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A Survey of Sustainable Supply Chain Management Practices in Indian Manufacturing Firms

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Abstract

Research on sustainable supply chain management (SSCM) has attracted increased attention in recent years. Although SSCM has been studied for developed and developing countries, there has been little information about the adoption of SSCM practices in India. This paper presents one of the earliest surveys on SSCM practices in Indian manufacturing firms. The items for the survey were developed based on the extant literature and feedback from corporates. Some of the major findings of the survey are as follows. We found that the state of adoption of SSCM practices by Indian firms was still in its infancy, the awareness of sustainability was quite low among consumers, and the regulatory framework was also

1. Introduction

Sustainability or sustainable development is a much-discussed and significant topic of today in the light of increasing environmental degradation (global warming, depletion of the ozone layer etc.) and violation of human rights (Gladwin et al., 1995). Sustainable development is defined as the development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987, also known as the Brundtland Commission). Sustainability has three dimensions: economic, social and environmental, also known as the triple bottom line (TBL) or 3BL, as shown in Figure 1.

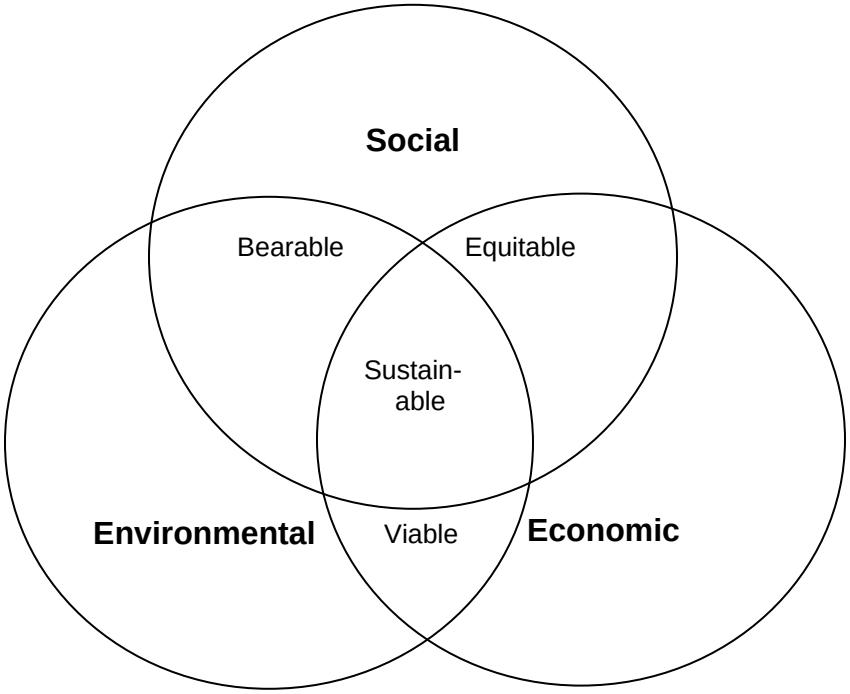

Fig. 1: Dimensions of sustainability: Triple Bottom Line (TBL or 3BL)

While economic viability is necessary for an organization to survive, it is not sufficient to sustain the organization in the long run if it causes irreversible damages to the ecosystem by emitting greenhouse gases (GHG) and toxic wastes and depleting non-renewable resources or it fails to ensure safety, security, dignity, healthcare, minimum wage,

indiscrimination and better working conditions for its employees, the community and the society in general. Therefore, it has become imperative for any organization to behave in a socially and environmentally responsible manner while trying to achieve its economic goals.

Although supply chain management has been widely studied since the last two decades, the discussion on sustainability in the supply chain literature has gained momentum since the early 2000s. Figure 2 traces the evolution of supply chain management (SCM) through the last four decades.

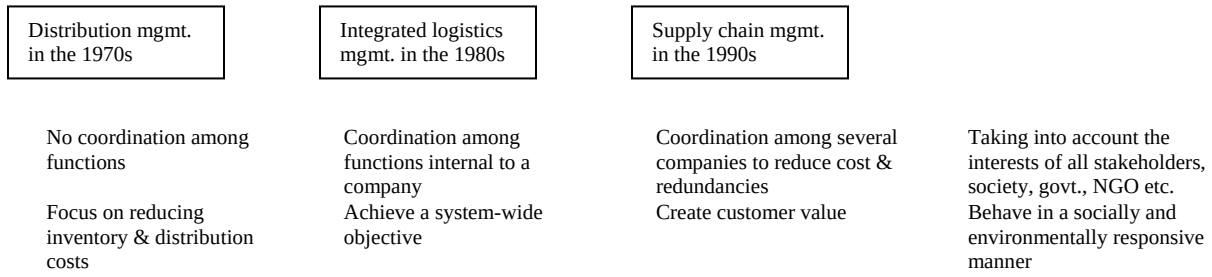

Fig. 2: Evolution of supply chain management

The evolution of SCM can be traced back to “distribution management” in the 1970s where there was no coordination among the various functions of an organization, and each was committed to attain its own goal. This myopic approach transformed into “integrated logistics management” in the 1980s that called for the integration of various functions to achieve a system-wide objective. SCM, which evolved in the 1990s due to increased competition and globalization, further widens this scope by including the suppliers and customers into the organizational fold, and coordinating the flow of materials and information from the procurement of raw materials to the consumption of finished goods. The objectives of SCM are to eliminate redundancies, and reduce cycle time and inventory so as to provide better customer service at lower cost (Mitra and Chatterjee, 2000). In the 2000s, it became imperative for a company to not only incorporate suppliers and customers into the supply chain, but also take into

represents a closed-loop supply chain and the different product recovery options based on the quality of returns and the degree of disassembly.

Fig. 3: Closed-loop supply chain and different product recovery options

In many developed countries in North America and Europe, manufacturers are being held responsible by law for collection, transportation and disposal or recovery of their products and packaging after use since areas earmarked for land-filling are gradually shrinking. Even the awareness among the general public towards environment-friendly products and processes has substantially increased. There is a market for “green” products, which is estimated to be in excess of USD 200 billion (Carter and Ellram, 1998). Since manufacturers are now being held accountable for the entire life cycle of their products, they should strive to design more eco-friendly and easily recoverable products, and recover the economic value as far as possible from returns. This would not

besides cost, quality, delivery, flexibility and innovation. Companies adopting SSCM practices can now explore new market opportunities and lobby with the government to frame laws and regulations to their advantage (Porter and van der Linde, 1995; Shrivastava, 1995; Kleindorfer et al., 2005; Krause et al., 2009; Flint and Golicic, 2009; Hazen et al., 2011; Schoenherr, 2012; Narasimhan and Schoenherr, 2012). Further reviews on SSCM or closed-loop supply chains are available in Linton et al. (2007), Carter and Rogers (2008), and Guide and van Wassenhove (2009).

authors' knowledge, there has been little study on SSCM practices in India so far. This paper is one of the earliest studies to conduct a survey to assess the extent of adoption of SSCM practices in Indian manufacturing firms and explore the causal relationships between SSCM practices and firm performance. The impact of adoption of SSCM practices on firm performance has so far been inconclusive (Carter et al., 2000; Pagell et al., 2004; Zhu et al., 2005; Hazen et al., 2011; Zhu et al., 2012; Green et al., 2012a, 2012b). If the present study finds a positive causal relationship between SSCM practices and firm performance, the same can act as a motivating factor for Indian supply chain managers to more proactively adopt sustainable practices. The objectives of the study have been three-fold – (a) to identify the key success factors (KSF) and key performance indicators (KPI) for successful implementation of SSCM practices, (b) to benchmark the Indian practices against the SSCM practices in other developed and developing countries, and (c) to draw implications for supply chain managers in terms of achieving better SSCM practices and thus making positive contributions to the firm, economy and environment.

In this paper, we focused on two dimensions of sustainability – economic and environmental. Therefore, SSCM, as it has been referred to throughout this paper, may as well be referred to as Green Supply Chain Management (GSCM) (Zhu and Sarkis, 2004; Zhu et al., 2005; Rao and Holt, 2005; Vachon and Klassen, 2006; Hazen et al., 2011; Giovanni (2012); Zhu et al., 2012; Kumar et al., 2012; Green et al., 2012b; Shi et al., 2012). The reason for dropping the social dimension of sustainability is that there are many aspects of this dimension such as dignity, diversity, human rights, education, indiscrimination, sanitation, healthcare, social security, food security, infrastructure, living condition and so on, which are very broad in concept and may have no direct link with supply chains per se. As noted by Giovanni (2012), it has been extremely difficult to identify the relevant items and measure social sustainability in supply chains. Although research has proposed some general indicators, till date it has not been able to develop a measurement scale to investigate the social bottom line. According to Shi et al. (2012), social aspects depend on the preferences and values of the people involved, and hence are more complex and less clear than environmental issues. Similar observation was made by

Hollos et al. (2012), who found that the environmental dimension was more observable than the social dimension. Krause et al. (2009) note that while many companies have made progress in terms of environmental and economic issues, significant progress is generally lacking in social issues. Many supply chain managers, who took part in the survey, expressed difficulty in linking the SSCM practices of their firms with the social initiatives and achievements. In literature, the environmental dimension has often received priority over the social dimension and except for a few papers incorporating the social dimension (Hollos et al., 2012; Giovanni et al., 2012; Zailani et al., 2012), most of the papers have dealt with the environmental and economic dimensions only. Also, in literature, SSCM and GSCM have often been interchangeably used (Flint and Golicic, 2009; Carter and Easton, 2011; Wu and Pagell, 2011).

The supply chain that we have considered in this paper consists of the manufacturer and its immediate (Tier-I) suppliers. Customers have not been included in the supply chain (except for 2 items on reverse supply chains, which have not been able to draw adequate responses and will be discussed later) since during the questionnaire design phase of the survey, discussions with the prospective respondents revealed that Indian customers were still lagging behind their U.S. and European counterparts in terms of their awareness towards sustainability and as such there was little or no involvement of customers with manufacturers towards collaborative product and process design, packaging, transportation and distribution of finished goods. This also draws support from the literature (Ishaswini and Datta, 2011; Das, 2012), as mentioned before. Further, the respondents to the survey, who belonged to manufacturing firms, felt comfortable to respond to questions related to their immediate or Tier-I suppliers. Tier-II, Tier-III and other higher-up suppliers have, therefore, been excluded from the survey. Also, in literature, very few papers have included items related to customers (Zhu and Sarkis, 2004; Zhu et al., 2005; Vachon

The organization of the paper is as follows. In Section 2, we review the relevant literature and derive the items for the questionnaire survey. We then review the existing theory, build the research framework and develop the hypotheses to be tested in Section 3. In Section 4, we discuss the research methodology including the design and administration of the questionnaire, data collection and collation, and tools and techniques for data analysis. Section 5 presents the results of the data analysis along with discussions on the results. Section 6 discusses the major findings and their implications for supply chain managers. Finally, concluding remarks and directions for future research are presented in Section 7.

2. Literature review

As mentioned in Section 1, the primary objective of this paper has been to explore the causal relationships between SSCM practices and firm performance in the Indian context. SSCM practices include sustainable purchasing practices, and sustainable manufacturing and logistics practices. Drivers of SSCM practices have also been included. In this section, we review the relevant literature on the drivers of SSCM practices, sustainable purchasing practices, sustainable manufacturing and logistics practices, and firm performance, and derive the items for inclusion in the questionnaire.

2.1 Drivers of SSCM

Min and Galle (2001) note that many buying firms get involved in sustainable purchasing in a reactive manner in that they do so just to avoid violations of regulatory laws. Rao (2002) notes that adoption of SSCM practices is encouraged by government and market forces. Zhu and Sarkis (2004) also mention competitive and regulatory pressures as drivers of SSCM. Pagell et al. (2004) and Shi et al. (2012) mention about proactive and reactive strategies for sustainability. They note that whid makcx-boolvedto51D0 Tceies for sustainabietit

increased their environmental awareness due to regulatory, competitive, and marketing pressures and drivers with regulatory factors being the most important among them all. According to Peters et al. (2011), sustainability strategies can be differentiated into compliance and proactive strategies. While compliance strategies reactively follow existing rules, norms and standards, proactive strategies in supply chains lead to voluntary adoption of SSCM practices. Green et al. (2012b) note that in addition to customer requirements, environmental legislations and regulations have been identified as drivers of the adoption of SSCM practices. Krause et al. (2009) and Walker and Jones (2012) note that some firms are driven from within by top management to adopt SSCM practices as part of their business strategy while others are coerced to do so and respond reactively to outside influences such as supplier and customer pressures and regulations.

From the discussion above, it is clear that firms may adopt SSCM practices voluntarily, without any external pressure, or they may be compelled to comply with regulations or adopt SSCM practices under pressure from customers and competitors. This forms the basis for developing the items on the drivers of SSCM.

2.2 Sustainable purchasing practices

According to Krause et al. (2009), a firm is no more sustainable than its suppliers and as such the purchasing function becomes central in a firm's sustainability effort. Rao and Holt (2005) note that stakeholders do not always distinguish between a manufacturer and nowhile otu3ey often hold the manufacturer responsible for any adverse environmental impact caused by the supply chain of which the manufacturer is a part (Rao, 2002). Eighty seven percent of customers would accuse the manufacturer of environmental negligence when its suppliers are environmentally irresponsible (Wong et al., 2012). u3erefore, sensitizing suppliers and integrating them with the firm's SSCM initiatives become a priority for the manufacturerotu3e manufacturer has to generate awareness

make the final product non-polluting, bio-degradable and/or recyclable, the manufacturer insists that its suppliers provide materials conforming to pre-specified environmental criteria (Carter et al., 2000; Zailani et al., 2012). Here, by suppliers, we mean not only the suppliers of raw materials, parts and components, but also the suppliers of packaging materials and providers of upstream and downstream logistics services such as transportation, warehousing and so on because all of them are part of the same supply chain (Krause et al., 2009). To ensure that its suppliers strictly follow environment-friendly practices, the manufacture may select them based on environment-related criteria (Min and Galle, 2001; Rao, 2004; Rao and Holt, 2005; Giovanni, 2012) and then periodically monitor/audit their performance for conformance (Zhu and Sarkis, 2004; Rao, 2002; Shi et al., 2012; Zailani et al., 2012). The manufacturer may also insist that its suppliers implement an Environment Management System (EMS) and/or get ISO 14001 certified, which will give an assurance to the manufacturer that its suppliers are following environment-friendly practices, as certified by an external agency (Zhu and Sarkis, 2004; Vachon and Klassen, 2006; Giovanni, 2012; Green et al., 2012b; Shi et al., 2012; Wong et al., 2012; Zailani et al., 2012; Zhu et al., 2005, 2012). This is especially important when the manufacturer and its suppliers are geographically dispersed, e.g. U.S. and European companies sourcing from the South-East Asian region (Rao and Holt, 2005).

Hollos et al. (2012) note that buyers have two options – (a) select and accept only sustainable suppliers and drop suppliers that do not meet environmental standards, and (b) cooperate with existing or new suppliers for higher levels of sustainability. This leads to two types of buyer-supplier relationships – cooperative or collaborative and transactional. In contrast to transactional relationships, cooperative or collaborative relationships can increase the performance of both buyers and suppliers. Drawing from the resource-based view (RBV) (Barney, 1991)/natural resource-based view (NRBV) (Hart, 1995) of the firm, the authors mention sustainability as one of the valuable, rare, inimitable and non-substitutable resources that may be a source of competitive advantage to a firm. Cooperative or collaborative relationships with suppliers for higher levels of sustainability will, therefore, not only improve a firm's performance, but also provide the firm with a significant competitive advantage over its competitors. Vachon and Klassen

finished goods, and recovery and/or disposal of products and packaging discarded/returned after use (reverse supply chains).

2.3.1 Sustainable product design

Zhu et al. (2005) note that the design of products is critical in that it is the most effective way to reduce the environmental impact of products through pollution prevention. Products should be designed with environment-friendly raw materials, parts and components to reduce energy consumption, emissions, and generation of solid and liquid wastes during production, transportation, storage and usage. Moreover, if products need to be disposed of and/or recycled after use, they should contain more and more bio-degradable and recyclable materials (Carter et al., 2000; Zhu and Sarkis, 2004; Rao and Holt, 2005; Green et al., 2012b; Zhu et al., 2005, 2012). Also, the design should facilitate easy disassembly of products for reuse and recycling (Carter et al., 2000; Carter and Easton, 2011; Hollos et al., 2012; Shi et al., 2012; Wong et al., 2012). A firm along with its supply chain partners should conduct life cycle analysis for its products to assess their environmental impacts through various stages of their life cycles (Carter et al., 2000; Linton et al., 2007; Kumar et al., 2012; Shi et al., 2012; Zailani et al., 2012). Large U.S. electronics firms such as AT&T, Digital, IBM and Xerox have design-for-environment (DfE) practices that involve life cycle analysis of their products. The DfE group at AT&T developed an environmentally-responsible-product (ERP) matrix to assess the life cycle impact of product designs. The DfE group also developed a software tool, the Green Index, to provide product designers with decision support and environmental assessment. At Xerox, designers chose a minimal number of materials from the material-environmental-index to avoid toxic and hazardous materials. The index specified the impact of various materials on the environment and helped designers choose non-toxic materials safe for disposal, reuse and recycling (Lenox et al., 2000; Maslennikova and Foley, 2000).

Based on the literature review, the following items on sustainable product design have been included in the survey – designing products with bio-degradable/recyclable

materials, designing products for easy disassembly and designing in association with life cycle analysis for products.

2.3.2 Sustainable process design

Along with sustainable product design, manufacturing processes should also be so designed that energy and resource consumption (Wong et al., 2012), air emissions, and generation of solid and liquid wastes are minimized (Rao, 2002, 2004; Pagell et al., 2004;

a legislation that makes it mandatory for manufacturers to take back all the packaging after use (Zsidisin and Hendrick, 1998). Packaging materials should be minimal and light-weight (Carter et al., 2000), and should not have any adverse environmental impact (Rao, 2002; Shi et al., 2012). Moreover, they should be recyclable (Hollos et al, 2012; Wong et al., 2012; Zailani et al., 2012), i.e. used as many times as possible before disposal, and bio-degradable (Zhu et al., 2012) as they need to be disposed of at the end-of-life. Corrugated packaging is being more extensively used since it is easier to recycle. Standardized, reusable shipping containers are also gradually replacing disposable ones. Manufacturers are more and more devising refilling systems for their products that not only reduce packaging wastes, but also save money for consumers (Green et al., 1998). Xerox developed two returnable boxes made of wood and steel to deliver equipment and recover them at the end-of-life. This not only eliminated the need for disposable packaging, but also reduced costs to customers by USD 15 per unit on average and saved USD 3.5 million per annum for the company (Maslennikova and Foley, 2000). Wu and Dunn (1995) identify safe warehousing and storage as a critical issue in distribution. They argue that efficient and safe warehousing layouts not only make it easy for storage, access and retrieval, but also lead to operational improvements and environmental sustainability. For transportation and distribution, firms should explore railways and waterways as alternative modes of transport since they are more environment-friendly (Rao, 2002; Rao and Holt, 2005; Green et al., 2012b; Kumar et al., 2012; Shi et al., 2012; Wong et al., 2012) than the conventional road and air transportation. Railways will also provide economies of scale compared with roadways and airways, which would not only

packaging, using environment-friendly storage, using alternative transport mechanisms and achieving economies of scale in transportation.

2.3.4 Recovery and/or disposal of products and packaging after use

Many countries have now passed legislations that hold manufacturers responsible for recovery and/or disposal of their products and packaging discarded/returned after use. The responsibilities of manufacturers include collection, transportation, inspection, recovery and/or disposal of returns. This reverse flow of materials is referred to as reverse logistics, and when integrated with the manufacturer's forward supply chain, is called a closed-loop supply chain. Although compelled by law to handle returns for recovery and/or disposal, manufacturers also find an economic incentive in engaging in the same. For example, in remanufacturing, one of the product recovery options shown in Figure 3, the quality of returns is upgraded to "as good as new" at 40-60% of the cost of manufacturing a virgin product with only 20% of the effort (Lund, 1984; Dowlatshahi, 2000). There is a market for remanufactured products where they are sold with the same warranty as that for a virgin product, but at substantially discounted prices (Thierry et al., 1995). Moreover, being engaged in recovery and/or disposal of returns boosts manufacturers' corporate image (Mitra, 2007, 2009).

There are many decision problems in reverse logistics such as the locations of collection and inspection centres and recovery facilities. Should inspection centres be located close to the points of collection or should they be centralized? In the former arrangement, there will be high investments in equipment for decentralized inspection, but transportation costs will be low since there is no need to carry irrecoverable returns for recovery. On the other hand, in the latter arrangement with centralized inspection, investments in equipment will be low, but transportation costs will be high (Mitra, 2007). Similarly, decisions have to be made on centralization/decentralization of recovery facilities, integration of recovery activities with normal production operations or outsourcing of recovery activities to third parties, and so on (Fleischmann et al., 1997).

Items that have been included for survey in the extant literature on SSCM are on

market opportunities under economic performance. They argue that adoption of SSCM practices improves a firm's corporate image, which in turn enables the firm to charge premium prices, increase sales and market share, and explore new market opportunities. Eventually, all this leads to increased profitability. Similarly, operational and competitive measures have been combined in the form of quality, productivity, efficiency and cost savings under the competitiveness dimension. Wong et al. (2012) consider different profitability measures under financial performance. Shi et al. (2012) consider quality, productivity, efficiency, flexibility and innovation under operational performance, and profitability, growth, market share and sales under financial performance. Green et al. (2012a, 2012b) consider profitability, growth, market share and sales under organizational performance. Giovanni (2012) consider profitability, market share and cost savings under economic performance. Zailani et al. (2012) consider cost savings under operational performance, and sales, market share and efficiency under economic performance. Zhu and Sarkis (2004), Zhu et al. (2005, 2012) and Green et al. (2012b), on the other hand, consider cost savings under economic performance and quality under operational performance. Hollos et al. (2012) consider quality and innovation under operational performance, and cost savings under a different dimension called cost reduction. Schoenherr (2012) uses cost, quality, delivery and flexibility as plant performance measures.

As indicated above, items may belong to different dimensions of firm performance depending on perception. We have followed Rao (2002) and Rao and Holt (2005), and retained the following two dimensions of firm performance – economic performance and competitiveness[2]. While economic performance covers organizational, financial, economic and marketing performance measures, competitiveness covers the operational and competitive dimensions of firm performance. The items that we felt relevant and have been included in the study are the following – quality, productivity, efficiency, innovation, cost savings, sales, market share, penetration of new market, acquisition of new customers, organizational profitability and growth. In addition, we felt the following items should be included in the study – corporate image, first-mover advantage, long-

[2] Factor analysis results discussed later show that the items have indeed loaded on two factors.

term benefits, patenting of products and processes, and influencing policy makers. It has already been mentioned that adoption of sustainable practices in supply chains enhances corporate image (Zailani et al. (2012) mentions this as a social performance measure). Adoption of sustainable practices also provides a first-mover competitive advantage including patenting of products and processes and influencing policy makers to frame rules and regulations to the advantage of the firm (Porter and van der Linde, 1995; Carter and Rogers, 2008). In the 1990s, German automaker BMW initiated a "design-for-disassembly" programme for product take-back and recycling, and being a first-mover, entered into long-term contractual agreements with a handful of sophisticated dismantlers. This initiative not only enhanced BMW's reputation as a maker of DfE automobiles, but also enabled BMW to influence the government to make product take-back and recycling a national standard in the German auto industry. When the other automakers had no other option but to follow suit, they were left to deal with small-scale, unorganized dismantlers and face diseconomies of scale. Since by then BMW had already built its dismantling infrastructure, it enjoyed a definite cost advantage over its competitors (Hart, 1995; Shrivastava, 1995).

3. Research framework

In this section, we review the existing theory, build the research framework and develop the hypotheses to be tested in this paper. In particular, the causal relationships among voluntary adoption, SSCM practices (sustainable purchasing and sustainable manufacturing and logistics practices) and firm performance are explored. The following subsections discuss the theory behind every pair of causal relati

advantage including innovations in design, patenting of products and processes, and influencing policy makers to frame rules and regulations to their advantage. Klassen and

Hypothesis H2b: Firms adopting SSCM practices voluntarily are more likely to engage in sustainable manufacturing and logistics practices than firms that adopt SSCM practices under regulatory compliance and customer and competitive pressure.

3.3 Sustainable purchasing, manufacturing and logistics practices

There is no consensus in the extant literature with respect to the causality between sustainable purchasing and sustainable manufacturing and logistics practices. Either no causality is assumed between these practices or if there is causality, there is no consensus on the direction of causality. Zhu and Sarkis (2004) consider no causal relationship between external GSCM practices and eco-design. Similarly Zailani et al. (2012) consider no causal relationship between

Although firms engage in sustainable purchasing practices as a consequence of adopting sustainable manufacturing and logistics practices, the former would have a positive learning effect on the latter in the long run (Hollos et al., 2012). According to Zhu et al. (2012), previous studies show that external GSCM practices facilitate the adoption of internal GSCM practices. Further, they note that environment-friendly inputs, through green purchasing, are a pre-requisite for eco-design of products. In other words, a firm is no more sustainable than its suppliers (Krause et al., 2009), which leads us to propose the following hypothesis.

Hypothesis H3: Sustainable purchasing practices are positively related to sustainable manufacturing and logistics practices.

3.4 SSCM practices and firm performance

As discussed before, the literature on the effect of SSCM practices on firm performance has been inconclusive. Klassen and McLaughlin (1996) note that earlier research on the linkage between environmental practices and financial performance has been mixed, although generally positively correlated. King and Lenox (2001) also do not find any conclusive link between the two and call for further investigation. For instance, sustainable purchasing practices are expected to reduce pollution at source, but whether that would translate into improved financial performance is not known. Similarly, sustainable manufacturing and logistics practices are expected to improve the competitiveness of a firm, but whether that would lead to improved financial performance is also not clear (Rao, 2002; Rao and Holt, 2005). Zhu et al. (2012) argue that the lower scale of adoption of external GSCM practices such as supplier collaboration compared with the scale of adoption of internal GSCM practices such as

leading to a long-term economic and competitive advantage (Zhu and Sarkis, 2004; Krause et al., 2009).

Rao and Holt (2005) note that since consumers are becoming more and more aware of the environment, environmental issues have emerged as a source of competitive advantage. Adoption of SSCM practices would improve operational performance through increased efficiency of processes and recycling of wastes, and avoidance of penalties, disposal costs and higher future costs of compliance. Moreover, environmental practices would enhance corporate image, increase market share and new market opportunities, and thereby lead to improved financial performance (Klassen and McLaughlin, 1996; Carter et al. 2000).

According to Schoenherr (2012), previous research has shown a positive effect of investments in environmental practices on a firm's competitive advantage and operational performance. Shi et al. (2012) propose that intra- and inter-organizational environmental practices are positively related to operational and financial performance. Klassen and McLaughlin (1996), Carter et al. (2000), Zhu and Sarkis (2004), Rao and Holt (2005), Hollos et al. (2012), Zailani et al. (2012) and Zhu et al. (2012) also find a positive effect of environmental purchasing/green practices on firm performance. Green et al. (2012a, 2012b) find an indirect positive relationship between environmental practices and organizational performance through other performance measures. Giovanni (2012), on the other hand, finds no significant direct relationships between internal and external environmental management and economic performance. Wong et al. (2012) examine the moderating effect of the environmental management capability of suppliers on the causal relationships between product and process stewardship and pollution reduction and financial performance, and find mixed results.

A review of the recent literature, as above, indicates mostly positive linkages between SSCM practices and firm performance, and leads us to propose the following hypotheses.

Hypothesis H4: Sustainable purchasing practices are positively related to competitiveness.

Hypothesis H5: Sustainable purchasing practices are positively related to economic performance.

Hypothesis H6: Sustainable manufacturing and logistics practices are positively related to competitiveness.

Hypothesis H7: Sustainable manufacturing and logistics practices are positively related to economic performance.

In addition, the following hypothesis is proposed based on the literature (Rao, 2002; Rao and Holt, 2005; Hazen et al. 2011) that suggests a positive relationship between competitiveness and economic/financial performance.

Hypothesis H8: Competitiveness is positively related to economic performance.
Figure 4 shows the research framework and hypotheses to be tested.

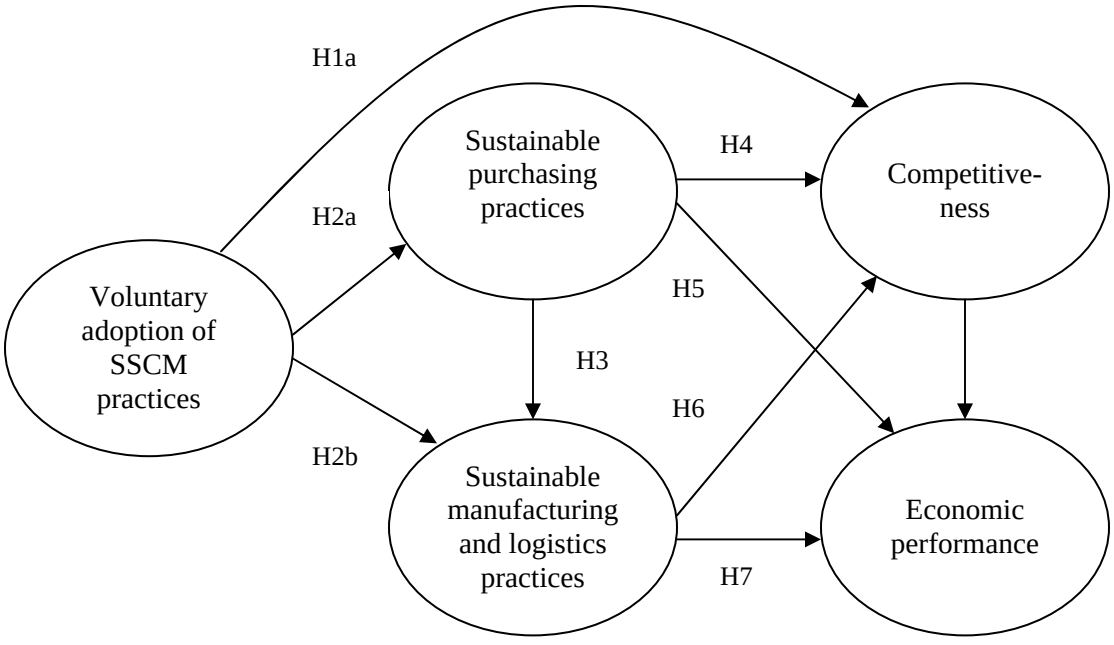

Fig. 4: Research framework

We also intend to explore the causal relationships between the following – (a) being ISO 14000 certified and adoption of SSCM practices, and (b) being an MNC and adoption of SSCM practices. Carter and Rogers (2008) associate the implementation of ISO 14000 standards with reduced costs, shorter lead times and better product quality. Pagell et al. (2004) note that a certified EMS, such as ISO 14000, leads to higher levels of operational performance. Schoenherr (2012) also finds a positive relationship between the extent of investments in ISO 14000 certification programmes and plant performance in terms of cost, quality, delivery and flexibility. Zhu and Sarkis (2004) and Zhu et al. (2012) find a positive relationship between internal environmental management, of which ISO 14000 certification is a part, and firm performance. However, Zhu et al. (2012) also observe that when green purchasing acts as a mediating variable for the relationship between internal environmental management and firm performance, the mediating effect is not significant.

The literature cited above explores the relationship between ISO 14000 certification and firm performance. However, the literature on the relationship between being ISO 14000 certified and adoption of SSCM practices is rather limited. Rao (2002, 2004) and Rao and Holt (2005) present their findings based on only ISO 14000 certified firms. Therefore, whether firms that are ISO 14000 certified are more likely to voluntarily adopt SSCM practices than firms that are not ISO 14000 certified is not explored. Green et al. (2012a, 2012b) find positive relationships between internal environmental management, of which ISO 14000 certification is a part, and green information system/eco-design (equivalent to sustainable manufacturing and logistics practices) and environmental collaboration with suppliers/green purchasing (equivalent to sustainable purchasing practices). In this studies, however, ISO 14000 is only one of the items of the construct, internal environmental management, and hence the direct causal relationship between ISO 14000 certification and adoption of SSCM practices is not explored. We believe that ISO 14000 certification, besides internal environmental improvement, leads to external collaborations with suppliers and other supply chain partners, and eventual adoption of SSCM practices. To examine the same, we propose the following hypothesis.

Hypothesis 9: ISO 14000 certified firms are more likely to voluntarily adopt SSCM practices, including sustainable purchasing, manufacturing and logistics practices, than firms that are not ISO 14000 certified.

The literature on the effect of being an MNC/non-MNC on the adoption of SSCM practices is scarce. Zhu and Sarkis (2004), in their study on Chinese manufacturing firms, observe that globalization increases MNC investments in developing countries where their subsidiaries are expected to engage in sustainable practices more than their domestic counterparts do. This is also true that MNCs prefer to institute the same environmental practices in every country they operate in, irrespective of the existing rules and regulations, since doing the same would not only confirm their environmental responsibility, but also make it easy for them to replicate and standardize the same set of practices across all the countries. Therefore, we propose the following hypothesis.

Hypothesis 10: MNCs are more likely to voluntarily adopt SSCM practices, including sustainable purchasing, manufacturing and logistics practices, than non-MNC Indian firms.

4. Research methodology

The research methodology was based on a survey of Indian manufacturing firms to assess the extent of adoption of SSCM practices and their impact on firm performance in terms of testing the proposed hypotheses. The items and scales for the survey questionnaire, shown in the Appendix, were 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 pre-tested among 10 firms, and based on their feedback, the questionnaire was finalized. Subsequently, we approached in person and over telephone the senior executives looking after or knowledgeable about the supply chain management function of about 232 firms located in the major industrial belts of India with a write-up on SSCM and the survey questionnaire asking the firms whether they deployed some of the SSCM 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 SSCM 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. Among the firms that responded in the affirmative, 114 agreed to fill in the questionnaire, and finally 81 filled-in, usable questionnaires were received. Since the respondents agreed to fill in the questionnaire and all the questionnaires were filled in in person by appointment, we conclude that there is no non-response bias. The respondent firms varied in size, from tens of millions of USD to a few hundred million USD in revenues (Max: USD 376 million, Min: USD 38 million, Mean: USD 106 million, Median: USD 77 million)[3], and the industry sectors they represented, from automobiles (8.64%), electronics (7.41%), engineering (17.28%) and consumer goods (14.81%) to leather (17.28%), textiles (14.81%), pharmaceuticals (11.11%), cement/iron and steel (8.64%). Therefore, we feel that the findings of this study are generalizable to a great extent across diverse industries and firms of different sizes. All respondent firms are ISO 9000 certified. Seventy two of them have implemented some form of EMS and 29 of them are ISO 14000 certified. The number of MNCs in the sample is 29. We defend the somewhat small sample size by the following arguments. First, since the concept of SSCM is still new in India and we required responding firms to have adopted at least some of the listed SSCM practices, many firms we contacted felt they were not yet ready to respond to the questionnaire. Secondly, our sample size still exceeds, or is comparable with, the sample sizes used by some of the published papers on SSCM/GSCM (See, for example, Rao (2002, 2004), Rao and Holt (2005), Vachon and Klassen (2006), and Hollos et al. (2012)). Finally, our sample size also exceeds the minimum sample size of 50 for multivariate data analysis, as recommended by Hair et al. (2007, p. 136).

Data collected were collated in Microsoft Excel, and analyzed using regression, factor analysis, confirmatory factor analysis and structural equation modelling. Although previous studies conducted factor analysis and assigned items/variables to different latent

[3] Many firms being unlisted and private did not wish to share financial data. The estimates made by the authors were based on informal information and secondary data. The USD~INR (Indian Rupees) exchange rate was taken as the average prevailing in the month of February, 2013.

constructs, there has been non-uniformity in the definition of items and their inclusion in constructs, as already mentioned before. Also, since this is one of the earliest studies on SSCM practices in India, items/constructs specific to the Indian context have not been developed yet. Therefore, we decided to include items in the questionnaire based on literature review and feedbacks received during pre-testing, and conduct factor analysis to identify the latent constructs and their composition of items. A confirmatory factor analysis was carried out for validity, reliability and an overall fit of the model. Regression analysis and structural equation modelling were employed to test the proposed hypotheses. As far as the software is concerned, SAS was used for factor analysis, and AMOS was used for confirmatory factor analysis and structural equation modelling.

5. Results and discussions

In this section, we present the results of factor analysis, confirmatory factor analysis, structural equation modelling and regression, followed by discussions. We have followed Hair et al. (2007) throughout for data analysis.

5.1 Factor analysis

The following points relate to factor analysis.

Normality, linearity, homoscedasticity and homogeneity of the sample are assumed.

The following criteria were satisfied:

(a) The minimum sample size is 50.

(b) The minimum respondents-to-variables ratio is 5.

(c) There exist significant correlations among many of the variables.

(d) Partial correlations among most of the variables are 0.5 or less.

(e) The measures of sampling adequacy (MSA), overall and for individual variables, are at least 0.5.

(f) Based on Harmon's one-factor test, it is found that the unrotated factor solution reveals no single factor, which accounts for more than 50% of the

variance, indicating the non-significance of the issue of common method bias (Hazen et al., 2011).

We employed the principal components analysis with varimax rotation.

The number of factors was decided based on the following criteria – (i) empirical evidence, (ii) eigen value is more than 1, and (iii) cumulative percentage of total variance extracted is at least 60%.

To consider an item to load on a factor, a minimum absolute factor loading of 0.65 is required.

Communalities of variables should be at least 0.5.

Content/face validity is assessed through the following means – (i) items taken from the extant literature, (ii) expert opinions, and (iii) pre-testing of the questionnaire.

Unidimensionality is assessed in terms of items loading on a single factor and non-existence of significant cross-loadings.

Reliability is assessed through the following means – (i) item-to-item correlation is more than 0.3, (ii) item-to-total (summated scale) correlation is more than 0.5, and (iii) Cronbach's alpha is at least 0.7.

5.1.1 Drivers of SSCM

Items 8a-8d in the questionnaire relate to the drivers of SSCM. Table 1 shows the descriptive statistics.

Table 1: Descriptive statistics related to the drivers of SSCM

Questionnaire item	Mean	Standard deviation	% agree or strongly agree
8a	3.89	0.71	77.78
8b	2.59	1.17	27.16
8c	2.05	0.63	0.00
8d	2.39	0.74	4.94

The following observations can be made from Table 1.

(a) Most of the respondents adopted SSCM practices voluntarily as the item 8a: Voluntary adoption has a mean score of 3.89 and 77.78% respondents either agree or strongly agree with the item.

(b) Few adopted SSCM practices to comply with regulations with a mean score of 2.59, well below the mid-point of the scale, i.e. 3 for the item 8b: Complying with regulations. This shows that in India, environmental norms are still not as stringent as in developed countries. Strict laws are yet to be put in place to compel firms to follow sustainable practices. Wu and Pagell (2011) also mention about the lack of stringent environmental regulations in China and India.

(c) Items 8c: Adoption under pressure from customers and 8d: Adoption under pressure from competition, are not relevant in the Indian context as evidenced by their very low mean scores and insignificant percentages of the respondents agreeing or strongly agreeing with the items. This shows the lack of external pressure on firms to adopt SSCM practices. Indian customers are still not sensitive towards environmental degradation and like their counterparts in developed countries do not demand environment-friendly practices from manufacturing firms (Ishaswini and Datta, 2011; Das, 2012).

By factor analysis, two meaningful factors were identified. One may be termed *voluntary adoption* and the other *adoption under external pressure*. Table 2 shows the items and their loadings on the respective factors.

Table 2: Factor loadings for the drivers of SSCM

Questionnaire item	Factor 1: Voluntary adoption	Factor 2: Adoption under external pressure
8a	0.77411	
8b	-0.75544	
8c		0.77606
8d		0.68716

It may be noted from Table 2 that items 8a: Voluntary adoption and 8b: Complying with regulations, load on the same factor with a negative factor loading for item 8b. This is also confirmed by the significant negative correlation between items 8a and 8b. This indicates that firms, which adopt SSCM practices voluntarily, do not do so for regulatory compliance. Items 8c: Adoption under pressure from customers and 8d: Adoption under pressure from competition, load on the same factor indicating adoption under external pressure. It has already been observed that none of the respondent firms adopted SSCM practices under external pressure. Cronbach's alpha for Factor 1: *Voluntary adoption* is 0.772570 (after reverse scoring item 8b because of its negative factor loading) and the same for Factor 2: *Adoption under external pressure* is 0.731634.

5.1.2 Sustainable purchasing practices

Seven items, 9a-9g in the questionnaire relate to sustainable purchasing practices. Table 3 shows the descriptive statistics.

Table 3: Descriptive statistics related to sustainable purchasing practices

Questionnaire item	Mean	Standard deviation	% agree or strongly agree
9a	3.15	1.00	32.10
9b	3.04	0.81	32.10
9c	2.38	0.75	6.17
9d	2.19	0.63	2.47
9e	3.58	0.74	55.56
9f	2.96	0.84	28.40
9g	3.31	0.94	41.98

The following observations can be made from Table 3.

(a) Except for the items, 9c: Putting pressure on suppliers to implement EMS and ISO 14001 and 9d: Incentivizing suppliers for conformance to EMS/ISO 14001, all other items have mean scores either very close to 3 or well above 3, the centre of the scale. Also, very small percentages of the respondents either agree or strongly agree in terms of the items 9c and 9d, meaning thereby that Indian firms

do not engage in putting pressure on and incentivizing suppliers as part of their sustainable purchasing practices.

(b) In terms of the percentage of respondents, who agree or strongly agree with an item, the most practised sustainability initiative is to urge suppliers to provide environment-friendly materials. Other sustainable purchasing practices, in the order of their importance, are selecting suppliers based on environment-related criteria, educating and generating awareness among suppliers, helping suppliers

suppliers' environmental performance and 9g: Selecting suppliers based on environment-related criteria loaded on Factor 1: *Collaborative relationships with suppliers* while in the literature they have been included as item

Table 5: Descriptive statistics related to sustainable manufacturing and logistics practices

Questionnaire item	Mean	Standard deviation	% agree or strongly agree
10a	3.20	1.02	44.44
10b	3.21	0.99	44.44
10c	3.12	0.86	35.80
10d	3.69	0.82	61.73
10e	3.85	0.67	76.54
10f	2.48	0.89	17.28
10g	3.78	0.67	76.54
10h	3.78	0.72	75.31
11a	3.67	0.79	64.20
11b	3.57	0.77	54.32
11c	3.35	0.79	39.51
11d	2.96	0.89	25.93
11e	3.21	0.86	33.33

The following observations can be made from Table 5.

(a) Except for the item, 10f: Using non-conventional sources of energy, all other items have mean scores either very close to 3 or considerably above 3, the mid-point of the scale. Also, a very small percentage of the respondents agree or strongly agree with item 10f, which indicates that Indian firms still lag behind in terms of using non-conventional sources of energy probably due to their unavailability (Alternative and nuclear energy accounts for only about 3% of total energy use in India, Source: http://www.worldbank.org) and lack of economies of scale.

(b) Except for item 10f, considerable percentages of the respondents either agree or strongly agree with the other items. Items 10e: Reducing energy usage during production, 10g: Reducing resource consumption during production and 10h: Reducing wastage and spill-over during production, are the leading practices indicating that Indian firms accord a high priority to the sustainable design of their production processes.

Factor analysis results showed two meaningful factors. One may be termed *sustainable product design and logistics* and the other *sustainable process design*. Table 6 shows the items and their loadings on the respective factors.

Table 6: Factor loadings for sustainable manufacturing and logistics practices

Questionnaire item	Factor 1: Sustainable product design and logistics	Factor 2: Sustainable process design
10c	0.78160	
10a	0.78032	
11d	0.72643	
11e	0.72425	
10b	0.71002	
11a	0.70160	
11b	0.68780	
11c	0.67507	
10g		0.89988
10e		0.84364
10h		0.82528

Note: Factor loadings of at least 0.65 are only shown.

Items 10d and 10f are dropped for low factor loadings.

Items are arranged in the descending order of their factor loadings.

Item 10d: Carrying out life cycle analysis for products, although had a high mean score and a significant percentage of the respondents either agree or strongly agree with the item, had to be dropped because of its low factor loading. One probable explanation for this exclusion could be the fact that nowadays firms carry out life cycle analysis for their products for various purposes such as to assess the total cost of ownership (TCO) or transaction cost economics (TCE) other than to assess the environmental impacts of their products. Therefore, it may be possible that firms, which score not so high on other dimensions of sustainable practices, may have a formal procedure to carry out life cycle analysis and score high on this item, leading to little correlation of this item to either of the factors.

ng non-conventional sources of energy, having below-average mean score spondents either agreeing or strongly agreeing with the item, displays little either of the factors, as expected, and hence is dropped.

Reducing energy usage during production, 10g: Reducing resource during production and 10h: Reducing wastage and spill-over during aving high percentages of the respondents agreeing or strongly agreeing s, have expectedly loaded on a single factor, Factor 2: *Sustainable process*

lpha for Factor 1: *Sustainable product design and logistics* is 0.91884 and Factor 2: *Sustainable process design* is 0.933555.

erformance

items, 15a-15o in the questionnaire on firm performance. Table 7 shows the atistics.

Table 7: Descriptive statistics related to firm performance

Questionnaire item	Mean	Standard deviation	% agree or strongly agree
15a	3.51	0.91	51.85
15b	3.75	0.73	62.96
15c	2.80	1.10	24.69
15d	3.86	0.65	71.60
15e	3.30	0.84	49.38
15f	3.31	0.85	51.85

The following observations can be made from Table 7.

(a) Except for the items, 15c: Innovation in product and process design, 15n: Patenting of products and processes and 15o: Influencing policy makers and regulators, all other items have mean scores well above 3, the centre of the scale,

Table 8: Factor loadings for firm performance

Questionnaire item	Factor 1: Economic performance	Factor 2: Competitiveness
15h	0.89110	
15g	0.87515	
15j	0.85478	
15k	0.82334	
15f	0.79907	
15l	0.75359	
15e	0.74003	
15i	0.70997	
15n		0.84948
15c		0.83814
15o		0.83719
15b		0.72622
15a		0.65568

Note: Factor loadings of at least 0.65 are only shown.

Items 15d and 15m are dropped for low communalities (< 0.5).

Items are arranged in the descending order of their factor loadings.

Items 15d: Cost savings in production and distribution and 15m: Reaping long-term benefits, although having the highest mean scores and significant percentages of the respondents agreeing or strongly agreeing with the items, have been dropped from factor analysis due to their low communality estimates. It may be noted that the loading of the

We included constructs having at least 3 items. Constructs with less than 3 items (*Voluntary adoption*, *Adoption under external pressure* and *Arms-length or transactional relations*

Table 9: Results of confirmatory factor analysis

It may be observed from Table 9 that the factor loadings of all items are statistically significant and the standardized loading estimates exceed 0.7 except for item 10a: Designing products with bio-degradable materials, for which the standardized loading estimate exceeds 0.6. Also, AVE and CR for all constructs exceed 0.5 and 0.7, respectively, confirming convergent validity. Discriminant validity was confirmed by the criterion given above. Also, the absolute values of all standardized residuals were less than 2.5. Overall model fit statistics: Chi-square = 153.31, Degrees of freedom = 98, Relative Chi-square value (Chi-square/Degrees of freedom) = 1.56 (< 3 recommended for a good fit), GFI = 0.81, AGFI = 0.74, CFI = 0.95 and RMSEA = 0.08 indicate a good fit.

5.3 Structural equation modelling

Since some of the constructs were dropped during CFA, not all of the hypotheses could be tested by structural equation modelling

Hypothesis H8 remains unchanged.

Maximum Likelihood Estimation (MLE) was used for the structural model. Figure 5 shows the path diagram indicating the significant relationships among constructs with the corresponding critical ratios for an overall fit of the structural model.

It was observed that standardized loading estimates for items determined by CFA virtually remained the same in SEM. Absolute values of the standardized residuals were less than 2.5. Also, overall model fit statistics: Chi-square = 154.699, Degrees of freedom = 101, Relative Chi-square value (Chi-square/Degrees of freedom) = 1.53 (< 3 recommended for a good fit), GFI = 0.81, AGFI = 0.75, CFI = 0.95 and RMSEA = 0.08 indicated a good fit.

SEM results show that Hypotheses H3R, H6R and H7R are supported while Hypotheses H4R, H5R and H8 are not supported.

5.4 Regression

Hypotheses H1a, H1b, H2a, H2b, H9 and H10 were tested by regression.

To test Hypothesis H1a, we conducted simple linear regression with items 15a-15c and 15n (items loaded on the construct *Competitiveness*) as the criterion variables and item 8a as the predictor variable. Table 11 shows the t-stats and p-values corresponding to the regression coefficients of the predictor variable for each criterion variable.

Table 11: Regression results for Hypothesis H1a

Questionnaire item	t-stat	p-value
15a: Improvement in product and process quality	1.50*	0.138
15b: Improvement in efficiency and productivity	2.39	0.019
15c: Innovation in product and process design	1.48*	0.143
15n: Patenting of products and processes	2.37	0.020

*Note: * indicates that the model fit is not significant at 5% level of significance. For others, both the model fit and the regression coefficient are significant at 5% level of significance.*

Regression results shown in Table 11 lend only weak support to the hypothesis that voluntary adoption of SSCM practices is positively related to competitiveness.

For testing Hypothesis H1b, we conducted simple linear regression with items 15f-15h and 15j-15k (items loaded on the construct *Economic performance*) as the criterion variables and item 8a as the predictor variable. Table 12 shows the t-stats and p-values corresponding to the regression coefficients of the predictor variable for each criterion variable.

Table 12: Regression results for Hypothesis H1b

Questionnaire item	t-stat	p-value
15f: Increase in market share	2.16	0.016
15g: Penetration of new markets	3.80	0.000

Table 13: Regression results for Hypotheses H2a and H2b

Questionnaire item	t-stat	p-value
9a: Educating and generating awareness among suppliers	2.68	0.009
9b: Helping suppliers set up environment-friendly practices	1.64*	0.106
9c: Putting pressure on suppliers to implement EMS and ISO 14001	-1.17*	0.245
9d: Incentivizing suppliers for conformance to EMS/14001	-0.58*	0.564
9e: Urging suppliers to supply environment-friendly materials	2.24	0.028
9f: Auditing suppliers' environmental performance	2.04	0.045
9g: Selecting suppliers based on environment-related criteria	2.37	0.020
10a: Designing products with bio-degradable materials	2.89	0.005
10b: Designing products with recyclable materials	2.61	0.011
10c: Designing products for quick disassembly	-0.53*	0.597
10d: Carrying out life cycle analysis for products	2.44	0.017
10e: Reducing energy usage during production	0.86*	0.392
10f: Using non-conventional sources of energy	3.89	0.000
10g: Reducing resource consumption during production	0.70*	0.483
10h: Reducing wastage and spill-over during production	-0.22*	0.829
11a: Use of environment-friendly packaging	-0.40*	0.692
11b: Use of recyclable packaging materials	0.84*	0.404
11c: Use of environment-friendly storage	1.84*	0.069
11d: Use of alternative transport mechanisms	2.13	0.037
11e: Achieving economies of scale in transportation	2.23	0.028

*Note: * indicates that the model fit is not significant at 5% level of significance. For others, both the model fit and the regression coefficient are significant at 5% level of significance.*

We observe from Table 13 that out of 20 items related to sustainable purchasing, product and process design, packaging, storage and transportation, only 10 items barely show the significance of the regression coefficients at 5% level of significance. Even after considering items 9c and 9d representing arms-length or transactional relationships with suppliers where expectedly no significant relationships have been found, the observation lends only weak support to the hypotheses that firms that adopt SSCM practices th24tation(aban)tiveps with

*Note: * indicates that the model fit is not significant at 5% level of significance. For others, both the model fit and the regression coefficient are significant at 5% level of significance.*

Hypothesis H9 that ISO 14000 certified firms are more likely to voluntarily adopt SSCM practices, enter into collaborative relationships with suppliers and engage in sustainable manufacturing and logistics practices than firms that are not ISO 14000 certified, is not supported since for only a handful of items, t-stats are significant. This may be due to the fact that many Indian firms being suppliers to U.S. and European firms are mandated to go through the ISO 14000 certification by their customers, although there may be a lack in adoption of commensurate sustainable practices in their supply chains. Also, as Schoenherr (2012) mentions, in developing countries, ISO 14000 certification is seen more from the point of view of compliance than for adoption of SSCM practices.

From the regression results shown in Table 14, the following inferences about MNCs operating in India may be drawn:

(a) MNCs adopt SSCM practices voluntarily, not for regulatory compliance only and not under customer and competitive pressure.
(b) With respect to purchasing practices, MNCs believe more in supplier development and collaborative relationships than in arms-length or transactional relationships such as putting pressure on or incentivizing suppliers.
(c) With respect to the design of products and processes, except for a few items, MNCs are well-focused on environment-friendly practices. The absence of any significant relationship between being an MNC and some of the items may possibly be attributed to the virtually non-existent market for remanufactured and refurbished products and less rigorous environmental regulations as compared to developed countries.
(d) With respect to packaging, storage and transportation, MNCs are well ahead in terms of environment-friendly packaging, storage, transportation and distribution of raw materials and finished goods.

The observations about MNCs as given above lend support to Hypothesis H10 that MNCs are more likely to voluntarily adopt SSCM practices, enter into collaborative relationships with suppliers and engage in sustainable manufacturing and logistics practices than Indian firms.

Table 15 summarizes the results of hypothesis testing.

Table 15: Summary of hypothesis testing

Hypothesis	Brief description			Result
H1a	Voluntary adoption	→	Competitiveness	Weakly supported
H1b	Voluntary adoption	→	Economic performance	Supported
H2a	Voluntary adoption	→	Sustainable purchasing	Weakly supported
H2b	Voluntary adoption	→	Sustainable manufacturing & logistics	Weakly supported
H3R	Collaboration with suppliers	→	Sustainable product design & logistics	Supported
H4R	Collaboration with suppliers	→	Competitiveness	Not supported
H5R	Collaboration with suppliers	→	Economic performance	Not supported
H6R	Sustainable product design & logistics	→	Competitiveness	Supported
H7R	Sustainable product design & logistics	→	Economic performance	Supported
H8	Competitiveness	→	Economic performance	Not supported
H9	ISO 14000	→	SSCM practices	Not supported
H10	MNC	→	SSCM practices	Supported

6. Major findings and managerial implications

The major findings of this study and the consequent managerial implications can be summarized as follows.

The concept of SSCM in India is still in its infancy. The rate of adoption of SSCM is still very low as in China (Zhu and Sarkis, 2004). Larger firms have access to more resources, and therefore, are more likely to adopt sustainability practices compared to smaller firms (Min and Galle, 2001; Zhu and Sarkis, 2004; Vachon and Klassen, 2006; Wu and Pagell, 2011; Zailani et al., 2012). The regulatory environment does not enforce the adoption of SSCM practices. Wu and Pagell (2011) note that many environmentally conscious exemplar firms do not wish to source from countries such as China and India where the environmental norms are less stringent even if sourcing from these countries would have been cheaper. India being one of the prominent exporters of goods and merchandise would do better if it takes steps in the direction of making the environmental regulations more stringent in line with the same in developed countries. Also, there are not enough external pressures from customers and competitors for making supply chains sustainable. As mentioned before, the awareness of sustainability among Indian customers is low. Although there were only 24 responses for items 13a-13j on reverse supply chains, we found that for item 13a, 75% of the respondents maintained that the extent of environment-consciousness among their customers was low. Only firms that had adopted some form of SSCM were the respondents to the survey, and most of them adopted SSCM practices voluntarily, not for regulatory compliance or under customer and competitive pressure. As Flint and Golicic (2009) note, in the short term regulations may be appropriate for compliance, but in the longer term it is more robust to rely on market pressures for implementation of SSCM. According to Krause et al. (2009), sustainability is less visible compared with the other dimensions of competitive priorities, i.e. cost, quality, delivery, flexibility and innovation. Therefore, firms adopting sustainability would benefit by documenting and communicating their SSCM practices to their customers and the markets in which they compete.

Firms that have adopted SSCM voluntarily are

standardization and economies of scale. One of the top global automobile manufacturers has followed the standard practice of setting up a supplier park adjacent to its manufacturing facility in India for co-locating critical suppliers for better integration and coordination, shorter lead times, and increased productivity, efficiency and flexibility. The company considers its suppliers as partners and has developed a collaborative relationship with them based on mutual trust and confidence. Unlike other Indian automobile manufacturers, who maintain an arms-length relationship with suppliers, this company requires its suppliers to obtain ISO 14000 certification, involves them in the product design and manufacturing process, trains them, monitors their performance and makes a genuine effort to help them overcome any problem that they may have come across. While Indian manufacturers force their suppliers to build up huge inventories to cater to rush orders, this company shares its production schedule with suppliers to help them plan accordingly and do away with the requirement of maintaining excess stock. Naturally, this leads to supplier satisfaction and preference over the competitors.

Domestic firms should learn how to adopt SSCM practices from MNCs, especially when doing the same leads to improved firm performance both in the short and long term. Many of the domestic firms are also suppliers to these MNCs requiring them to implement sustainability practices in order to retain the status of preferred suppliers in the long run. As observed by Zhu and Sarkis (2004) for China, due to globalization, the increasing presence of MNCs in India would create a market pressure for domestic firms to eventually adopt SSCM practices to a greater extent.

Collection of products after use for recovery/disposal is virtually non-existent in India. The 24 responses received on items, 13a-13j on reverse supply chains relate to recovery/disposal of products from the point of view of normal business operations rather than from the closed-loop supply chain perspective. For example, for automobiles, there is no return of used vehicles to the manufacturer; only defective auto parts are brought back from the field and replaced. For engineering and iron and steel, defective items are melted, re-moulded and recycled. For pharmaceuticals, medicines damaged during transportation or beyond the date of expiry are collected, returned and disposed of. For

leather goods, rejected export items are either sold as they are or re-cut, re-stitched and re-labelled before selling in the domestic market at a lower price. For textiles, if there is any printing defect, they are brought back to the natural base colour and re-printed. Rejected items are re-cut and re-labelled for selling at a lower price. For electronics, consumer goods and cement, there are no returns.

The non-existence of reverse logistics or closed-loop supply chains in India can be attributed to the lack of legislations, awareness, infrastructure and technology, as also observed by Zhu and Sarkis (2004) in the case of China. Like in developed countries, there is no legislation in India that holds manufacturers responsible for collection/recovery/disposal of their products and packaging after use. The level of awareness of environment-friendly products is also low. Among the 24 responses received for item 13i, 87.5% indicated that there was no market for recovered products. This was corroborated by a senior executive of a top global construction and mining equipment manufacturer, who could not convince his large Indian customers that remanufactured equipment were not “second-hand”; in fact, they were comparable with new equipment in terms of functionality and performance, cost less and bore the same warranty. His company was trying to sell its equipment based on life cycle costing where the price paid by the customer would include the purchase price and the fees payable towards maintenance and repair throughout the life cycle of the equipment. Customers were given the option of buying either a newly manufactured equipment at its original price or a remanufactured equipment at 40-60% discount. However, as experience showed, there were a few takers of the latter offer. The company also could not fully replicate its sustainability practices in other developed countries in its Indian operations although it wished to. The less stringent regulatory norms in India made investments in advanced technologies uneconomical, e.g. the clean fuel the company used worldwide for its engines for fuel efficiency and reduced carbon emissions were not available in India, and importing the same would have been cost-prohibitive. The same executive also mentioned that although his company had a remanufacturing base in its home country, it could not set up a base in India since for this they had to bring used equipment from other Asian countries into India for scale economies, which was not permitted under the

existing law that banned the import of “used” or “second-hand” items on the apprehension of dumping by developed countries. The company felt that in the absence of a supporting regulatory infrastructure, its remanufacturing business in India was not viable.

There are evidences that recovery of used products and packaging not only reduces environmental pollution by eliminating the need for disposal and additional resource consumption, but also adds to corporate profitability and enhances corporate image. The government should revisit the regulatory framework to facilitate product recovery. Efforts should be made to generate awareness towards the benefits of collection and recovery of used products and packaging. Once Indian consumers become more environment-conscious, the market for remanufactured/refurbished products is expected to take off. This may also reduce the import bill for the country. Therefore, increasing product recovery activities and the developm

reduced absenteeism and employee turnover rate, and improved employee satisfaction, productivity and efficiency. Although we have not specifically addressed social sustainability in this paper, results show that productivity and efficiency improve as part of competitiveness with the implementation of SSCM practices. Also, Zailani et al. (2012) consider the image of the firm in the eyes of customers and community stakeholders as an item under social performance, which is the same as the item, corporate image coming under economic performance in this paper, and results again show that economic performance indeed improves with the adoption of SSCM practices. Giovanni (2012) also finds support for the hypothesis that social performance mediates the relationship between internal environmental management and economic performance. Therefore, we may say that investments in environment-friendly practices are positively related to social sustainability in terms of EHS, better working conditions and improved corporate image.

7. Conclusions and directions for future research

In this paper, we have presented one of the earliest surveys on SSCM practices in India. We have developed India-specific items for the survey based on the relevant literature and feedback from corporates. The items on SSCM practices and firm performance may b6(m)812 lt-8(ma3r in)TJn

may include items on Tier-II and Tier-III suppliers and customers, and explore a dyadic relationship between suppliers and manufacturers (Hollos et al., 2012). We have focused on the environmental dimension only. Future studies may also include social sustainability for which, of course, the relevant items may have to be identified. We have solicited responses from diverse industries and hence there may be apprehensions with regard to the generalizability of results. We propose future research to focus on specific industries so that the findings relate to, and are generalizable for, these industries. Although we have observed how being an MNC increases the propensity to adopt SSCM practices and commented on the lessons to be learnt by domestic firms, we feel a more focused study may be designed to address the impact of globalization, and hence more investments by MNCs, on the extent of adoption of SSCM practices in India. Similarly,

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59.

Appendix

Questionnaire for A Survey of Sustainable Supply Chain Management Practices in India

1. Name of the company: _____ Division: _____

2. Address and contact information:

   Phone: Fax: E-mail:

3. Main product lines: _____

4. Ours can be best described as an Indian / multi-national company (Please encircle your response)

5. We are ISO 9000 certified: Yes / No (Please encircle your response) If "Yes", which year: _____

6. We are ISO 14000 certified: Yes / No (Please encircle your response) If "Yes", which year: _____

7. We have implemented Environment Management System (EMS): Yes / No (Please encircle your response) If "Yes", which year: _____

8. We have adopted SSCM practices (Please encircle your response)
   (1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree)

(a) voluntarily	1	2	3	4	5
(b) to comply with regulations	1	2	3	4	5
(c) under pressure from customers	1	2	3	4	5
(d) under pressure from competition	1	2	3	4	5

9. With regard to our suppliers, we do the following (Please encircle your response)
   (1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree)

(a) educate and generate awareness	1	2	3	4	5
(b) help set up environment-friendly practices	1	2	3	4	5
(c) put pressure to implement EMS and ISO 14001	1	2	3	4	5
(d) incentivize for conformance to EMS/ISO 14001	1	2	3	4	5

10. While designing our products and processes, we do the following (Please encircle your response)
(1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree)

(a) design products with bio-degradable materials	1	2	3	4	5
(b) design products with recyclable materials	1	2	3	4	5
(c) design products for quick disassembly	1	2	3	4	5
(d) carry out life cycle analysis for products	1	2	3	4	5
(e) reduce energy usage during production	1	2	3	4	5
(f) use non-conventional sources of energy	1	2	3	4	5
(g) reduce resource consumption during production	1	2	3	4	5
(h) reduce wastage and spill-over during production	1	2	3	4	5

11. In packaging, storage, transportation and distribution of raw materials and finished products, we focus on the following (Please encircle your response)
(1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree)

(a) use of environment-friendly packaging	1	2	3	4	5
(b) use of recyclable packaging materials	1	2	3	4	5
(c) use of environment-friendly storage	1	2	3	4	5
(d) use of alternative transport mechanisms	1	2	3	4	5
(e) achieve economies of scale in transportation	1	2	3	4	5

12. We are engaged in the disposal and/or recovery of our products and packaging discarded/returned after use: Yes / No (Please encircle your response) If "Yes" go to Q. 13, If "No" go to Q. 15

13. With regard to reverse supply chains, disposal and/or recovery of our products and packaging, we have the following observations (Please encircle your response)
(1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree)

(a) our customers are environment-conscious	1	2	3	4	5
(b) our customers cooperate in returns handling	1	2	3	4	5
(c) we have a centralized returns collection facility	1	2	3	4	5
(d) we have a centralized returns inspection facility	1	2	3	4	5
(e) we engage in environmentally friendly disposal	1	2	3	4	5
(f) we have a centralized returns recovery facility	1	2	3	4	5
(g) we have integrated production with recovery	1	2	3	4	5
(h) we engage third-parties for product recovery	1	2	3	4	5

(i) there is a market for our recovered products	1	2	3	4	5
(j) pricing for our recovered products is competitive	1	2	3	4	5

14. The product recovery option(s) that best describe(s) our recovery operation(s) is (are) the following:

    refurbishing / remanufacturing / cannibalization / recycling (Please encircle your response(s))

15. By adopting SSCM practices, we have achieved the following (Please encircle your response)
    (1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree)

(a) improvement in product and process quality	1	2	3	4	5
(b) improvement in efficiency and productivity	1	2	3	4	5
(c) innovation in product and process design	1	2	3	4	5
(d) cost savings in production and distribution	1	2	3	4	5
(e) increase in sales of products	1	2	3	4	5
(f) increase in market share	1	2	3	4	5
(g) penetration of new markets	1	2	3	4	5
(h) acquisition of new customers	1	2	3	4	5