified.

Phase II

- GSCM model has been developed by using ISM technique which was further refined using MICMAC analysis.
- The functional relationship of the proposed GSCM model was tested by applying Linear Regression analysis.

4.3. Identified Factors

Based on the synthesis of systematic literature review fifteen factors have been identified:-

1) Supplier Relationship Management (SRM)

2) Customer Relationship (CR)

3) Environmental and Social Responsibility (ESR)

4) Top Management Commitment (TM)

5) Cleaner Production (CP)

6) Regulatory Pressures (RP)

7) Market Pressures (MP)

8) Flexible Operations (FO)

9) Green Technology Adoption (GTA)

10) Total Quality Management (TQM)

11) Technology Innovativeness (TI)

12) Reduction in Carbon Emissions (RCE)

13) Return on Investment (ROI)

14) Market Share (MS)

15) Profitability (PR)

To seek experts opinion researcher employed telephonic interview with selected ten experts who are having more than twenty years of work experience in rubber goods manufacturing sector. Entire session lasted from average 10-20 minutes. Before starting the telephonic interview an ISM format (excel file format) was sent by email to the target respondents. Interview started with briefing the background of the research and finally asking them the importance/relevance of the fifteen factors in context of Indian rubber goods manufacturing sector.

The final shortlisted factors are as under:-

1) Supplier Relationship Management (SRM)

2) Customer Relationship (CR)

3) Top Management Commitment (TMC)

4) Regulatory Pressures (RP)

5) Market Pressures (MP)

6) Green Technology Adoption (GTA)

7) Total Quality Management (TQM)

8) Reduction in Carbon Emissions (RCE)

9) Market Share (MS)

10) Profit (PR)

Table 4.1: Final set of key factors with references are listed below

Key Factors	***References***
Supplier Relationship Management (SRM)	Sarkis, J., Zhu, Q., & Lai, K. H. (2011); Carter, C. R., & Rogers, D. S. (2008); Zhu, Q., Sarkis, J., & Lai, K. H. (2008); Vachon, S., & Klassen, R. D. (2008); Darnall, N., Jolley, G. J., & Handfield, R. (2008); Zhu, Q., Sarkis, J., Cordeiro, J. J., & Lai, K. H. (2008); Chien, M. K., & Shih, L. H. (2007); Vachon, S., & Klassen, R. D. (2006); Zhu, Q., & Sarkis, J. (2006); Rao, P., & Holt, D. (2005); Simpson, D. F., & Power, D. J. (2005); Helms, M. M., & Sarkis, J. (2005); Hervani, A. A., Zhu, Q., Sarkis, J., & Geng, Y. (2005); Barratt, M. (2004); Zhu, Q., & Sarkis, J. (2004); Sarkis, J. (2003);

	Stock, J. R., & Lambert, D. M. (2001); Croom, S., Romano, P., & Giannakis, M. (2000); Nagel, M. H. (2000); Beamon, B. M. (1999); Walton, S. V., Handfield, R. B., & Melnyk, S. A. (1998); Choi, T. Y., & Hartley, J. L. (1996);
Customer Relationship Management (CRM)	Zhu, Q., Sarkis, J., Cordeiro, J. J., & Lai, K. H. (2008); Seuring, S., & Müller, M. (2008); Zhu, Q., Sarkis, J., & Lai, K. H. (2008); Chien, M. K., & Shih, L. H. (2007); Zhu, Q., Sarkis, J., & Lai, K. H (2007); Darnall Vachon, S., & Klassen, R. D. (2006); Zhu, Q., & Sarkis, J. (2006); Zhu, Q., Sarkis, J., & Geng, Y. (2005); Hervani, A. A., Helms, M. M., & Sarkis, J. (2005); Zhu, Q., Sarkis, J., & Geng, Y. (2005); Zhu, Q., & Sarkis, J. (2004); Barratt, M. (2004); Zhu, Q., & Cote, R. P. (2004); Sarkis, J. (2003); Croom, S., Romano, P., & Giannakis, M. (2000); Van Hoek, R. I. (1999)
Top Management Commitment (TMC)	Diabat, A., & Govindan, K. (2011); Pagell, M., & Wu, Z. (2009); Hsu, C. W., & Hu, A. H. (2008); Zhu, Q., Sarkis, J., & Lai, K. H. (2008); Zhu, Q., Sarkis, J., Cordeiro, J. J., & Lai, K. H. (2008); Zhu, Q., & Sarkis, J. (2006); Hervani, A. A., Helms, M. M., & Sarkis, J. (2005); Handfield, R., Sroufe, R., & Walton, S. (2005); Zhu, Q., Sarkis, J., & Geng, Y. (2005); Zhu, Q., & Sarkis, J. (2004); Barratt, M. (2004); Lamming, R., & Hampson, J. (1996)
Regulatory Pressures (RP)	Diabat, A., & Govindan, K. (2011); Sarkis, J., Zhu, Q., & Lai, K. H. (2011); Lee, S. Y. (2008); Zhu, Q., Sarkis, J., Cordeiro, J. J., & Lai, K. H. (2008); Zhu, Q., Sarkis, J., & Lai, K. H. (2008); Walker, H., Di Sisto, L., & McBain, D. (2008); Darnall, N., Jolley, G. J., & Handfield, R. (2008); Zhu, Q., Sarkis, J., & Lai, K. H. (2007); Chien, M. K., & Shih, L. H.

	(2007); Zhu, Q., & Sarkis, J. (2007); Vachon, S., & Klassen, R. D. (2006); Zhu, Q., & Sarkis, J. (2006); Hervani, A. A., Helms, M. M., & Sarkis, J. (2005); Zhu, Q., Sarkis, J., & Geng, Y. (2005); Zhu, Q., & Sarkis, J. (2004); Zhu, Q., & Sarkis, J. (2004); Christmann, P., & Taylor, G. (2001); Hall, J. (2000)
Market Pressures (MP)	Sarkis, J., Zhu, Q., & Lai, K. H. (2011); Walker, H., Di Sisto, L., & McBain, D. (2008); Lee, S. Y. (2008); Zhu, Q., Sarkis, J., Cordeiro, J. J., & Lai, K. H. (2008); Srivastava, S. K. (2007); Zhu, Q., Sarkis, J., & Lai, K. H. (2007); Zhu, Q., & Sarkis, J. (2007); Zhu, Q., Sarkis, J., & Geng, Y. (2005); Hall, J. (2000); Beamon, B. M. (1999)
Green Technology Adoption (GTA)	Sarkis, J., Zhu, Q., & Lai, K. H. (2011); Darnall, N., Jolley, G. J., & Handfield, R. (2008); Vachon, S. (2007); Linton, J. D., Klassen, R., & Jayaraman, V. (2007); Rao, P., & Holt, D. (2005); Hervani, A. A., Helms, M. M., & Sarkis, J. (2005); Sarkis, J. (2003); Florida, R. (1996)
Total Quality Management (TQM)	Luthra, S., Kumar, V., Kumar, S., & Haleem, A. (2011); Pagell, M., & Wu, Z. (2009); Carter, C. R., & Rogers, D. S. (2008); Zhu, Q., Sarkis, J., Cordeiro, J. J., & Lai, K. H. (2008); Hsu, C. W., & Hu, A. H. (2008); Rao, P., & Holt, D. (2005); Lee, H. L., & Whang, S. (2005); Zhu, Q., & Sarkis, J. (2004); Rao, P. (2002); Gillen, D. (2001); Stock, J. R., & Lambert, D. M. (2001); Walton, S. V., Handfield, R. B., & Melnyk, S. A. (1998)
Reduction in Carbon Emissions (RCE)	Benjaafar, S., Li, Y., & Daskin, M. (2013); Hsu, C. W., Kuo, T. C., Chen, S. H., & Hu, A. H. (2013); Shi, V. G., Koh, S. L., Baldwin, J., & Cucchiella, F. (2012); Chaabane, A., Ramudhin, A., & Paquet, M.

	(2012); Wang, F., Lai, X., & Shi, N. (2011); Diabat, A., & Govindan, K. (2011); Lee, K. H. (2011); Sarkis, J., Zhu, Q., & Lai, K. H. (2011); Sundarakani, B., De Souza, R., Goh, M., Wagner, S. M., & Manikandan, S. (2010); Halldórsson, Á., & Kovács, G. (2010); Abdallah, T., Diabat, A., & Simchi-Levi, D. (2010); Diabat, A., & Simchi-Levi, D. (2009); Ramudhin, A., Chaabane, A., Kharoune, M., & Paquet, M. (2008); Walker, H., Di Sisto, L., & McBain, D. (2008); Carter, C. R., & Rogers, D. S. (2008); Matthews, H. S., Hendrickson, C. T., & Weber, C. L. (2008); Nagel, M. H. (2000)
Market Share (MS)	Testa, F., & Iraldo, F. (2010); Chen, Y. J., & Sheu, J. B. (2009); Zhu, Q., Sarkis, J., & Lai, K. H. (2008); Green Jr, K. W., Whitten, D., & Inman, R. A. (2008); Zhu, Q., & Sarkis, J. (2007); Chien, M. K., & Shih, L. H. (2007); Zhu, Q., Sarkis, J., & Geng, Y. (2005); Rao, P., & Holt, D. (2005); Zhu, Q., & Sarkis, J. (2004); Zhu, Q., & Cote, R. P. (2004); Rao, P. (2002); Roberts, S. (2003);
Profitability (PR)	Closs, D. J., Speier, C., & Meacham, N. (2011); Carter, C. R., & Rogers, D. S. (2008); Chien, M. K., & Shih, L. H. (2007); Zhu, Q., Sarkis, J., & Lai, K. H. (2007); Clemens, B. (2006); Rao, P., & Holt, D. (2005); Zhu, Q., Sarkis, J., & Geng, Y. (2005); Sheu, J. B., Chou, Y. H., & Hu, C. C. (2005); Savaskan, R. C., Bhattacharya, S., & Van Wassenhove, L. N. (2004); Guide, V. D. R., Harrison, T. P., & Van Wassenhove, L. N. (2003); Dowlatshahi, S. (2000); Carter, C. R., Kale, R., & Grimm, C. M. (2000);

4.4. Theoretical Framework

There is a confusion related to the underlying relationship existing among the research factors and; therefore researcher will develop a model for formulating the relationship based on the results of Interpretive Structural Modeling technique.

4.4.1. Interpretive Structural Model

ISM is a proven and popular methodology for understanding relationships among specific items that define a problem. ISM is useful to achieve the objective in presence of large number of directly and indirectly related elements and complex interactions among them which may or may not be expressed in a proper manner. ISM plays a vital role in this kind of situation and helps in understanding a structure within a system. The ISM model depicts the structure of a complex problem in a carefully designed pattern.

ISM has been used in the past by several researchers due to multiple benefits. It guides and records the results of group response on complex issues in an efficient and systematic manner, (Source: Attri et al., 2013; Warfield 1994; Warfield 1974). ISM has been applied in different areas of the supply chain starting from purchasing to production and logistics management. Sushil., (2012) have contributed in the ISM literature by providing directions to interpret the links in ISM using the tool of interpretive matrix.

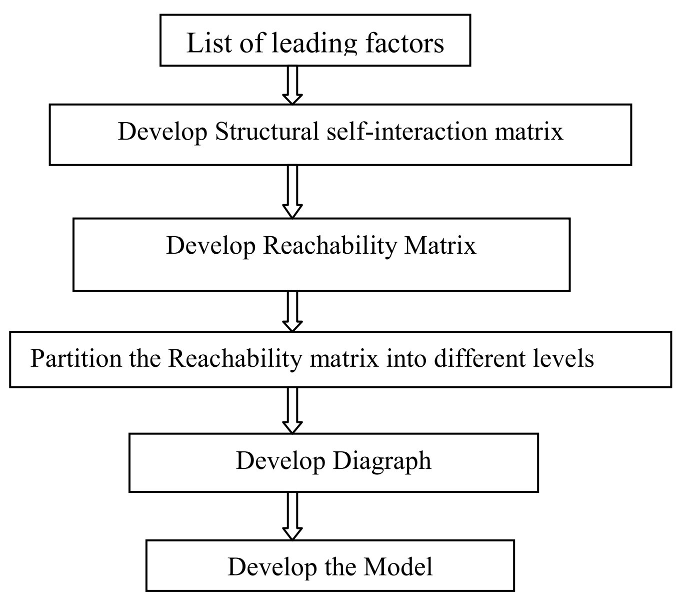
Table 4.2: Review on ISM application

Author and Year	***ISM Application***
Hawthrone and Sage.,(1975)	Higher education program planning
Sage., (1977)	Modeling complex situations
Jedlica and Meyer., (1980)	Exploring factors involved in a cross cultural context
Saxena et al., (1992)	Determining the hierarchy and class of elements in cement industry
Mandal and Desmukh., (1993)	Vendor selection
Kanungo et al., (1999)	Developing an IS effectiveness framework
Ravi and Shankar., (2004)	Explore reverse logistics barriers
Jharkaria and Shankar., (2005)	Enablers of IT implementation in SC
Ravi et al., (2005)	Indentify key reverse logistics variables
Faisal et al., (2006)	Modeling the enablers for supply chain risk mitigation
Thakkar et al., (2006)	Integrated approach with ISM and ANP to develop a balanced scorecard
Singh and Kant., (2008)	Knowledge Management
Subramanian et al., (2010)	Buyer Supplier relationship

Diabat et al., (2012)	Modeling various supply chain risks
Gorane and Kant., (2012)	Modeling supply chain management enablers
Khan and Haleem., (2013)	Technology Management enablers
Kumar et al., (2013)	Customer involvement in green supply chain
Dubey et al., (2013)	Antecedents of truck freight
Dubey et al., (2014)	Flexible Manufacturing Systems
Dubey et al., (2014)	Modeling Antecedents of Innovation

ISM steps are as follows:-

Fig 4.2: Flowchart for the ISM Methodology



4.4.2. List of leading factors

1) Supplier Relationship Management (SRM)

2) Customer Relationship Management (CRM)

3) Top Management Commitment (TMC)

4) Regulatory Pressures (RP)

5) Market Pressures (MP)

6) Green Technology Adoption (GTA)

7) Total Quality Management (TQM)

8) Reduction in Carbon Emissions (RC)

9) Increase in Market Share (MS)

10) Increase in Profitability (PR)

4.4.3. Developing the structural self interaction matrix (SSIM)

For developing SSIM, the below symbols have been used to denote the direction of relationships between factors (i and j):

V: i lead to j but j does not lead to i

A: i do not lead to j but j lead to i

X: i lead to j and j lead to i

O: i and j are unrelated to each other

Table 4.3: Structural self interaction matrix (SSIM)

	X	IX	VIII	VII	VI	V	IV	III	II	I
I	V	V	V	A	V	V	A	A	O	
II	V	V	V	A	V	V	O	A		
III	V	V	V	A	V	V	A			
IV	O	O	V	X	O	V				
V	O	V	V	A	A					
VI	V	V	V	A						
VII	O	O	V							
VIII	O	V								
IX	O									
X										

4.4.4. Develop Reachability Matrix

The SSIM has been converted into a binary matrix i.e., the rechability matrix (Table 6) by substituting V, A X and O by 1 and 0. The substitutions of ‘1’ and ‘0’ have been done as below:

I. If the (i, j) entry in the SSIM is V, then the (i.j) entry in the rechability matrix becomes ‘1’ and (j,i) entry becomes ‘0’

II. If the (i, j) entry in the SSIM is A, then the (i.j) entry in the rechability matrix becomes ‘0’ and (j,i) entry becomes ‘1’

III. If the (i, j) entry in the SSIM is X, then the (i.j) entry in the rechability matrix becomes ‘1’ and (j,i) entry also becomes ‘1’

IV. If the (i, j) entry in the SSIM is O, then the (i.j) entry in the rechability matrix becomes ‘0’ and (j,i) entry also becomes ‘0’

Table 4.4: Reachability Matrix

	I	II	III	IV	V	VI	VII	VIII	IX	X	Driving Power (Y)
I	1	0	0	0	1	1	0	1	1	1	6
II	0	1	0	0	1	1	0	1	1	1	6
III	1	1	1	0	1	1	0	1	1	1	8
IV	1	0	1	1	1	0	1	1	0	0	6
V	0	0	0	0	1	0	0	1	1	0	3
VI	0	0	0	0	1	1	0	1	1	1	5
VII	1	1	1	1	1	1	1	1	0	0	8
VIII	0	0	0	0	0	0	0	1	1	0	2
IX	0	0	0	0	0	0	0	0	1	0	1
X	0	0	0	0	0	0	0	0	0	1	1
Dependence Power (X)	4	3	3	2	7	5	2	8	7	5	

4.4.5. LEVEL PARTITIONING

Table 4.5: Level Partitioning (Iteration 1)

Variables	Reachability Set	Antecedent Set	Intersection Set	Level
1	1,5,6,8,9,10	1,3,4,7	1	
2	2,5,6,8,9,10	2,3,7	2	
3	1,2,3,5,6,8,9,10	3,4,7	3	
4	1,3,4,5,7,8	4,7	4,7	
5	5,8,9	1,2,3,4,5,6,7	5	
6	5,6,8,9,10	1,2,3,6,7	6	
7	1,2,3,4,5,6,7,8	4,7	4,7	
8	8,9	1,2,3,4,5,6,7,8	8	
9	9	9	9	*Level1*
10	10	10	10	*Level1*

Table 4.6: Level Partitioning (Iteration 2)

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

Table 4.7: Level Partitioning (Iteration 3)

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

Table 4.8: Level Partitioning (Iteration 4)

Variables	Reachability Set	Antecedent Set	Intersection Set	Level
1	1,6	1,3,4,7	1	
2	2,6	2,3,7	2	
3	1,2,3,6	3,4,7	3	
4	1,3,4,7	4,7	4,7	
6	6	1,2,3,6,7	6	*Level 4*
7	1,2,3,4,6,7	4,7	4,7	

Table 4.9: Level Partitioning (Iteration 5)

Variables	Reachability Set	Antecedent Set	Intersection Set	Level
1	1	1,3,4,7	1	*Level 5*
2	2	2,3,7	2	*Level 5*
3	1,2,3	3,4,7	3	
4	1,3,4,7	4,7	4,7	
7	1,2,3,4,7	4,7	4,7	

Table 4.10: Level Partitioning (Iteration 6)

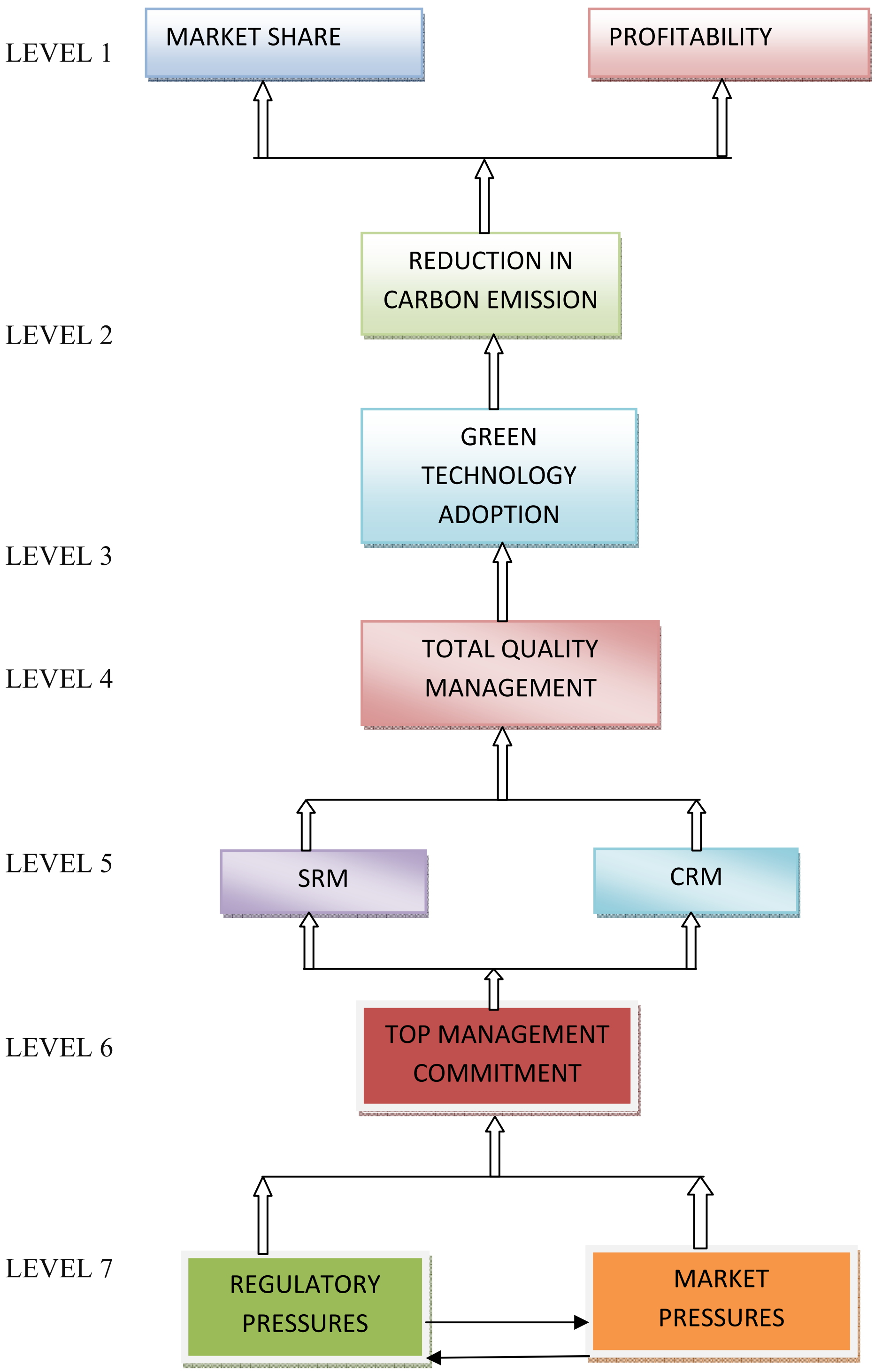
Variables	Reachability Set	Antecedent Set	Intersection Set	Level
3	3	3,4,7	3	*Level 6*
4	3,4,7	4,7	4,7	
7	3,4,7	4,7	4,7	

Table 4.11: Level Partitioning (Iteration 7)

Variables	Reachability Set	Antecedent Set	Intersection Set	Level
4	4,7	4,7	4,7	*Level 7*
7	4,7	4,7	4,7	*Level 7*

4.4.6. ISM MODEL

Figure 4.3: ISM Model



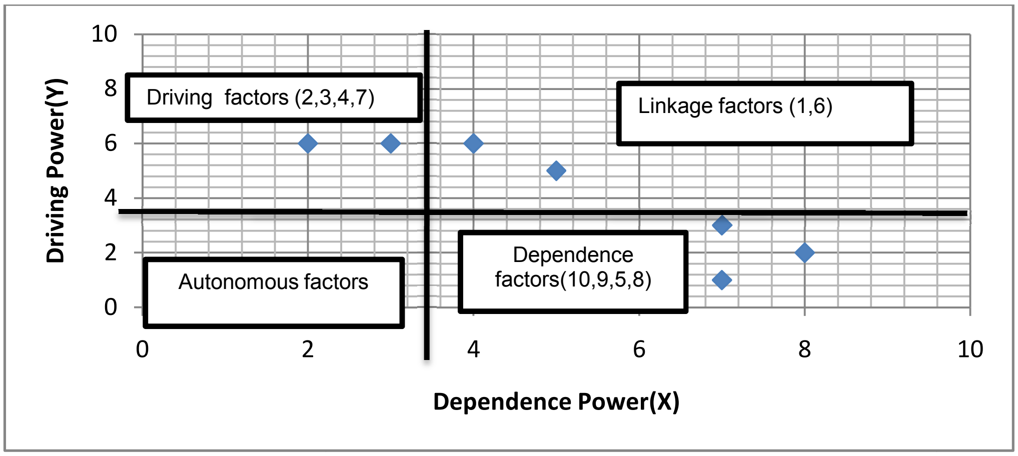
4.4.7. MICMAC ANALYSIS

MICMAC analysis "Matrice d' Impacts croises multiplication appliqué an classment" (cross-impact matrix multiplication applied to classification) is abbreviated as MICMAC. The objective of MICMAC analysis is to analyze the drive power and dependence power of factors. Based on the drive power and dependence power the factors have been classified into four factors: autonomous factors, linkage factors, dependent and independent factors.

Table 4.12: Position coordinates of identified factors

Factors	Dependence Power(X)	Driving Power(Y)
1	4	6
2	3	6
3	3	8
4	2	6
5	7	3
6	5	5
7	2	8
8	8	2
9	7	1
10	5	1

Fig 4.4: MICMAC graphical representation



Cluster 1: Autonomous factors

These factors have a weak drive power and weak dependence power. In this cluster we do not have any factor.

Cluster 2: Dependence factors

These factors have a weak drive power but strong dependence power. In this cluster we have three factors, i.e, 5 (Market Pressures), 8 (Reduction in Carbon Emissions), 9 (Market Share) and 10 (Profit).

Cluster 3: Linkage factors

These factors have a strong drive power as well as strong dependence power. In this cluster we have two factors, i.e., 1(Supplier Relationship Management) and 6 (Green Technology Adoption).

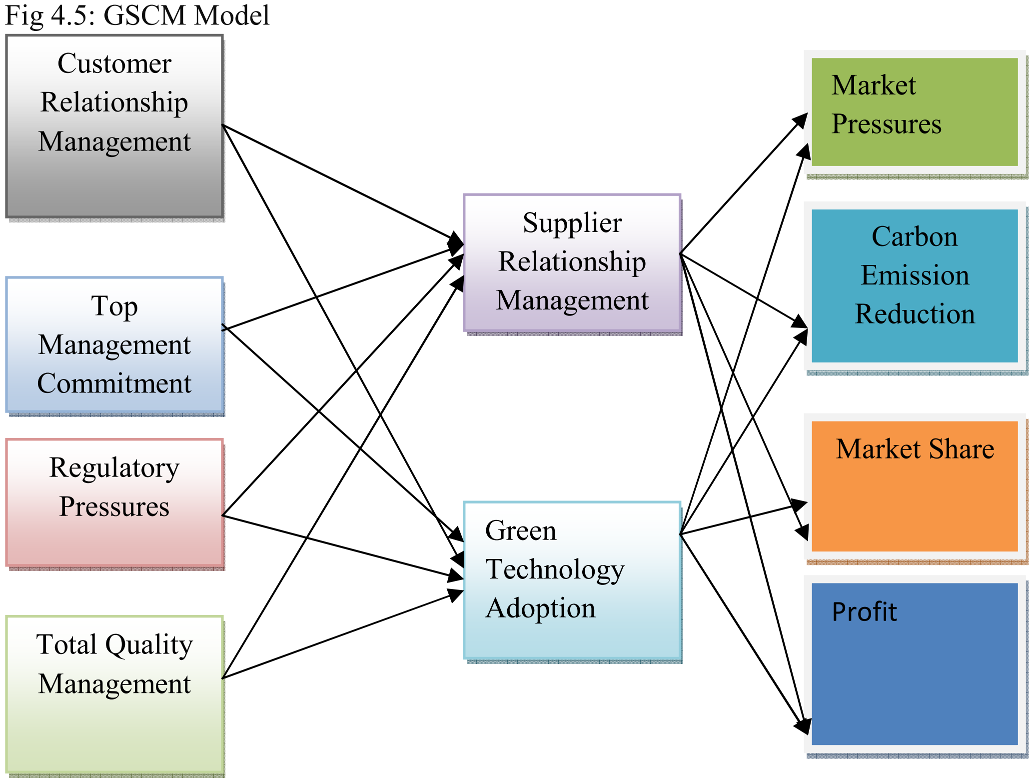
Cluster 4: Driving factors

These factors have a strong drive power but weak dependence power. In this cluster we have four factors, i.e., 2 (Customer Relationship Management), 3 (Top Management Commitment), 4 (Regulatory Pressures) and 7 (Total Quality Management).

Based on ISM and MICMAC analysis we propose the below model as shown in fig 4.5.

4.5. GSCM MODEL

Fig 4.5: GSCM Model



Hypothesis Formulation

In order to examine "GSCM" practices on performance of rubber goods manufacturing sector, researcher proposes fourteen research hypotheses as under:

H1: There is a positive relationship between Customer relationship management and Supplier relationship management

H2: There is a positive relationship between Customer relationship management and Green technology adoption

H3: There is a positive relationship between Top management commitment and Supplier relationship management

H4: There is a positive relationship between Top management commitment and Green technology adoption

H5: There is a positive relationship between Regulatory pressures and Supplier relationship management

H6: There is a positive relationship between Regulatory pressures and Green technology adoption

H7: There is a positive relationship between Total quality management and Supplier relationship management

H8: There is a positive relationship between Total quality management and Green technology adoption

H9: There is a positive relationship between Supplier relationship management and Market pressures

H10: There is a positive relationship between Supplier relationship management and Carbon emission reduction

H11: There is a positive relationship between Supplier relationship management and Market Share

H12: There is a positive relationship between Supplier relationship management and Profit

H13: There is a positive relationship between Green technology adoption and Market pressures

H14: There is a positive relationship between Green technology adoption and Carbon emission reduction

H15: There is a positive relationship between Green technology adoption and Market Share

H16: There is a positive relationship between Green technology adoption and Profit

4.5.2. Questionnaire Design

The items and scales for the survey questionnaire was adapted from the extant literature, as mentioned before, to suit the Indian context. Each response was measured on a 5-point Likert scale where "1" meant "strongly disagree" and "5" meant “strongly agree”. The questionnaire was pretested among twenty firms, and based on their feedback, the questionnaire was finalized. Subsequently, researcher approached in person and over telephone the senior executives looking after or knowledgeable about the supply chain management function of about 370 organizations located in the major industrial belts of India with a write-up on GSCM and the survey questionnaire asking the organizations whether they deployed some of the GSCM practices listed in the write-up and the questionnaire. In a way, this was akin to convenience sampling, which was felt appropriate for a developing country at this stage when the awareness of GSCM is still at a low level leading to difficulties in data collection, as also observed by Zhu and Sarkis (2004) in the case of China.

4.5.3 Instrument Reliability

Measurement Instrument Analysis

The success of any survey based research depends upon questionnaire design. Once the questionnaire is developed, it becomes necessary for checking the reliability of the instrument, to ensure that the data collected can further be used for analysis.

According to Hair (1995), reliability of a variable reflects the extent, to which a variable or a set of variables is consistent in what it is intended to measure. If multiple measurements are taken, reliable measures will be very consistent in their values.

Validity of the variable reflects the extent by which the differences in scores among objectives reflect the objects' true differences related to the construct that is sought to be measured (Hair *et. al.*, 1999). The reliability of a variable is a necessary, but not a sufficient condition for its validity. Validity can never be established unequivocally, but can only be inferred either by direct assessment or indirectly by assessing the reliability.

Reliability, applies to a measure when similar results are obtained overtime and across situations. Broadly defined, reliability is the degree to which measures are free from error and therefore yielding consistent results. Imperfection in the measuring process, that affect the assignment of scores or number, in different ways each time a measure is taken, such as a respondent who misunderstands a question, are the cause of low reliability (Hair *et. al.,* 1999).There are two dimensions that underline the concept of reliability. The first dimension is concerned with repeatability which requires the use of test-retest method, to administer the same scale or measure to the same respondents at two separate times in order to test for stability (Hair *et. al.,* 1999). The second dimension of reliability is concerned with the homogeneity of the measure. To measure the internal consistency of a multiple-item measure, scores on subsets of the items within the scale are correlated (Hair *et. al.,* 1999). Wiklund (1999) also points out that the reliability of a measure is established by testing for both stability and consistency. Consistency indicates how well the items measuring a concept hang together as a set and Chronbach's Alpha is a reliability coefficient, indicating how well the items in a set are positively correlated to one another. Chronbach's Alpha is computed in terms of the average inter-correlations among the items measuring the concept. The closer Chronbach's Alpha is to 1, the higher the internal consistency or reliability (Green and Mulaik, 1977; Hair *et. al.,* 1999).According to Hair et al. (1999), no single item is a perfect measure of a concept. Researchers must rely on a series of diagnostic measures to assess the internal consistency. First, there are several measures relating to each separate item, including the item-to-total correlation (the correlation among items). Rules of thumb suggest that the item-to-total correlations exceed 0.5 and that the inter-item correlations exceed 0.3. For the second type of diagnostic measure, the generally agreed upon lower limit for Chronbach's Alpha is 0.7, although may decrease to 0.6 in exploratory research (Hair et. al., 1999; Nunnally, 1978).In order to assess the reliability of the measures in this study, item-to-total correlations and Chronbach's Alpha were employed. The criteria for retaining a scale item includes an item-to-total correlation of at least 0.35 (Nunnally, 1978) and a Chronbach's Alpha for the scale of at least 0.7. The Chronbach's Alpha is calculated for GSCM dimensions and firm performance constructs as, shown in Table 4.13 below:

Table 4.13: Reliability Test

SL NO	SCALE	ITEMS	FACTOR LOADINGS
1	Top Management Commitment Chronbach's Alpha: 0.947	Well defined environmental policy of Company	0.927
2		Employee awareness about the firm's environmental policy	0.904
3		Top management support to environmental programs	0.848
4		Top management approval to special funds for investment in cleaner technologies	0.879
5		Positive attitude of senior managers towards green practices	0.845
6		Senior managers motivate and support new ideas received from junior executives	0.861
7		Employees recognition for innovative ideas	0.868
8	Regulatory Pressures Chronbach's Alpha: 0.885	Regional pollution control board pressures to adopt green practices	0.905
9		Government regulations to control pollution level	0.83
10		Strict monitoring by Pollution control board	0.887
11		Green practices decrease incidence of penalty fee charged by pollution control board	0.83
12	Market Pressures Chronbach's Alpha: 0.773	Company focus on Export sales	0.928
13		Foreign customers sensitivity towards green practices	0.928
14	Supplier Relationship Management	Environmental criteria for supplier selection	0.904
15		Environment collaboration with suppliers	0.952

16	Chronbach's Alpha: 0.960	Technological integration with suppliers	0.897
17		Training and educating suppliers in implementing ISO 14001	0.947
18		Environmental audit for suppliers	0.948
19	Total Quality Management	Total Quality Management implementation	0.905
20	Chronbach's Alpha: 0.715	Green practices promote product quality	0.905
21	Green Technology Adoption Chronbach's Alpha: 0.926	Company focus on green design of products	0.92
22		Wastage reduction from green design	0.881
23		Real time information available any point of time by using Information technology infrastructure SAP/ERP	0.907
24		Usage of alternate source of energy	0.874
25		Process optimization to reduce wastage	0.563
26		Eco friendly packaging	0.868
27		Reduction of emission of Green House Gases by use of clean technology	0.864
28	Profit Chronbach's Alpha: 0.982	Green practices improve firm's profit	0.73
29	Market Share Chronbach's Alpha: 0.981	Green practices improve firm's market share	0.87
30	Reduction in Carbon emission Chronbach's Alpha: 0.881	Green practices Reduce solid waste generation	0.88
31		Effluent meets CPCB norms by converting into green operations	0.823
32		Green practices reduce environmental accidents & hazards	0.875

33		Green practices decrease of cost of raw materials	0.541
34		Green practices reduce the inventory levels	0.858
35		Green practices reduce cost for energy consumption	0.798
36	Customer Relationship Management Chronbach's Alpha: 0.787	Green practices improve customer satisfaction	0.821
37		Firm recover end of life products from customers	0.837
38		Customers appreciate eco friendly products	0.869

Table 4.13 indicates that the reliability and factor loadings of items are high and suitable for study.

4.5.4. Instrument Validity

The questionnaire constructed has to be checked, whether it is valid or not (Nullay, 1967). Validity means the measurement must be unbiased and free from systematic errors. Two forms of validity mentioned in research literature are internal validity and external validity.

Internal Validity refers the extent to which differences found with a measuring tool reflect true differences among those being tested. The widely accepted classification of validity consisted of three major forms: content, criterion related and construct.

Content validity is the extent to which the instrument provides adequate coverage of the topic under study. Content validity has been defined as the representativeness of the content of a measuring instrument contains a representative sample of the universe of the subject matter of interest, then content validity is good.

In the present study the instrument were classified into ten categories. The pilot study was conducted at initial stage to seek the inputs from twenty experts who are having work experience for over twenty five years from the rubber goods manufacturing sector and professional members of Indian Rubber Institute, All India Rubber Association and CILT.

The validation of the questionnaire proved the validity of the instrument used in the research.

Responses were collected after the questionnaire was administered to the industry experts. Their confirmation to the understanding of the questionnaire helped in establishing the face validity of the instrument.

No cross loadings among the variables were found in the factor loadings which prove discriminant validity.

4.5.5. Pretesting

Before questionnaire is finalized for survey, it was pretested with twenty experts from the rubber goods manufacturing sector who are having work experience for over twenty five years and professional members of Indian Rubber Institute, All India Rubber Association and CILT. Based on the pretesting the questionnaire was changed and finalized for the final survey. In response to experts comment, seven items were dropped to avoid any puzzlement among survey respondents.

4.5.6. Sampling Design

Several qualitative factors should be taken into consideration when determining the sample size. These include the importance of the decision, the nature of research, the number of variables, the nature of analysis, sample sizes used in similar studies, incidence rates, completion rates and response constraints.

There are 6000 licensed rubber goods manufacturing firms in India however researcher have aimed at 370 firms who are practicing green supply chain practices based on initial information provided by All India Rubber Association (AIRA). Target respondents are senior level executives of each firm having more than ten years of work experience and from the area of supply chain. Targeted recipients were instructed to complete the survey themselves or refer it to an appropriate person for the same. Here convenience sampling technique was employed to collect the data.

After four months of follow ups with targeted firms we received 174 usable filled up questionnaires, which represent (47%) response rate.

Table 4.14: Distribution of Responded Firms

Nature of Enterprise	*No. of Targeted Firms*	*No. of Responded Firms*	*Response Rate (%)*
Large Scale	50	44	88
Medium Scale	100	60	60
MSME	220	70	31.8
	370	174	47

4.5.7. Concluding Remarks

The research strategies adopted in this study are presented in this chapter on Research Methodology. The detailed processes and the methods of conducting the questionnaire survey, structured interviews were described. The subsequent chapter covers data analysis and interpretations.

CHAPTER 5

DATA ANALYSIS AND INTERPRETATIONS

5.1. Overview

This chapter presents the analysis of the data, collected for the study and the findings related to it. After coding the data, all necessary assumptions of parametric test are checked and then multivariate data analysis is conducted. It is analyzed by using statistical software package SPSS 19.0.

5.2 Linear Regression Modeling and Hypothesis Testing

In statistics, linear regression is an approach to modeling the relationship between a scalar variable *y or dependent variable or endogenous variable* and one or more explanatory variables or independent variables or exogenous variables denoted with *X*. The case of one explanatory variable is called *simple regression*. Given a data set $\{y_i, x_{i1}, \ldots, x_{ip}\}_{i=1}^{n}$ of *n* statistical units, a linear regression model assumes that the relationship between the dependent variable y_i and the *p*-vector of regressors x_i is linear. This relationship is modeled through a so-called "disturbance term" ε_i — an unobserved random variable that adds noise to the linear relationship between the dependent variable and regressors. Thus the model takes the form

$$Y=\alpha + \beta 1X1+\beta 2X2+\beta 3X3+\beta 4X4+\beta 5X5 \ldots..+Error$$

Where ′ denotes the transpose, so that $x_i'\beta$ is the inner product between vectors x_i and β.

Often these *n* equations are stacked together and written in vector form as

$$Y=\beta X + €,$$

The basic assumptions of the use of regression are:

1. All predictor and outcome variables must be quantitative i.e. to be measured at the interval level.
2. Ratio of cases to independent variables: In order to empirically test a model the minimum sample size is (50+8K), where k is the no. of predictors (Field,2005).In our research there are 25 predictors and sample size is 275 which satisfy the assumption.
3. Variables should be free from multicollinearity. High multicollinearity increases the complexity due to interrelationships of variables. It is to be checked in regression analysis itself. *The consequences of a high degree of multicollinearity are:*
    - The standard errors of the affected coefficients tend to be large because of multicollinearity. In that case, the test of the hypothesis, that the coefficient is equal to zero leads to a failure to reject the null hypothesis.

However, if a simple linear regression of the dependent variable on this explanatory variable is estimated, the coefficient will be found to be significant; specifically, the analyst will reject the hypothesis that the coefficient is zero. In the presence of multicollinearity, an analyst might falsely conclude that there is no linear relationship between an independent and a dependent variable.

- A principal risk of such data redundancy is that of over fitting in regression analysis models. The best regression models are those in which the predictor variables each correlate highly with the dependent (outcome) variable, but correlate at most only minimally with each other.

  Such a model is often called "low noise" and will be statistically robust (that is, it will predict reliably across numerous samples of variable sets drawn from the same statistical population).

- Multicollinearity does not actually bias results; it just produces large standard errors, in the related independent variables.

  Here as we know tolerance, is defined as, Tolerance= (1- R^2), where as R^2 is termed as coefficient of determination, where as VIF (Variance Inflation Factor) = (1/Tolerance) so here (VIF) * (Tolerance) = 1. In case if the value of Tolerance is high, then the value of VIF will be lower .This is desirable for predictors to be "Orthogonal" or simply speaking regression model in the present case is free from "multicollinearity".

Other parameters reported in regression analysis are:

- t -statistic: The "t" statistic is computed by dividing the estimated value of the parameter by its standard error. This statistic is a measure of the likelihood that the actual value of the parameter is not zero. The larger the absolute value of t, the less likely that the actual value of the parameter could be zero.
- Proportion of Variance Explained (R^2): The "Proportion of variance explained (R^2)" indicates how much better the function predicts the dependent variable than just using the mean value of the dependent variable. This is also known as the "coefficient of multiple determinations." It is computed as follows: Suppose that an equation is not fitted to the data and ignored all information about the independent variables in each observation. Then, the best prediction for the dependent variable value for any observation would be the mean value of the dependent variable over all observations. The "variance" is the sum of the squared differences between the mean value and the value of the dependent variable for each observation. Now, if fitted function is used to

predict the value of the dependent variable, rather than using the mean value, a second kind of variance can be computed, by taking the sum of the squared difference between the value of the dependent variable, predicted by the function and the actual value. Hopefully, the variance computed by using the values predicted, by the function is better (i.e., a smaller value) than the variance computed using the mean value. The "Proportion of variance explained" is computed as 1 – (variance using predicted value / variance using mean). If the function perfectly predicts the observed data, the value of this statistic will be 1.00 (100%). If the function does no better a job of predicting the dependent variable than using the mean, the value will be 0.00.

- Adjusted Coefficient of Multiple Determination: The "adjusted coefficient of multiple determination (Ra^2)" is an R^2 statistic adjusted for the number of parameters in the equation and the number of data observations. It is a more conservative estimate of the percent of variance explained, especially when the sample size is small compared to the number of parameters.
- Durbin-Watson Statistic: The "Durbin-Watson test for autocorrelation" is a statistic that indicates the likelihood that the deviation (error) values for the regression have a first-order auto regression component. The

regression models assume that the error deviations are uncorrelated. It is desired that value of Durbin-Watson should lie between 1.5 to 2.5 (Hair, 1998; Field, 2005).

- Significance level: In statistics, a result is called "statistically significant" if it is unlikely to have occurred by chance. The phrase test of significance was coined by Fisher (1925). Researchers urge that tests of significance should always be accompanied by effect-size statistics, which approximate the size and thus the practical importance of the difference. The amount of evidence required to accept that an event is unlikely to have arisen by chance is known as the significance level or critical p-value: in traditional Fisherian statistical hypothesis testing, the p-value is the probability of observing data at least as extreme as that observed, given that the null hypothesis is true. If the obtained p-value is small, then it can be said either the null hypothesis is false or an unusual event has occurred. The lower the significance level, the stronger the evidence required. Choosing level of significance is a somewhat arbitrary task, but for many applications, a level of 5% is chosen. In the present research the significant level has been taken at 5%.

5.3. Findings and Results

Model 1: There is a positive relationship between Customer relationship management and Supplier relationship management

Table 5.1

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H1	0.838	0.702	0.70	0.838	20.113	0.000	1

In table 5.1, the positive beta value suggests that CRM variable moves in the direction of SRM variable.

The value of R= 0.838 indicates the degree of association between CRM and that predicted by the model. The value of R^2= 0.702, indicates that the fitted model explain 70% of the total variance, which is very strong in context to social science (Field, 2005).

The VIF value of regression output as shown in Table 5.1, is less than 5 which shows that regression output is relatively free from multicollinearity effect.

Table: 5.2

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	137.540	1	137.540	404.545	.000[a]
	Residual	58.478	172	.340		
	Total	196.018	173			

a. Predictors: (Constant), CRM

b. Dependent Variable: SRM

Table 5.2 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 1 is statistically significant.

F_{cr} (1,172) = 3.84 and F_{cal}= 404.545

The F calculated value is greater than the F critical value. Therefore null hypothesis is rejected and the research (alternate) hypothesis is not rejected.

Model 2: There is a positive relationship between Customer relationship management and Green technology adoption

Table 5.3

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H2	0.903	0.815	0.814	0.903	27.506	0.000	1

In table 5.3, the positive beta value suggests that CRM variable moves in the direction of GTA variable.

The value of R= 0.903 indicates the degree of association between CRM and that predicted by the model. The value of R^2= 0.815, indicates that the fitted model explain 81.5% of the total variance, which is very strong in context to social science (Field, 2005).

Table 5.4

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	112.156	1	112.156	756.592	.000[a]
	Residual	25.497	172	.148		
	Total	137.653	173			

a. Predictors: (Constant), CRM

b. Dependent Variable: GTA

Table 5.4 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 2 is statistically significant.

Fcr (1,172) = 3.84 and Fcal= 756.592

The F calculated value is greater than the Fcr. Therefore the research hypothesis is not rejected.

Model 3: There is a positive relationship between Top management commitment and Supplier relationship management

Table 5.5

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H3	0.829	0.687	0.685	0.829	19.438	0.000	1

In table 5.5, the positive beta value suggests that TMC variable moves in the direction of SRM variable.

The value of R= 0.829 indicates the degree of association between TMC and that predicted by the model. The value of R^2= 0.687, indicates that the fitted model explain 68.7% of the total variance, which is very strong in context to social science (Field, 2005).

Table 5.6

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	134.701	1	134.701	377.851	.000[a]
	Residual	61.317	172	.356		
	Total	196.018	173			

a. Predictors: (Constant), TMC

b. Dependent Variable: SRM

Table 5.6 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 3 is statistically significant.

Fcr (1,172) = 3.84 and Fcal= 377.851

The F statistics value is greater than the Fcr. Therefore the research hypothesis is not rejected.

Model 4: There is a positive relationship between Top management commitment and Green technology adoption

Table 5.7

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H4	0.904	0.817	0.816	0.904	27.744	0.000	1

In table 5.7, the positive beta value suggests that TMC variable moves in the direction of GTA variable.

The value of R= 0.904 indicates the degree of association between TMC and that predicted by the model. The value of R^2= 0.817, indicates that the fitted model explain 81.7% of the total variance, which is very strong in context to social science (Field, 2005).

Table 5.8

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	112.511	1	112.511	769.724	.000[a]
	Residual	25.141	172	.146		
	Total	137.653	173			

a. Predictors: (Constant), TMC

b. Dependent Variable: GTA

Table 5.8 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 4 is statistically significant.

Fcr (1,172) = 3.84 and Fcal = 769.724

The F statistics value is greater than the Fcr. Therefore the research hypothesis is not rejected.

Model 5: There is a positive relationship between Regulatory pressures and Supplier relationship management

Table 5.9

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H5	0.731	0.534	0.531	0.731	14.031	0.000	1

In table 5.9, the positive beta value suggests that RP variable moves in the direction of SRM variable.

The value of R= 0.731 indicates the degree of association between TMC and that predicted by the model. The value of R^2= 0.53, indicates that the fitted model explain 53% of the total variance.

Table 5.10

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	104.618	1	104.618	196.874	.000[a]
	Residual	91.400	172	.531		
	Total	196.018	173			

a. Predictors: (Constant), RP

b. Dependent Variable: SRM

Table 5.10 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 5 is statistically significant.

Fcr (1,172) = 3.84 and Fcal = 196.874

The F statistics value is greater than the Fcr. Therefore the research hypothesis is not rejected.

Model 6: There is a positive relationship between Regulatory pressures and Green technology adoption

Table 5.11

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H6	0.753	0.566	0.564	0.753	14.987	0.000	1

In table 5.11, the positive beta value suggests that RP variable moves in the direction of GTA variable.

The value of R= 0.753 indicates the degree of association between RP and that predicted by the model. The value of R^2= 0.56, indicates that the fitted model explain 56% of the total variance.

Table 5.12

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	77.958	1	77.958	224.622	.000[a]
	Residual	59.695	172	.347		
	Total	137.653	173			

a. Predictors: (Constant), RP

b. Dependent Variable: GTA

Table 5.12 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 6 is statistically significant.

Fcr (1,172) = 3.84 and Fcal= 224.622

The F statistics value is greater than the Fcr. Therefore the research hypothesis is not rejected.

Model 7: There is a positive relationship between Total quality management and Supplier relationship management

Table 5.13

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H7	0.813	0.66	0.659	0.813	18.292	0.000	1

In table 5.13, the positive beta value suggests that TQM variable moves in the direction of SRM variable.

The value of R= 0.813 indicates the degree of association between TQM and that predicted by the model. The value of R^2= 0.66, indicates that the fitted model explain 66% of the total variance.

Table 5.14

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	129.466	1	129.466	334.594	.000[a]
	Residual	66.553	172	.387		
	Total	196.018	173			

a. Predictors: (Constant), TQM

b. Dependent Variable: SRM

Table 5.14 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 7 is statistically significant.

Fcr (1,172) = 3.84 and Fcal = 334.594

The F statistics value is greater than the Fcr. Therefore the research hypothesis is not rejected.

Model 8: There is a positive relationship between Total quality management and Green technology adoption

Table 5.15

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H8	0.91	0.829	0.828	0.910	28.856	0.000	1

In table 5.15, the positive beta value suggests that TQM variable moves in the direction of GTA variable.

The value of R= 0.91 indicates the degree of association between TQM and that predicted by the model. The value of R^2= 0.829, indicates that the fitted model explain 82% of the total variance, which is very strong in context to social science (Field, 2005).

Table 5.16

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	114.086	1	114.086	832.642	.000[a]
	Residual	23.567	172	.137		
	Total	137.653	173			

a. Predictors: (Constant), TQM

b. Dependent Variable: GTA

Table 5.16 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 8 is statistically significant.

Fcr (1,172) = 3.84 and Fcal= 832.642

The F statistics value is greater than the Fcr. Therefore the research hypothesis is not rejected.

Model 9: There is a positive relationship between Supplier relationship management and Market pressures

Table 5.17

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H9	0.756	0.571	0.569	0.756	15.142	0.000	1

In table 5.17, the positive beta value suggests that SRM variable moves in the direction of MP variable.

The value of R= 0.756 indicates the degree of association between SRM and that predicted by the model. The value of R^2= 0.57, indicates that the fitted model explain 57% of the total variance.

Table 5.18

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	108.107	1	108.107	229.295	.000[a]
	Residual	81.094	172	.471		
	Total	189.201	173			

a. Predictors: (Constant), SRM

b. Dependent Variable: MP

Table 5.18 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 9 is statistically significant.

Fcr (1,172) = 3.84 and Fcal = 229.295

The F statistics value is greater than the Fcr. Therefore the research hypothesis is not rejected.

Model 10: There is a positive relationship between Supplier relationship management and Carbon emission reduction

Table 5.19

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H10	0.764	0.583	0.581	0.764	15.52	0.000	1

In table 5.19, the positive beta value suggests that SRM variable moves in the direction of RCE variable.

The value of R= 0.76 indicates the degree of association between SRM and that predicted by the model. The value of R^2= 0.58, indicates that the fitted model explain 58% of the total variance.

Table 5.20

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	45.237	1	45.237	240.872	.000[a]
	Residual	32.303	172	.188		
	Total	77.540	173			

a. Predictors: (Constant), SRM

b. Dependent Variable: RCE

Table 5.20 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 10 is statistically significant.

$F_{cr}(1,172) = 3.84$ and $F_{cal} = 240.872$

The F statistics value is greater than the Fcr. Therefore the research hypothesis is not rejected.

Model 11: There is a positive relationship between Supplier relationship management and Market Share

Table 5.21

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H11	0.736	0.541	0.539	0.736	14.25	0.000	1

In table 5.21, the positive beta value suggests that SRM variable moves in the direction of MS variable.

The value of R= 0.73 indicates the degree of association between SRM and that predicted by the model. The value of R^2= 0.54, indicates that the fitted model explain 54% of the total variance.

Table 5.22

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	69.934	1	69.934	203.056	.000[a]
	Residual	59.238	172	.344		
	Total	129.172	173			

a. Predictors: (Constant), SRM

b. Dependent Variable: MS

Table 5.22 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 11 is statistically significant.

The F statistics value is greater than the Fcr. Therefore the research hypothesis is not rejected.

Model 12: There is a positive relationship between Supplier relationship management and Profit

Table 5.23

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H12	0.642	0.412	0.408	0.642	10.97	0.000	1

In table 5.23, the positive beta value suggests that SRM variable moves in the direction of Profit variable.

The value of R= 0.64 indicates the degree of association between TQM and that predicted by the model. The value of R^2= 0.41, indicates that the fitted model explain 41% of the total variance.

Table 5.24

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	45.433	1	45.433	120.333	.000[a]
	Residual	64.940	172	.378		
	Total	110.374	173			

a. Predictors: (Constant), SRM

b. Dependent Variable: PROFIT

Table 5.24 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 12 is statistically significant.

Fcr (1,172) = 3.84 and Fcal = 120.333

The F statistics value is greater than the Fcr. Therefore the research hypothesis is not rejected.

Model 13: There is a positive relationship between Green technology adoption and Market pressures

Table 5.25

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H13	0.884	0.781	0.78	0.884	24.772	0.000	1

In table 5.25, the positive beta value suggests that GTA variable moves in the direction of MP variable.

The value of R= 0.88 indicates the degree of association between GTA and that predicted by the model. The value of R^2= 0.78, indicates that the fitted model explain 78% of the total variance, which is very strong in context to social science (Field, 2005).

Table 5.26

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	147.780	1	147.780	613.645	.000[a]
	Residual	41.422	172	.241		
	Total	189.201	173			

a. Predictors: (Constant), GTA

b. Dependent Variable: MP

Table 5.26 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 13 is statistically significant.

Fcr (1,172) = 3.84 and Fcal = 613.645

The F statistics value is greater than the Fcr. Therefore the hypothesis is not rejected.

Model 14: There is a positive relationship between Green technology adoption and Carbon emission reduction

Table 5.27

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H14	0.849	0.721	0.72	0.849	21.102	0.000	1

In table 5.27, the positive beta value suggests that GTA variable moves in the direction of RCE variable.

The value of R= 0.84 indicates the degree of association between TQM and that predicted by the model. The value of R^2= 0.72, indicates that the fitted model explain 72% of the total variance, which is very strong in context to social science (Field, 2005).

Table 5.28

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	55.935	1	55.935	445.311	.000[a]
	Residual	21.605	172	.126		
	Total	77.540	173			

a. Predictors: (Constant), GTA

b. Dependent Variable: RCE

Table 5.28 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 14 is statistically significant.

Fcr (1,172) = 3.84 and Fcal = 445.311

The F statistics value is greater than the Fcr. Therefore the research hypothesis is not rejected.

Model 15: There is a positive relationship between Green technology adoption and Market Share

Table 5.29

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H15	0.809	0.654	0.652	0.809	18.036	0.000	1

In table 5.29, the positive beta value suggests that GTA variable moves in the direction of MS variable.

The value of R= 0.80 indicates the degree of association between GTA and that predicted by the model. The value of R^2= 0.65, indicates that the fitted model explain 65% of the total variance.

Table 5.30

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	84.495	1	84.495	325.295	.000[a]
	Residual	44.677	172	.260		
	Total	129.172	173			

a. Predictors: (Constant), GTA

b. Dependent Variable: MS

Table 5.30 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 15 is statistically significant.

Fcr (1,172) = 3.84 and Fcal = 325.295

The F statistics value is greater than the Fcr. Therefore the research hypothesis is not rejected.

Model 16: There is a positive relationship between Green technology adoption and Profit

Table 5.31

Hypothesis	R	R Square	Adjusted R Square	Beta Coefficient	t Statistics	Statistical significance	VIF statistics
H16	0.68	0.462	0.459	0.680	12.158	0.000	1

In table 5.31, the positive beta value suggests that GTA variable moves in the direction of Profit variable.

The value of R= 0.68 indicates the degree of association between GTA and that predicted by the model. The value of R^2= 0.46, indicates that the fitted model explain 46% of the total variance.

Table 5.32

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	51.012	1	51.012	147.808	.000[a]
	Residual	59.361	172	.345		
	Total	110.374	173			

a. Predictors: (Constant), GTA

b. Dependent Variable: PROFIT

Table 5.32 indicates that the proposed regression model is statistically significant at 0.000 hence the proposed Model 16 is statistically significant.

F_{cr} (1,172) = 3.84 and F_{cal} = 147.808

The F statistics value is greater than the Fcr. Therefore the research hypothesis is not rejected.

5.4. Concluding Remarks

This chapter discussed the results, based on the responses gathered with the help of questionnaire. First of all data set was prepared with the help of SPSS.

Multivariate tools were used for hypotheses testing particularly simple linear regression analysis were performed. It is done to test the proposed GSCM framework empirically. While testing the hypotheses, none of the research hypotheses are rejected. These findings provide deep insights into the Indian rubber goods manufacturing sector. The subsequent chapter presents the conclusions, recommendations, limitations and contributions.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction

This chapter presents conclusion and recommendations drawn from the study. Conclusions are drawn on the basis of literature review and reference available in the area, as well as statistical analysis conducted. The GSCM model concluded from hypotheses testing is also presented in this chapter. Observations and insight of the researcher is duly incorporated in this chapter. Subsequently recommendations based on the same are listed below. At the end, limitations, unique contributions of the study, and further directions of the research are given.

6.2. Conclusions

Rubber goods manufacturing sector is of national important for the growth of Indian economy. Rubber board of India is putting emphasis in enhancing export sales volume and showing interest in environmental practices. Literature reflects that without focusing on GSCM practices it is impossible to develop competitiveness in the global market. Therefore greening the supply chain of rubber goods manufacturing sector has been identified as a central approach for enhancing the operational performance and thereby the business performance. Ten key factors influencing successful GSCM implementation in rubber goods manufacturing sector have been identified from the literature. These factors have been validated through experts' opinion. Experts constituted from the rubber industry and also academicians from the rubber technology program.

ISM methodology has been used in finding contextual relationships among the ten factors. A green supply chain management model is developed from ISM methodology.

MICMAC analysis has also been carried out. The driving power and dependence power figure assist to categorize different factors for successful green supply chain practices in the rubber goods manufacturing sector. Four factors have been identified as dependent factors and three factors as dependent factors. Two factors have been identified as linkage factors and no factors as autonomous factors.

The driving factors will play an important role in successful green supply chain management practices whereas dependent factors characterize desired objectives for achieving success in green supply chain management practices.

Customer Relationship Management, Top Management Commitment, Regulatory Pressures and Total Quality Management are the key drivers of GSCM practices in Indian rubber goods manufacturing sector.

The dependence factors are Market Pressures, Reduction in Carbon Emissions, Market Share and Profit.

Linkage factors are very sensitive and unstable that any action on the factors will trigger an effect on other factors and also a feedback on themselves. Supplier relationship management and Green technology adoption are the linkage factors identified in present study. One interesting observation from the study is the role of supplier relationship management in influencing GSCM practices in Indian rubber goods manufacturing sector. In today's business practice it is important to build good relationship with suppliers and should look upon them as a business partner. The depth of relationship management may vary between industries and the relationship model must fit with the industry practicing GSCM. Executives must understand the importance of buyer-supplier relationship. SRM not only enhances productivity but also improves overall performance of firm practicing GSCM. Firms must be careful while evaluating its potential vendors. The process might be time taking but the suppliers must be nurtured for a definite period of time before considering as a regular supplier. GSCM practices seek a win-win situation between the buyer and supplier. Trust must be backbone of such a relationship where any issues can be resolved transparently to avoid any impact on relationship. Findings suggest that SRM is the pillar to strengthen the GSCM implementation for a sustainable development in rubber industry.

Present study provides a systematic approach in developing a structural GSCM model pertaining to Indian rubber goods manufacturing sector. Further this study provided hierarchy of factors which will help supply chain managers in decision making towards building a clean system in the supply chain with reduced environmental impact.

GSCM has emerged as an important new archetype for enhancing rubber goods manufacturing sector reputation and achieve sales volume and market share objectives by lowering their environmental risks and impacts and while raising their ecological efficiency.

The GSCM model developed in the present work is based upon experts' opinion which may be biased. It may raise a question to the results of GSCM model analysis which may vary in real world setting. To eradicate the limitation the model is specifically developed for rubber goods manufacturing sector where factors have been refined through experts' opinion. Hypothesis testing has been carried out to test the validity of the hypothetical model. All criteria have been checked to prove that the proposed GSCM model is statistically valid.

6.3. Recommendations

- ***There is no Single Formula for Greening***

  Every organization must chart its own greening course. Green practices, the subject of green supply chain management, and even the central objective can vary a lot from organization to organization. Organizations have different opportunities for greening, vary in resources, institutional pressures and different leaders available, each with their own innovative ideas, who do green practices distinctively. The greening strategies are unique in details across organizations. It is seen that organizations progress with green practices through standardized measurement and data capturing protocols. Reducing carbon emissions requires a sustained and focused effort. Organizations must form a cross functional team and proceed with the action plan for implementing GSCM in a holistic way. It takes long to adopt GSCM practices and therefore organizations must monitor progress on a periodic basis to understand the progress. In summary the differences in structure, size, availability of resources and market opportunities exists across organizations, which means the details of green practices are diverse.

- ***Strong Leadership and Commitment of Top Management***

  Greening success is driven by dynamic leaders. In large sized organizations greening is driven by these leaders in a more professional manner than smaller sized organizations. Top management should prepare GSCM policy and create awareness among all employees.

- ***Greening the Supply Chain Network***

  Green organizations drive greening among their supply chain partners in the entire network. Greening organizations alter product design with emphasis on green design and waste disposal protocol to facilitate reuse and recycle in order to close the supply chain loop; this is simply to reduce environmental impact during the stages of product life cycle., i.e. from birth to the end of its useful life.

- ***Systematically Green necessitates an Organization to be Competent at SRM***

  Organizations that aspire to be green must emphasis on supplier relationship management. Suppliers should be provided training and education so as to implement EMS and ISO 14001. Care should be taken to ensure suppliers follow the policy strictly. Organizations that are high on SRM have a strong sense of discipline, and focus on value creation.

- ***Greening can become Fully Embedded in an Organization's DNA sequence***

  Greening must be embedded within the organization system so that it flows normally through the arteries and produce desired results. Organizations with strong Information Technology (SAP/ERP) setup help to develop it more systematically. Proper MIS is generated which gives 360 degree view of the organization in terms of producing the correct production related wastage report, energy savings, and activity based costing report etc. Managers and decision makers must understand the links of the GSCM model clearly before adopting implementing the system. This leads to the development of green culture and set of behaviors, until ultimately, holistic approach is expected as a part of each activity.

- ***Environmental Friendly State of Mind***

  It is indeed the way of greening organizations. In addition to performing the daily functions in workplace, these green organizations involve all employees having a second activity in mind, which is finding innovative methods to eco-friendly practices. This is not disconnected from the routine work, but must be integrated to all aspects of daily activity. Problems must be solved jointly with out of the box thinking approach.

- ***Green is Not Free. It requires Investment in Training and Development***

  Organizations aspire to be green must be prepared to take risks, and a tolerance for efforts that fetches failure. Since at the initial stage it involves financial risks therefore proper training of human resources is required so as to develop a culture that undertake risks. Further investment in clean technologies and best practices is necessary which will fetch long term benefits. Focus on maximizing energy efficiency potential by replacing obsolete, inefficient equipments and adopting best available technologies is vital for organizations who aspire to develop competitive edge in the market.

- ***Greening helps Organizations to Attract and Retain Talents***

  Talented human resources at all levels are attracted to progressive organizations since these organizations do world class practices. Hence green practices support reputational advantages and help in enhancing the brand image. Greening is associated with high employee motivation, low employee turnover and ultimately, labour market success.

- ***Green Firms Attract Customers***

  Customers are always curious about interesting organizational practices which benefit society and environment. If there is a new creative solution to a problem, that creates net positive value for customers, then certainly it will be attractive to customers. Customers will expect low risks involved in the organizational offerings and hence organizations should invite their foreign/domestic customers to show the GSCM practices so as to develop mutual trust. GSCM practices will lead to increase in market share by attracting more customers.

- ***Green Organizations helps to increase Profitability***

  Green practices improve quality and lower wastages which results in significant savings and improved profitability. Green firms switch to low carbon energy sources to reduce carbon emissions. This reduces the market and government pressures. The enhanced brand image of the organization helps to increase in sales volume with lower input costs. Hence GSCM is the path to achieve sustainability for those aspiring to become world class organizations in the future.

6.4. Limitations

Every management research has its own limitations; the present study also suffers from certain limitations. ISM methodology has its own limitation because it is purely based on human response. To eradicate the limitations, the present research can be extended using Total Interpretive Structural Modeling which can further nullify the limitation of ISM methodology.

6.5. Contributions

There are three important components of 'Unique Contributions' i.e., What, How and Why. (Whetten, 1989)., In the present study effort was given to answer the three vital questions in terms of factors which have been identified from the synthesis of literature and refined based on experts opinion specific to rubber goods manufacturing sector. Contextual relationships has been developed using ISM approach and further refined using MICMAC analysis. The GSCM model is unique as no such model exists for the rubber goods manufacturing sector. Definitely the sector will be able to improve their performance after adopting the model.

6.6. Future Directions for Research

To eradicate the limitations of present research it is proposed to validate the model empirically in other sectors by using Exploratory factor analysis and further test using multiple regression analysis using SEM packages such as AMOS/LISREL. The ISM methodology can be extended using Total Interpretive Structural Modeling which can further nullify the limitation of ISM methodology. Also further research can be carried out to test the impact of SRM on GSCM practices under the mediating effect of institutional pressures.

6.7. Concluding Remarks

It has been observed that the study was able to provide insights into key factors of GSCM and contextual relationships, it also provides an immense scope to the Indian rubber goods manufacturing sector to maximize the benefits from GSCM practices. A number of important recommendations have been made out of the present study. These recommendations would benefit the practitioners and policy makers in taking the right steps. The chapter ends with limitations of the study and finally contribution of the study.

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Annexure-1

Questionnaire

Survey on GSCM Practices in Rubber Goods Manufacturing Sector

General

Name ……………………………………………………………….……………………..

Designation……………………………………………………………………………..

Experience (in years)…………………………………………………………. ……

Name of the Organization……………………………………………………………….

Address………………………………………………………………………………….

Telephone………………………………………………………………………………..

E-mail…………………………………………………………...………………….

Product…………………………………………………………………………………..

Company Turnover………………………………………………………………………

No.	Statements	Please rate the following statements on a scale of 1 to 5				
		1= strongly agree	**2= agree**	**3= neutral**	**4= disagree**	**5= strongly disagree**
A.	Top Management Commitment					
1	Firm have a well defined environmental policy					
2	Every employee aware about the firm's environmental policy					
3	Top management support environmental programs					
4	Top management generally approve special funds for investment in cleaner technologies					
5	Senior managers show positive attitude towards green practices					
6	Senior managers motivate and support new ideas received from junior executives					

7	Employees recognized for innovative ideas and awarded on a periodic basis					
B.	Regulatory Pressures					
8	Regional pollution control board pressurize the firm to adopt green practices					
9	Government regulations provide clear guidelines in controlling pollution level					
10	Pollution control board strictly monitors the pollution level of firm on a periodic basis					
11	Green practices decrease incidence of penalty fee charged by pollution control board					
C.	Market Pressures					
12	Maximum sales of the company are export oriented					
13	Foreign customers more sensitive towards green practices					
D.	Supplier Relationship Management					
14	Environmental criteria considered while selecting suppliers					
15	Firm consider environment collaboration with suppliers					
16	Firm have technological integration with suppliers					
17	Firm train and educate suppliers in implementing ISO 14001					
18	Environmental audit for suppliers done periodically					
E.	Total Quality Management					
19	Firm have successfully implemented Total Quality Management					
20	Green practices promote products quality					
F.	Green Technology Adoption					
21	Company focusing on green design of products					
22	Green design reduce wastage					
23	Real time information available any point of time by using					

	Information technology infrastructure SAP/ERP					
24	Firm focus on using alternate source of energy					
25	Firm have optimized process to reduce wastage					
26	Eco friendly materials are used for packaging					
27	Reduced emission of green house gases in the environment by use of clean technology					
G.	Profit					
28	Green practices improve firm's profit					
H.	Market Share					
29	Green practices improve firm's market share					
I.	Reduction in Carbon emission					
30	Reduction of solid waste generation					
31	Effluent meets CPCB norms by converting into green operations					
32	Green practices reduce environmental accidents and heath hazards					
33	Green practices decrease of cost of raw materials					
34	Green practices reduce inventory levels					
35	Green practices reduce cost for energy consumption					
J.	Customer Relationship Management					
36	Green practices improve customer satisfaction					
37	Firm recovers end of life products from customers					
38	Customers appreciate eco friendly products					

Profile of the Author

Surajit Bag is a PhD scholar in the branch of Supply Chain Management under ***University of Petroleum &Energy Studies.*** *Surajit is actively involved in research. Surajit Bag has trained in Case Study Teaching from* ***Indian Institute of Management Calcutta****. He has also trained in Total Quality Management from* ***Indian Institute of Technology Kanpur****. His research interests are in the area of* ***Green Supply Chain, Sustainable supply chains; Green Manufacturing, Environmental Management; Total Quality Management****. He has attended several National and International conferences and has published more than ten papers in reputed International journals. He has contributed a chapter in the book titled "Antecedents of Green Manufacturing Practices: A Journey towards Manufacturing Sustainability", Smart Manufacturing Innovation and Transformation: Interconnection and Intelligence" under IGI Global publishers. He has delivered lectures on sustainability and environmental supply chains at*

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