

GSCM: practices, trends and prospects in Indian context

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Abstract

Purpose – Environmental friendliness, in context of industrial operations, is an issue that has evoked much interest among environmentalists, governments, academicians and other sections of society in recent times. The said development has been more profound and broad-based in developed economies of the world, though, the trend is catching fast in developing countries, as well. Green Supply Chain Management (GSCM) is a management technique that aims to make a supply chain eco-friendly, without diluting the organizational objectives. The purpose of this paper is to investigate the scale of adoption and implementation of GSCM practices in the context of Indian industries.

Design/methodology/approach – The investigation used literature review approach to determine the current status of implementation of GSCM by Indian industry, and associated aspects of the same. Literature pertaining to the subject in context of non-Indian industries has also been studied for the purpose of rudimentary knowledge on the management concept, as well for comparing the measures taken by foreign-based companies with Indian ones.

Findings – The study shows that in general, Indian companies are lacking on the front of adoption and implementation of GSCM measures in their supply chains. Though, certain companies are showing appreciable enthusiasm for the eco-friendly concept, the same does not apply to majority of the Indian enterprises, owing to a multitude of factors. GSCM has the potential to drive economic gains, and can act as a big motivator for companies to go green. As India leaps towards higher levels of industrialization and economic growth, GSCM becomes more of a necessity rather than an option for Indian companies to survive the competition.

Practical implications – Findings from this study helps in discerning the present status of GSCM in the country, and assess the same in comparison to that of developed countries. The findings will also help the firms to have a greater understanding of their current standing and the possible gains that can accrue by adoption of GSCM practices in real. The philosophy, stance and endeavours of government with respect to GSCM has also been spelt out in the paper. The paper contributes to the literature by providing empirical evidence on various aspects of GSCM in the country and the trajectory that it will chart in future.

Originality/value – The paper though, brings forth the findings of other researches on the subject of GSCM practices in India in a consolidated manner, yet its value is reflected in the cohesive manner in which contrary findings have been analysed to present a comprehensive and holistic picture of GSCM implementation in India. An attempt has been made not only to assess the inputs of individual firms, but also of government and other stakeholders in their efforts to make supply chains more environment friendly.

Keywords Green operations, Green supply chain management, Green core competence, Green design

Paper type General review

1. Introduction

Increased industrialization and ever growing consumerism has led to a situation where industrial pursuits of mankind have started to cast an unfavourable impact on environment that may prove self-destructive for the former. Developed countries, in their pursuit of economic development and progression to their current economic status, showed little respect for environmental concerns, earlier. But as on today, there is an increased awareness on part of their industries, governments and even consumers



for conserving environment and cutting down on pollution. Conversely, industries in developing nations are not so sensitive towards the cause of conserving the environment, and thus there is greater need of adoption of GSCM practices. They are in a race for faster economic growth and their economies are booming owing to rapid industrial expansion. This has led to a situation where they are emerging as top polluters of the world for tomorrow. China has been at forefront amongst developing countries, when it comes to harm caused to environment for the sake of industrial growth. India also has shown little respect towards environmental conservation while pursuing for economic growth. But there is now a glimmer of hope, as India, like other developing nations, is slowly waking up to the necessity and gains of GSCM practices. Nevertheless, it is just a beginning and there is a long, long-way to go. In the wake of this, it is required to introduce environmental friendly practices in industrial supply chains to ensure that there is no degradation of environment; coupled with materialization of economic gains. The growing awareness for environmental concerns led to adoption of GSCM, which though, of relatively recent origin has gained worldwide popularity and recognition in a brief time period. In Indian context, during the last few years, hundreds of studies have been carried out on the subject, addressing the various facets of the concept. This has led to establishment of various generic/specific laws, identification of previously unknown parameters associated with its implications and the possibilities that GSCM holds for future improvements in manufacturing and supply chain execution.

2. Literature review

There is relative dearth of unanimity in defining the nature and scope of Green supply chain Management (GSCM) as its building blocks, i.e. Corporate Environmental Management and supply chain management are themselves in their nascent stages of evolution. Nevertheless, in general, GSCM deals with adoption and implementation of environmental friendly means while executing various actions in the progression of a supply chain. GSCM is a holistic terms that involves within itself concepts like Green Purchasing, Green Manufacturing/Materials Management, Green Distribution, Green Marketing, Waste Management and reverse logistics (RL).

2.1 GSCM in developed countries

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 products after its useful life. GSCM covers activities such as Green Design, Green Sourcing/Procurement, Green Operations or Green Manufacturing, Green Distribution, Logistics/Marketing and RL.

The origin and extensive spread of GSCM is relatively more associated with developed economies, rather than developing/non-developed ones. Developed countries are characterized by high level of economic growth, industrialization and Human Development Index. Various researchers conducted their study in developed countries to examine the integration of environmental concept and supply chain management. One study from Germany conducted by Large and Thomsen (2011) identified five potential drivers of GSCM performance namely Green Supply Management capabilities, strategic level of purchasing department, level of environmental commitment, degree of green supplier assessment, and degree of green collaboration with suppliers. Azevedo *et al.* (2011) examined the links between green practices featuring in a supply chain, and the subsequent effect on the latter's performance in context of Portuguese Automotive

Supply Chain. The study of Chiou *et al.* (2011) in Taiwan concluded that greening the supplier through green innovation leads to significant benefits to the environmental performance and competitive advantage of the firm. A study in Italy carried out by Cagno *et al.* (2011) examined Green Supply Chain Practices (GSCP) adopted by third party logistics (3PLs) service providers, such as specific practices implemented and level of adoption of each practice by examining the potential effects of GSCP on company performance. In a study carried out in Japan by Arimura *et al.* (2011), the influence of ISO 14001 certification on the GSCM was determined by using Japanese facility level data. The study proved that ISO 14001 and voluntary Environment Management System government programme significantly influence GSCM practices. These programmes help in evaluating suppliers environmental performances and ask them to undertake specific environmental practices. Another study from Japan by Zhu *et al.* (2010) sought to introduce environmental, GSCM experiences of large Japanese manufactures. The study showed that large companies by greening their supply chains, can create win-win relationships with their partners, and hence realize sustainable growth for across their supply chains. Besides, it also indicates that suitable regulations and policies set by government can help GSCM circulation from larger leading companies to smaller companies. Hsu and Hu (2008) investigated the consistency approaches by factor analysis that determine adoption and implementation of GSCM in Taiwanese electronic industry. The fuzzy analytic hierarchy process method was applied to prioritize the relative importance of four dimensions and 20 approaches among nine firms in electronic industry. Meanwhile, Shang *et al.* (2010) explored key GSCM capability dimensions and firm performance based on electronics-related manufacturing firms in Taiwan. On the basis of factor analysis, six GSCM dimensions were identified: green manufacturing and packaging, environmental participation, green marketing, green suppliers, green stock, and green eco-design. Holt and Ghobadian (2009) investigated the level and nature of greening the supply chain in manufacturing sector of UK. In this study, the work explores the driving forces behind environmental management, the specific practices accruing from them, and the relationships between them. The study by Nawrocka *et al.* (2009) in Sweden, has concentrated on the role of ISO 14001 in environmental supply management practices in Swedish companies. The study described the existing and potential role of ISO 14001 for three key operational tasks of environmental supply chain management: communicating the requirements to the supplier, to motivate and enable the supplier, and to verify that the supplier follows the requirements. A study from South Korea carried out by Lee (2008) identified the drivers of participation in GSC initiatives by considering small and medium-sized suppliers and their most important stakeholders, including buyers and the government. Raymond *et al.* (2008) examined the relationship between supply chains and environmental performance of Small and Medium-sized Enterprises (SMEs) in Canada. This study proved that time and financial resources to deal with solid waste and energy issues are the most limiting factors. In addition, Chen (2008) looked into the relationship between green innovation and green image of companies in Taiwan. The study proposed a new concept of Green Core Competence. Chien and Shih (2007) examined adoption of GSCM practices among electrical and electronic industry in Taiwan. The relationship between GSCM practices and environmental performance, as well as financial performance has been studied. One study from Australia, conducted by Simpson *et al.* (2007) explored the moderating impact of relationship conditions existing between a customer and its suppliers and effectiveness of the customer's environmental performance requirements. Practically no research exists on the actual effectiveness of green supply requirements when placed in context with the realities of inter-organizational dynamics.

2.2 GSCM in developing countries

GSCM, in general, is believed to represent the environment-friendly image of products, process, systems, technologies and conduct of business. Most companies especially in developing countries adopted the green solutions into their business to reduce the negative environmental effects rather than adopting a proactive approach to reduce the sources of waste or pollution. These adopted green solutions continue to be traditional “command-and control” or “end-of-the-pipe” solutions (Anbumozhi and Kanada, 2005). Not enough literature has been devoted to the concern of GSCM in developing countries. The GSCM concept is relatively new concept in South East Asian Region and probably only a few companies are actually able to implement it (Rao, 2002). However, as claimed by Rao (2002) in his study on green supply chain in South East Asian Region (Philippines, Indonesia, Malaysia, Thailand, and Singapore), GSCM practices have started to take firm roots. Thus, the findings from those researches in Asian region can be useful for manufacturing in developing countries in order to develop the appropriate GSCM practices and help to reduce the environmental problems. Recent literature showed that a number of researchers have started investigating the spread of GSCM in East Asian region, such as China, that is identified with complex GSCM issues being a major manufacturing country. Zhu *et al.* (2011) investigated that whether different Chinese manufacturer clusters vary in their extent of implementing GSCM from the ecological modernization perspective or not. The study also examined Chinese manufacturer’s awareness of local and international environmental ESPR-oriented (enhancing energy savings and pollution reduction) compliance related to GSCM implementation. He also deduced that mediating effect of regulatory pressure plays a major role in adoption of GSCM practices. It is concluded that the varying pace of Chinese manufacturers to ecological modernize with GSCM practices and the significance of regulatory pressure to distribute the practices adoption by Chinese manufacturing industry. The study by Liu *et al.* (2011) in China has analysed the relationship between GSCM level and the classified determinant factors. The study confirmed that a company’s environmental management capacities will be strongly enhanced by frequent internal training of employees to increase its involvement in GSCM practices. Another research from China, studied by Yan Li (2011), examined the adoption levels of GSCM practices in China and explored the performance measurement for GSCM. The findings demonstrated that GSCM was strongly balancing to other advanced management practices, and contributed to improving environmental performance. Zhu *et al.* (2008) evaluated GSCM practices relating GSCM to closing the supply chain loop for four Chinese industries (power generating, chemical/petroleum, electrical/electronics and automobile). They concluded that adoption of GSCM practices in different industrial contexts is not uniform across the four industries. Another study also by Zhu *et al.* (2005) in China has evaluated and explained GSCM drivers, practices and performance among diverse Chinese manufacturing firms. Concern about the environmental issues has also augmented the interest of researchers to investigate the adoption and implementation of GSCM practices in another Asian countries such as Thailand, India and Malaysia. A study of Ninlawan *et al.* (2011) in Thailand analysed recent green activities in computer parts manufacturers and also measured the level of GSCM. The in-depth interview regarding green procurement, green manufacturing, green distribution, and reverse logistic has been conducted. The study conducted in India by Diabat and Govindan (2011) identified the drivers influencing the implementation of GSCM using an Interpretive Structural Modelling

methodology and extracted 11 drivers collected through literature. One study from Malaysia by Eltayeb and Zailani (2009) has identified the four key drivers or motivators to GSC initiatives: regulations, customer requirements, expected business gains, and social responsibility. Eltayeb *et al.* (2011) analysed the relationship between GSC initiatives and performance outcomes and identified the key initiatives (eco-design) that have positive effect on the four types of outcomes (environmental, economic, cost reductions, and intangible outcomes).

2.3 GSCM in India

In India, industrial waste accounts for over 50 per cent of total pollution caused in the country. The government itself has classified 17 industries as highly polluting and 24 industries as environmentally problematic in nature. Chemical and Engineering industries are the major culprits, causing bulk of industrial pollution in the country. Other notable industries include integrated iron and steel plants, non-ferrous metallurgical units, pharmaceutical and petrochemical complexes, fertilizers and pesticide plants, thermal power plants, textiles, pulp and paper, tanneries and chloralkali units. In 2006, SMEs which accounted for 40 per cent of industrial production, deployed limited pollution control technologies and were responsible for an estimated 70 per cent of the total industrial pollution caused nationwide. (OECD Report, 2006).

Being the fourth largest economy in the world, there are no surprises that the country is also the fifth largest global Green House Gasses (GHG) emitter. Between 1990 and 2008, India's carbon dioxide emissions increased more than 1.5 times, which is second-highest globally after China. Rapid industrialization is putting strain on resources and generating tremendous waste, to the tune of four million tonnes. Only 3 per cent of E-waste, that is a hazardous class in itself, is recycled in authorized recycling facilities. The status of pollution and wastage calls for adoption of GSCM measures on an immediate basis across the Indian industrial sector (Bhattacharya *et al.*, 2011).

The relevance of adopting GSCP is greater in India than anywhere else. Manufacturing sector which accounts for 16 per cent of GDP is poised for growth and its share as percentage growth of GDP will go up to 25 per cent by 2022, propelled by SME sector. The record of SME sector on the front of efficiency is not that encouraging. SMEs are challenged by rising input costs, including energy costs, unavailability of resources (especially power, fossil based fuels, etc.), poor logistics management and lack of skilled labour force. To counter these, cost rationalizations by greening of supply chains in SME sector needs to be taken more seriously in India, than ever before. The Indian SME scene is identified with lack of willingness to move away from traditional practices which is a hindrance to the spread of GSCM measures in a significant way. The phenomenon is equally applicable to larger corporate houses, as well. Coupled with willingness, the knowledge of green technologies, practices and methodologies also play a crucial role in making the supply chain green. There is considerable lack of knowledge on the part of top management that retards the proliferation of GSCM in India (TERI, 2013).

Apart from SMEs, the other focus area is agriculture, that being central to Indian socio-economic set up, cannot be neglected. Agriculture is a big guzzler of power in India, and knowledge about renewable energy technologies can help the sector to go green substantially. Modern technologies such as sprinkler, drip and micro-irrigation are crucial not only in reducing the water-requirement for irrigation purposes, but also electricity or diesel requirement for running the pump sets. Energy efficient motors account for a very small percentage of motor sales in India. Retrofitting of even 10 per cent of the existing inefficient pump sets (~15.35 million as on March 2007) annually would translate into a

savings of ~ 4 billion kWh (kilowatt-hour) per year at the user's end and ~900 MW of equivalent generation capacity. On a similar note, green measures need to be undertaken with respect to crop residue management, nutrient management, irrigation water management, precision agriculture, pesticide management etc. (Govindan and Bhanot, 2012). The "National Mission on sustainable agriculture" calls for measures to secure improved crop seeds, livestock and fish culture, improved water efficiency; pest management, improved farm practices; nutrient management; agriculture insurance and credit support; creation of new market infrastructure and alignment of R&D with market needs and livelihood diversification (NMSA Report, 2010).

On an optimistic note, certain sections in Indian SME sector have taken lead in adoption of GSCM practices owing to the advantages offered by it in terms of increased efficiency. Cutting and hand tools, auto parts, spare parts, industrial equipment's, machinery manufacturer etc. seem to be quite advanced in the implementation of green warehousing and distribution initiatives. But such instances are more of an exception, rather than a norm. In 2012, India's Environmental Performance Index (EPI) rank stood at a dismal 125 out of 132 countries ranked. EPI measures effectiveness of national environmental protection efforts, on the count of measurable outcomes such as emissions or deforestation rates rather than policy inputs, such as programme budget expenditures, etc. India's poor rank indicates the miserable status of country's awareness of GSCM practices (Nimawat and Namdev, 2012). Despite that, it can safely be said that environmental consciousness, if not optimally significant, is still on the increase across various stakeholders of supply chains in India. The concept of "Green Products" like organic food, solar heaters, electrical cars, etc., are gaining wider acceptance with both Indian companies and consumers. Indian manufacturing is catching up with the long-term benefits of green processes to improve corporate brands, reduce costs, and achieve compliance simultaneously. Energy intensive companies are implementing lean processes to minimize waste and enhance energy efficiency (CII, 2011). In India, though, the number of companies embracing GSCM is increasing, yet it can safely be said that there is limited awareness about the concept amongst suppliers, consumers and employees, in general. The notion of RL is also absent in majority of companies, whereby waste can be retrieved from the end consumer for capturing its remaining value or for its environment-friendly disposal (Dutta and Vaibhavanand, 2012).

Indian government, realizing the importance of eco-friendly industrial practices and the gains that accrue from them, is serious about enforcing measures that can curb environmental degradation. As per the Manufacturing Plan of the Planning Commission of India "being green" should be the primary focus of businesses, and should not be treated as an obligation by the manufacturers. On the other hand, it is important that government must come out with institutional support for the micro, small and medium enterprises (MSMEs) because of their outdated and incompetent technologies will find obligatory imposition of standards on them as challenging. The government may come out with initiatives like regulations encouraging disclosure by firms of their environmental sustainability performance, low-interest loans for manufacturing to invest in new plants to produce clean/green technology or invest in new plants to produce green products; creation of a central fund for supporting research in the area of green manufacturing and making it mandatory to get a certain percentage of its electricity mix from renewable sources (Planning Commission). In nutshell, the process of greening the MSME sector is a two way process, wherein both the manufacturers and government should make efforts to address the challenges in the way of augmenting GSCM adoption across the industrial sector of India.

Sarkis (2011), in his study has stated that there are enormous opportunities for researchers to find new dimensions of the concept of GSCM, as still much of its possible facets remain unexplored. Furthermore, much of the literature on the subject is of recent origin, which points to the fact that the concept is still in its nascent stage, and more surprises are waiting to manifest, as our knowledge on the subject will progress towards its growth and maturity. Sarkis has made his statement in global context. Sarkis is of the view that despite in primary stages of development even in western world; GSCM has delivered substantial gains – both economic and environmental, for the practising firms. That being true, the gains awaiting for developing countries like India are immense, given the fact that the percolation of GSCM, even in its existing status of infancy, has been limited. This offers not only opportunities, but also poses challenges in the shape of dissemination of information and know how; as well as developing the capacities to the required level of achieving its threshold level of acceptance, adoption and implementation. Major causes for the mentioned challenges are specific to developing countries like India because of many reasons namely weak information-sharing channels, limited exchange of technology between enterprises, lack of capital, limited enthusiasm to switch over to more environment-friendly technology etc.

3. Research methods and directions

The study is aimed at exploring the various facets of GSCM in Indian context; which makes it exploratory in nature. It has purposely focused on addressing common aspects of GSCM; and thus refrained from laying emphasis on any peculiar aspect of any particular industry. The approach of undertaking a survey would have been more suitable, if the study was aimed at eliciting responses from a small target group. A case study could have been ideal, if the subject had revolved around a certain small operational domain. That not being the case, literature review was undertaken to gather a holistic view of the most accurate and most reliable facts on the subject. The research approach encompasses the study of the most rudimentary aspects of the main theme of research. Major drivers of GSCM were identified, and their present status was traced in context of Indian settings and those of other important industrial nations across the globe. The status of India's adoption and implementation of GSCM was juxtaposed with those of Chinese and US firms; and parallels as well as commonalities, were drawn.

On the basis of review of literature on GSCM – the concept, its dimensions, its applications and its ensuing evolution; sufficient information to introduce the concept was gathered, to shape the preliminary/introductory part of the research. Though the implementation of GSCM may reflect variations on case to case basis, based on peculiarities inherent to the studied case; yet there are broad commonalities that define the concept in its generalized form. Accordingly, certain drivers were identified that are integral to nearly all the GSCM implemented systems. They were subjected to study in context of India and one developed nation and one developing nation; to draw parallels between them. The comparative analysis helped in ascertaining the depth of penetration of GSCM in industrial sector, *vis à vis* what is being practiced in other significant transnational industrialized domains. Thereafter, various aspects of the concept in study were like inter-relation between Economic Growth and Environmental Degradation, Managing Growth with Environmental Concerns, Relation between Environmental Pollution and Development Status of an Economy, Chasing Growth and Environmental Concerns simultaneously, Government Regulations, Top Technologies, Barriers, etc. were studied. An attempt was made to study the GSCM initiatives taken by Indian firms

and leading companies to adopt and implement GSCM in their operational systems; to understand the most significant and relevant developments in eco-friendly industrial processes in Indian context.

3.1 Status of important drivers of GSCM of India vis á vis other developed/developing countries

Although GSCM, in itself is not of very late origin; the concept has seen tremendous acceptability and practice across the globe – amongst the developed as well as developing nations. Obviously, the developed nations have made bigger leaps in embracing it, putting it to practical usage. The developing nations, on the other hand, are characterized by mixed responses to the environment friendly management technique. It is enlightening to see the progress of GSCM India vis á vis some developed nation; and also in comparison to a leading developing economy. USA is an optimal example of a developed economy with substantial lead in practicing GSCM by its industrial set up. China, on the other hand, presents an ideal choice as a developing country to compare its advances on the front of GSCM in comparison with India.

A brief analysis of the status of few selected drivers of GSCM in case of India, China and USA has been done to assess the relative positioning of India with respect to other global manufacturing giants. The findings have been enumerated driver-wise to gauge the relative strengths and weakness of the same in Indian context.

Green procurement. United Nation Environment Programme in its report titled “Sustainable Public Procurement: A Global Review” (2013) states that Green Public Procurement (GPP) is a relatively new concept in Indian context, which can be used as a policy instrument to further the cause of environment conservation across the industrial scenario of the country. The fact that public procurement sums up to 30 per cent of the total GDP in case of India, the concept of GPP offers bright prospects to promote GSCM in a big way by leveraging its sheer strength to make supply chains across various industries eco-friendly. As of now, there is no procurement law in place, and the public purchases are materialized on the basis of government policies only. Hence, there is room to streamline purchases made by public sector enterprises and contribute towards greening the environment. The government has also woken up to the need of developing a framework to execute green purchases and Public Procurement Bill is on the anvil. Nevertheless, Eco labels and environment standards are in place since long. ISO 14001 was introduced in 1996 to depict a firm’s commitment to environmental management, as well as Eco mark-the Eco label for Indian products in 1991, but that has not been embraced by the suppliers to the extent, it was originally intended.

In its report titled “Procurement, Innovation and Green Growth” (2012) by International Institute for Sustainable Development, Canada; the efforts of Chinese Government have been highlighted in ensuring GPP across its various levels of functioning. Local government accrue 90 per cent of the government expenditure on procurement, and that shows the potential of GPP that China has at its hands. In context of purchasing, the government has released a list of energy saving products which enlists more than 30,000 products. However, the purchase of these products is voluntary on the basis of the local governments, which leaves the effectiveness of GPP in case of China, an open ended issue. One of the peculiar issues affecting GPP in China is the inability of new products getting visibility in the said list. Innovation is happening fast in China and innovators are coming with ever-improved products. But the authorities, already overburdened with the task of evaluating the huge number of new products coming for appraisal, find it hard to

evaluate and assess all the emerging innovative inventions. Nevertheless, the intention of Chinese Government in promoting GPP cannot be doubted, as is evident from the national dialogue, backed by a national questionnaire, initiated by it to promote the culture of green purchasing in the country.

In USA, the concept of GPP is being promoted by a number of organizations acting independently towards securing the goals of green procurement. In fact, Organization for Economic Cooperation and Development (OECD) of which USA is a prominent member, has been carrying out extensive research, work shop programmes and policy analysis on the issue of GPP since 1996. North American Green Purchasing Initiative is an inter government body which apart from USA, has Canada and Mexico as its members; working together to ensure that environmental conservation should be considered duly while making purchases by the government. On the end of private endeavours, Responsible Purchasing Network is another network of buyers that aims to encourage the culture of Green Purchasing on translational basis in North America. Hence, it can be concluded that GPP is backed not only by the state players, but by non-state actors as well; pointing to the maturity of the concept in American markets.

Green technology. India and China, because of their cheap labour markets and being profitable markets for the west, are emerging as investment and production hotspots for established companies of the developed world. Furthermore, because of increased technological capacity and suitable human resources to carry out innovations, many MNCs are shifting their R&D facilities in these countries; by which of virtue Green Technology is receiving a fillip on its own. So, in a sense, Green Technology in India and China can be considered to be closely related with the concept of Technology Transfer from relatively more developed countries. But at the same time, it needs to be accepted that that technology is transferred in a narrow sense of the word and alterations and innovations in the acquired technology determines the shape of final technology that is developed and deployed. Having mentioned that, the governments in two countries are also striving to invest in development of Green Technology. Chinese Govt. in the last decade has extended a support of two billion Yuans for R&D works, and has plans for tenfold increase in that amount for the coming decade. The emergence of China is the largest producer of rechargeable batteries used in vehicles in the world. Similarly, in India expenditure in R&D activities to develop Green Technology is manifested in many examples. For example Bharat Heavy Electricals Limited has started manufacturing electric buses, vans and special purpose vehicles through indigenous technology only (Lema and Lema, 2012). As per Watson (2013) 57 per cent of business houses based in USA, use green technologies aimed at securing energy efficiency while more than 50 per cent deploy green technology to cut down on wastages. Evidently, this is an appreciable number, which points to awareness and acceptability of environment friendly technology amongst the Americans.

Green energy. The fact that industrial sector is dependent upon power for sustenance and growth; the concept of Green Energy acquires significance in the wake of another fact that generation of energy by conventional means is synonymous with environmental pollution. Any effort to make industrial operations green and conserve the environment is closely related with availability of green power. It is in this background, that the green energy should be considered integral to any of the GSCM study undertaken.

Arora *et al.* (2010) point towards India's seriousness towards development of Green Energy towards meeting the domestic energy needs, which owes largely to curtail its

ever growing expenditure on fuels. In fact, India was the first country in the world to constitute a ministry dedicated to the cause of development of green energy, when in 1992 it constituted Ministry of New and Renewable Energy aimed at generating eco-friendly power/energy. By the mid of 2010, the country had an installed capacity of 17.5 GW of installed renewable energy capacity, amounting to 10 per cent of India's net installed power generating capacity. Apart from that, the government has set up dedicated centres of studies like Solar Energy Centre and the Centre for Wind Energy Technology to tap the potential of renewable energy sources in the country. Furthermore, the Indian Renewable Energy Development Agency has been set up to provide financial assistance to green power projects of the country. The Electricity Act 2003 enacted by the government mandates that each State Electricity Regulatory Commission (SERC) establishes minimum renewable power purchases and National Electricity Policy 2005: Allows SERCs to establish preferential tariffs for electricity generated from renewable sources. India has made an appreciable beginning in tapping its green energy potential, but it is still in its infancy.

On similar grounds, China has also been an enthusiast of Green Energy with its focus not just on hydro power but other non-renewable sources of energy, as well. Most predominantly, after hydro power, China has made big strides in development of its wind power generating capacity with an ambitious target of 100 GW by 2020. Riding high on its Renewable Energy Law 2005, China offers subsidies to companies managing grids, who buy power from renewable energy producers. USA on the other hand does not have a comprehensive national policy on promotion of green energy, owing to the fact that higher initial cost of generating green energy is in conflict with the "Market Economy" principle to which the US relates itself with. However, bio fuels have emerged as a popular form of renewable energy, mostly due to substantial support extended to their development by the Federal Government in the shape of Renewable Fuel Standards (RFS). RFS mandates the blending of specified quantities of renewable fuels with gasoline/diesel etc. The policies on renewable energy, however little may be, have their roots in the erratic changes in global energy prices during the last quarter of last century, prompting the US authorities to look at renewable energy as an alternative and cheap source of power (Campbell, 2010).

Green legislations. In India, as per the report of High Level Committee of Ministry of Environment, Forest & Climate Change, Government of India (2014) on "Review of Various Acts administered by the Ministry", environment related legislations received attention only after Bhopal gas leak disaster of December 1984; following which EP Act 1986 was enacted. The law empowered Central Government to regulate emissions and effluent standards, restricts sites for industrial use, handling of hazardous waste, investigate and research pollution issues. The EP Act in 1986 gave way to amendments in Air Act 1987 and Air Act 1988, which play a significant role in the ensuring regulating industrial undertakings on the count of environment protection. Other laws relating with environmental protection include Handling of Management of Hazardous Waste Rules in 1989 and 2008, Public Liability Insurance Act 1991, EIA Notification 1994 and 2006, CRZ Notification 1991 and Bio Diversity Act 2002, National Green Tribunal 2010, etc. Significantly, informal regulations propelled by NGOs, civil society and social media have furthered the cause of promulgating environment related legislations in the country. Nevertheless, the enforcement of legislations pertaining to environment conservation on the part of industrial establishments is an area of concern, with little or no punitive action against the offenders in general.

In China, laws pertaining to environmental conservation were initiated in 1979 as a result of rapid environment deterioration resulting from industrialization of the country in early 1970s. There are as many as 30 laws pertaining to the issue are environment conservation, with relevance to industrial sectors of the country too. Environmental Protection Law is the axial environmental legislative provision for enforcing environment friendly operations at the end of industry, organizations and individuals in general. Nevertheless, there are lots of limitations in the same, and attempts have been made to bring about amendments in it. Though, effectiveness in enforcement of green legislations is an issue open to debate in the case of China, it is encouraging to see that the legislations have evolved over a period of time, due to learning from the experiences of relatively developed nations.

At the moment there are no set procedures or legislation regulating e-waste in India. The e-waste is mostly taken by scrap dealers, either collected from various users and scavengers or bought at auctions from large companies. The reusable parts are sold as spares and the rest is used to recover various metals. The biggest environmental and health hazards come from the recovery of metals such as gold, silver, copper, etc. The residues which contain heavy metals and toxic organic traces are often dumped in the open.

Customer involvement. Presumably, there seems to be greater awareness in developed countries amongst the consumers pertaining to environmental issues, which is reflected in their buying behaviour patterns as well. In a studied carried out by Kumar *et al.* (2013), nearly 75 per cent of consumers based in USA stated that their buying decisions get affected by the environment friendly reputation of the company; and nearly 80 per cent stated that they had no reluctance in paying an extra amount for a commodity, with environment friendly attributes. This shows that customers are more aware and more responsive towards environmental aspects of products/commodities they use, in case of a developed nation like USA.

In India there is relative limited awareness amongst the end users of the green nature of the products of the users. This further limits the customer's involvement in the greening the supply chain. However, the manufacturers can take initiatives in ensuring that the consumers play an active part in the GSCM; for example, green labelling of products will help in disseminating information about the green aspects about the product; that will effectively help the consumers to make choices among the options available to them. Companies can also use their marketing and advertising channels to push with green products and can calibrate their marketing campaign to launch pad for greener products. Such moves will trigger consumer awareness about GSCM practices, which will snowball into greater spread of the same across a wider spread of customer base. This will eventually result in increased quantum of customers' commitment towards conserving the environment.

Chinese firm being more export oriented, have a larger broader-based customer base. Exports and overseas sales hinge upon the preferences of overseas customers, who exhibit a more profound concern towards green products. This means the Chinese firms have to look at GSCM more as a requirement than an option while manufacturing their products. Subsequently, the Chinese consumers are also getting exposed to the concept of green manufacturing and green products, which is now becoming more conspicuous in their buying behaviour patterns across various product categories, most predominantly in automobile industry. Nevertheless, there are companies

(mostly in Electronics/ electrical commodities), which are not willing to embrace GSCM that effectively, as they already have long-term relationship with the customer base, and need no green-make over to win or retain their customers.

RL. It is strange that developing nations act as dumping grounds of products used and discarded by the developed countries, and yet they fail to execute the concept of RL to its optimum, when it comes to indigenous products. Sharma *et al.* (2011) in their study on RL in Indian context, state that though, India has both the technology and manpower to execute RL, the latter find limited application in Indian industrial scenario because of various reasons namely lack of RL structure, unresponsive management, financial limitations, company's policy-frameworks etc. Top managements see RL as a measure that relates with financial and operational facets of the company's undertakings and may affect company's performance in an unfavourable manner. It is a risky endeavour for the top management as it involves financial and operational aspects which determine the performance of the company in long-run. The barriers mentioned not only affect the operations of RL but also influences one another. Thus, it is very essential to understand the mutual relationship among the barriers. The study revealed that in Indian perspective, limited awareness about the concept of RL, monetary constraints and legal issues affect the deployment of RL, in a predominant way. Some of the legal provisions also act as a hindrance in executing RL. For example Goods for which excise tax has been paid, cannot be brought back again by the manufacturing enterprise, unless consent is secured from the excise department, regarding the same. In an effort to the avoid Red Tapeism, the manufacturer simply does not go for execution of RL at his end. Financial constraints too form a significant hurdle in carrying out recycling by Indian firms, on a significant scale. Deployment of IT-based systems to track/trace the reclamation of products is a cost intensive proposition; along with the cost associated with aligning and training human resources towards executing RL exercises. Moreover, unawareness on the part of stakeholders regarding the concept of RL, its prospective gains and the methodology to implement it; retard its adoption and spread on a massive scale.

In context of Chinese companies, (Abdulrahman and Subramanian, 2012) stated that the economic boom in the country has led to enormous consumption by the Chinese, resulting in voluminous generation of waste. Pollution spurt in the country can be gauged from the fact that contaminated water and solid waste per unit of China is much higher than many of the developed countries. Electrical and Electronics waste are particularly more prominent with them accounting for thrice the volume of the conventional waste. The Chinese have woken up to need of RL, but Chinese forms are still way behind the US ones as far as spread and status of RL is concerned across the Chinese industrial scenes. Lack of capital to initiate RL operations and setting up monitoring systems to execute its returns is the single most important reason for the relative lesser spread of RL implementation. Furthermore, low levels of commitment on the part of Chinese firms to the concept and lack of expertise also contributes to less than desired penetration of RL culture in China.

The culture of RL is comparatively more broad-based and advanced in USA, where the market for RL was pegged at \$58 billion in 2004, comprising 0.5 per cent of the US gross domestic product; as per a study conducted by Olorunniwo and Li (2011), and was poised for an upswing with progression of time. But despite that, it cannot be stated that RL has reached desirably high levels in USA, as a significantly high number of companies do not spend even 5 per cent of their total logistic cost on RL, and many

managers do not see it as integral part of their operations citing their none or little contribution to company's profits. In fact, some see RL as a "Cost" to the company, rather than a "Gain". But, there are firms which while evaluating RL doesn't consider only the monetary gains, but also non-monetary gains while evaluating RL applications and hold an appreciable view of the concept.

3.2 Inter-relation between economic growth and environmental degradation

The relationship between the environment and pollution is the subject of intense public debate. Pollution and GHG emissions are often used as indicators for environmental quality with the obvious intuition that more emissions imply worse environmental quality. One's intuition may lead to the belief that emissions simply increase linearly as an area's economy grows through time. An examination of the empirical relationship between economic growth and emissions, however, reveals different results. Grossman and Krueger (1995) proposed that emissions followed an inverse-U shaped path as a country's economy grew over time. The authors defined this relationship as the Environmental Kuznets Curve (EKC) hypothesis named after the Kuznets Curve hypothesis developed by Kuznets in 1955. Since the proposal of the EKC hypothesis, several other studies have been conducted to examine the validity of the hypothesis. Till date, no comprehensive theoretical model has been developed to explain the relationship between environmental quality and economic growth from which an empirical EKC can be explicitly derived. Since no comprehensive theory exists researchers have only used regression models to examine the relationship. The potential problem with numerous studies is that the emissions data from some countries may not reflect the actual facts (particularly countries with little environmental regulatory oversight) and could present potential problems of measurement error. Examining the data at a national level may also be doubtful because valuable information is potentially lost as the emissions data are aggregated to a national level. Nevertheless, it can be said with certainty that economic growth has a "potential" by-product in the shape of environmental degradation. The word "potential" should be noted, signifying that it is not necessary that the economic growth is achieved at the cost of healthy environment. There are ways by which we can scale economic prosperity by giving due consideration to environmental concerns. GSCM is an effective tool, that if practiced sincerely could significantly minimize, if not eliminate the chances of environmental deterioration.

3.3 GSCM: managing growth with environmental concerns

GSCM is an emerging concept, which has evolved tremendously over the last few years. This idea covers every stage in manufacturing from the first to the last stage of life cycle of the product to its recycling. Industries in every sector are feeling the pressure to reduce their impact on the environment. The aim is to change the traditional open-loop supply chain structures into the GSC to minimize the negative impact of the environment, increase the recycling link, to achieve material and energy recovery in order to eventually achieve economic and environmental benefits for the most optimized sustainable economic development by examining the companies who have already made progress at the front of GSCM, that will help others to begin their own transition.

3.4 Exploring the relation between environmental pollution and development status of a country

Major economies of the world, in general, also rank highly in term of environment pollution caused by them. The same is depicted in Figure 1.

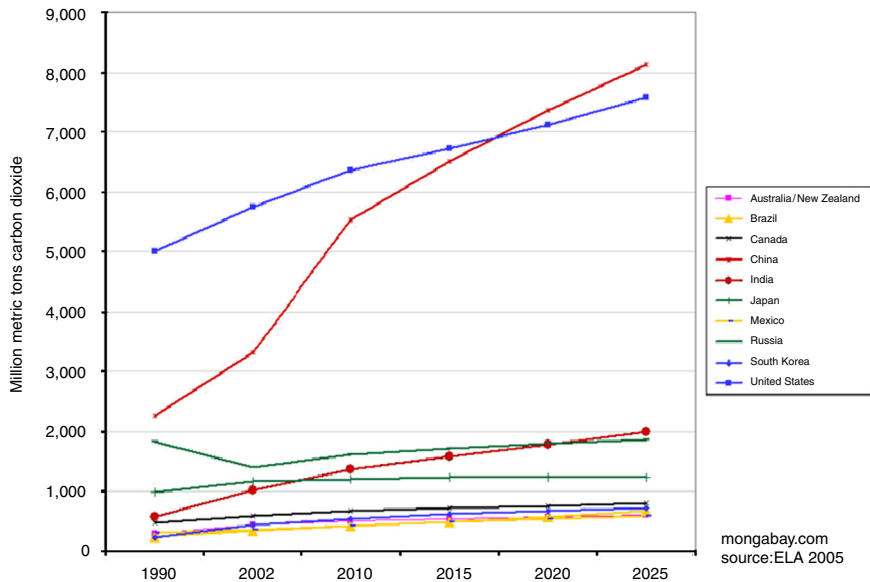


Figure 1.
World carbon dioxide emissions by country, 1990-2025

Source: “Energy Information Administration” of the US Department of Energy (DOE), www.eia.doe.gov/neic/aboutEIA/copy_right.html

Conversely, there are nations as well, that are doing pretty well on the count of environmental conservation. All such countries belong to the category of developed nations; that shows that industrial progress and environmental conservation are not mutually exclusive. GSCM practices make it possible for a country to be industrially developed and eco-friendly at the same time. The top most eco-friendly nations of the world (Energy Information Administration of the US Department of Energy (DOE), 2014) are depicted in List-I.

List-I – top most eco-friendly nations of the world:

- (1) Switzerland
- (2) Luxembourg
- (3) Australia
- (4) Singapore
- (5) Czech Republic
- (6) Germany
- (7) Spain
- (8) Austria
- (9) Sweden
- (10) Norway

List-I and Figure 1 clearly signify that it is a myth that adoption of GSCM practices has any bearing on the development status of any country. There are developed countries like USA, Japan and Russia in the list of polluting nations, and also developing

countries like India, China and Mexico. Similarly, the list of eco-friendly countries has host of developed nations, and also finds the mention of Spain and Austria, that are certainly not economic power houses. It can be inferred that economic growth may or may not lead to environmental degradation, depending upon adoption of certain practices that ensure that the latter does not take place. For sure, the countries that show greater commitment towards conservation of environment are adopting a good measure of GSCM practices. Nevertheless, a substantially detailed status of GSCM adoption in developed and developing countries are discussed in the following sections.

3.5 The Indian story: chasing growth and environmental concerns simultaneously

India is one of the fastest growing economies in the world today. Projections from the Indian government, global financial institutions and international economic bodies indicate that India's GDP will double in the next 20 years from current levels. And so will the demand for energy, to fuel this growth, and the consequent per capita carbon emission levels. The need for India is to embark on a path of sustainable growth that will maintain the economic growth momentum while addressing the need for reducing carbon emissions through the use of green technologies. Over the next five years, it is expected to see a flurry of sustainability initiative and programmes being introduced that will lay the foundation for sustainable growth in the future. This will lead to India's spending on sustainability initiatives that impact various spheres of economy, industries and the society at large, doubling from the current levels through 2015.

3.6 GSCM: government regulations and level of adoption by Indian corporate

India has a lot of regulations pertaining to environmental conservation, starting from energy ratings standards by Bureau of Energy Efficiency for all kinds of IT hardware equipment's and consumer electronic equipment's to the mandatory reporting and spending on corporate social responsibility for Indian organizations. The government has set a target to increase energy efficiency by 20 per cent by 2016, and to achieve a 20 per cent to 25 per cent reduction (from 2005 levels) in emission intensity by 2020. Moreover a chapter on sustainable development and climate change was introduced in the government's annual Indian Economic Survey, 2011-2012. The survey has suggested making lower- carbon sustainable growth a central element of India's 12th Five Year Plan that commenced in April 2012. This will certainly have a bearing on the adoption levels of GSCM practices by Indian firms.

3.7 Top technologies at the forefront of green operations in India:

There are many existing technologies and applications that are applied to improving the sustainable performance of Indian enterprises – technologies that are mature and simply need repurposing. In addition to this, there is an emergence of a plethora of new exciting and interesting technologies and applications that will help enterprises to make both incremental and substantial improvements in sustainable performance. While there is much excitement around many of these technologies, it is important to recognize their relative maturity or immaturity and how apt they are for your organization's critical business issues. Innovation is happening on two fronts – IT-based technologies and New-age innovative technologies front. IT-based technologies help in lowering power consumption and cooling requirements. These technologies including virtualisation, cloud computing etc. are very popular among companies. Adoption of these technologies helps to save power and reduce carbon emission. These could help industrial units for whom electricity bills constitute a large part of their operational cost. By using energy

monitoring devices, various companies have successfully reduced the electricity bill by 3-4 percentage points. At the forefront are the Information technologies that are pushing ahead with GSCM practices are Environmental Health and Safety applications, sustainability/CSR performance management systems, enterprise wide carbon and energy management, sustainable design and product life cycle management tools, and sustainability business operations etc. On the front of new-age innovative technologies are advanced metering infrastructure, carbon capture and sequestration, intelligent transportation system, solar energy technology, building integrated PV systems, Eco labels and footprints, combined heat and power technology, e-waste, distributed power generation, and water management are very essential to usher in low carbon sustainable growth, and a variety of pilot projects funded by private organizations and government bodies are underway in many of these technology areas currently.

Major hindrances in the adoption of GSCM practices in India. Prohibitive cost. The biggest perceived barrier to adopting GSCM is prohibitive costs. The biggest perceived barrier (26 per cent of respondents) to adopting GSCM practices is that it is cost prohibitive, followed closely by it being too complicated to implement (25 per cent of respondents). Almost a third of the companies surveyed (17 per cent) felt that there were no financial incentives to justify adopting GSCM. Lack of executive support was not felt to be a significant barrier. Insufficient technology was only perceived by one in five respondents as a barrier. The message seems clear that if GSCM makes financial sense and is easy to implement, chances for adoption are much higher.

Lack of awareness. According to the individuals surveyed, the most important issue facing manufacturing sectors in India is the lack of awareness about environmental issues (51 per cent) followed by waste disposal (40 per cent). Others issues such as conserving natural resources and green buying preferences were also in concern. The challenge of complying with government regulations came out as the least important issue, although it was still cited by one in five respondents as important. Open ended responses raised additional pertinent issues. For example, there is a strong need to ensure that the standards and protocols of retail customers in the Indian market are clearly communicated in India with partner factories and their management. Other concerns included overproduction of goods, green packaging, green energy and complying with chemical and hazardous materials regulations. The bright side to a lack of awareness about environmental issues is that it can easily be addressed through education. The general signs are optimistic that Indian manufacturing sector is moving in the direction of making its operations more eco-friendly. In total 51 per cent of manufacturing industries feel that lack of awareness of environmental issues is the biggest issue facing manufacturing sectors in India.

Dithering with implementing green initiatives. On an approximate basis, one in six of the industries surveyed state they would be implementing GSCM initiatives in the next six months. Another one-third plan to implement green initiatives within the next six months to two years. More than one in five (24 per cent) of industries have no initiatives planned and another one in five (24 per cent) are not sure about their company's plans. In total 36 per cent of manufacturing industries have plans to implement GSCM initiatives within two years.

3.8 GSCM Initiatives taken by Indian firms

Green sourcing and procurement focused initiatives using electronic processes. Leveraging the might of IT-based tools, Indian firms are creating efficiencies in sourcing and procurement, that was top initiative cited to majority of industries. Other

initiatives such as employing environment friendly design and product life cycle management and working with suppliers on sustainability and GSCM guidelines were almost equally planned and implemented initiatives in manufacturing sectors of India. Training and development of internal staff, suppliers and clients were also cited as important initiatives. Reducing use of paper in contract and auditing suppliers were the least commonly implemented initiatives (both cited by less than a third of respondents). The indicators here are positive and suggest that as technology improves and supply chains become more efficient, green practices will become more prevalent. Nearly half of Indian companies use electronic processes to create efficiencies in sourcing and procurement.

Green productions and manufacturing focused initiatives. Given that recycling is a concept that has time and support to be success should be adopted by consumers and the broader society, even in Indian manufacturing sector, it is not surprising that utilization of fuel efficient tools and machine initiatives are a priority for companies. Recycling programmes for raw materials and for reusable component parts were the most common green production and manufacturing focused initiatives. Applying carbon offsetting was a distant priority. Carbon offsetting is a relatively new and abstract concept that will take time to adopt. Other green production and manufacturing initiatives that Indian manufacturing companies are implementing include the introduction of “returnable and reusable packaging, reducing the usage of solvent-based chemicals and choosing compliant factory and supplier partners.

Green warehousing and distribution focused initiatives. Most companies seem to be quite advanced in the implementation of green warehousing and distribution initiatives, most likely because these initiatives often mean improved efficiency. Companies appear to be most ahead in green practices in their inventory reduction and product handling (53 per cent) have already implemented initiatives; and their ability to consolidate orders (44 per cent) have already implemented these initiatives; and usage of reusable containers and storage equipment, where (57 per cent) have already implemented these initiatives. When it comes to reducing energy consumption through the use of solar panels or green roofing options, surprisingly (14 per cent) of companies have already adopted such initiatives. Similarly around (22 per cent) of companies report that they have already optimized the location of their distribution hubs. While these types of initiatives show direct cost and efficiency benefits, the up-front cost associated with them may be the reason why other companies have not adopted them.

Green transportation focused initiatives. Manufacturing companies in India are also fairly well advanced in the types of green transportation. Similar to their production and warehousing initiatives, there is a cross-over between implementation of green and levels of efficiency. Almost half of companies surveyed are already periodically services of the vehicles at service stations along reducing empty miles, truck idle time and increasing cube utilization to create efficiency. Adoption of more sophisticated green transportation measures which have less direct relation to efficiency and cost savings are not in wide practice. These more advanced green transportation measure such as using more aerodynamic trucks (9 per cent) and more alternative fuel powered trucks are all adopted by (11 per cent) or less of companies.

4. Conclusion

As Indian economy expands to new frontiers, the industrial activity in the country braces itself for manifold growth, fuelling fears of adverse impact on environment.

The industrial growth of the country cannot be compromised at any cost; and this causes genuine concerns for the conservation of environment in the midst of all ensuing industrial growth. Nevertheless, in contrary to the general belief that economic development has a direct correlation with the environmental degradation, GSCM offers a glimmer of hope on the front of developing eco-friendly supply chains across various industrial sectors.

There are many developed countries that have been very eco-friendly in their industrial undertakings, and have made tremendous strides at the front of green industrial operations, without affecting their profits and other organizational objectives in a negative way. Rather, GSCM has helped them to save on resources and streamlining their supply chains for better. Developing countries, in contrast, have not fared equally well on environment conservation front while achieving their industrial and economic growth. The distinguishing factor between the developed and developing economies that accounts for the difference in pollution and environmental degradation caused by them is the extent of adoption of GSCM by them. China, a developing nation, despite its dismal record on environmental pollution caused by rapid industrialization, is making quick strides on the issue of GSCM as its government has realised the gains that the management tool can extend to its industrial sector. India despite its substantial progress on the front, still remains in transition stage with respect to adoption of GSCM. The spread of GSCM is not uniform across the Indian industrial horizon, and there are only few players who have realised that GSCM is more of a necessity rather than an option for them, in the new order of global industrial scene.

Till now the interest shown by Indian companies in adoption of GSCM in their respective organizations is not much enthusiastic; as is evident from the pollution caused by its industrial units. Nevertheless, the future of GSCM adoption in the country is not bleak, as a number of companies have shown increased interest in saying yes to eco-friendly practices. As India becomes R&D destination because of adequate skilled manpower, available at cheap costs, there is optimism of emergence of innovative green technologies fuelled by research works and technology transfer. These technologies will percolate in industrial undertakings of the country making them more environment friendly. There is enormous potential for promoting GPP in the country, but that will require providing of adequate number of legislations governing the issue of green procurement, and their strict enforcement on ground. The legislations on the issue of securing eco-friendly industrial operations are in place, but are not adequately enforced resulting in gross damage to environment by erring industries. There is a need to revise them to give them more sinew, and should be enforced strictly to set exemplary precedence for various stakeholders of supply chains. Customer awareness with respect to their part in greening the supply chain is negligible, which is largely due to lack of their knowledge regarding their roles and involvement in GSCM. This results in slow progress made by country on the front of adoption and implementation of GSCM. Furthermore, in India major stakeholders of supply chains are unaware of the value of waste generated, and are thus oblivious of the concept of RL. Though, RL is visible in a crude form across Indian industrial scene, yet there is general absence of a systematic structure to recycle waste and generate value out of it.

Nevertheless India has witnessed appreciable endeavours by various corporate houses and successive governments in making serious attempts to embrace environment friendly industrial practices. This auger well for the spread of GSCM in India, in coming times. It is hoped that in near future, there will be immense escalation in awareness and adoption levels of GSCM amongst various stakeholders of supply chains of various

industries in the country. Hopefully, Indian manufacturers, industrialists and corporate houses will exhibit greater responsibility towards safeguarding environment for a healthy future for coming generations, which will be manifested by greater and more comprehensive adoption of GSCM practices at their end.

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