

Empirical Study on Adoption of Green Supply Chain Practices for Developing Economy

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Abstract— The objective of study is to analysis the current adoption level of green practices by industries in their processes and to assess their impact on organizational performance such as environmental, financial and operational performance in developing countries. The study is based on survey of 161 Indian companies which are from automobile, electronics, electrical and manufacturing sector. The research shows that there is significant positive relationship between Green Supply Chain Management (GSCM) practices and organizational performances which induces the study to develop GSCM practices model for Indian industry. The research is conducted by a conceptual model for GSCM practices which includes internal environmental management, green designing, green purchasing, customer cooperation for environmental, and investment recovery. The research explores the GSCM initiatives and performance of the supply chain using an empirical analysis of 161 organizations' within India. It concludes that Indian industry can develop a competitive edge through the implementation of green supply chain management practices.

Index Terms— Green Supply Chain Management, Green Practices, Indian Industry, Organizational Performance.

I. INTRODUCTION

“The word **green** is fast catching among companies and success today is being evaluated on this vibrant word **green**.” The success of any industry depends largely upon its supply chain management (SCM). Hence Industries/Corporates have started focusing on greening all the phases of their supply chain (Vijayvargy and Agarwal, 2014).

Companies applying green principles to their internal operations prefer to purchase goods & services from suppliers who meet certain minimum environmental standard, as these companies are focused to minimize environmental liability (Sarkis, 2001). Lamming and Hampson (1996) envisaged ‘the prospect of environmental soundness becoming a recognized feature of a supplier’s overall performance’. A US survey by Gavaghan et al. (1998) examined the extent to which companies were using four sets of environmental criteria in assessing suppliers, under the headings of regulatory compliance, environmental management system, eco-efficiency and green design. The greening of purchasing activities has since become a fertile area of research considering issues such as the environmental criteria for supplier selection and environmental accreditation (Min and Galle, 2001). Walton et al. (1998), Bowen et al. (2001) and others adopted a

broader supply management perspective on the subject, examining ways in which vendors could work with their suppliers to improve their joint environmental performance. Min & Galle (2001) found that green supply chains are lean supply chains with minimal or zero waste. Minimizing waste within the supply chain will make the supply chain green. In recent times, SCM is focusing in two important aspects; one its impact on natural environment and second on the generation of environment performance changes. This shift is basically due to the legislative changes, maintaining social pressures and environment requirements. The relevance and purpose of GSCM is now generally accepted. Hence GSCM scope is not just related to greening practices without a definite purpose; however substantial scope lies for improving and applying the potential strategies of GSCM. The study tries to identify an evolving set of distinct supply chain practices in an environment of rapid developments in the field of GSCM.

Environment and energy issues have drawn major attention in the last decade, and many researches and studies have been done in this context. GSCM is a good way to balance the environmental, profitability and social benefits (Carter and Narasimhan, 2000; Govindan et al., 2013). GSCM, which has already been mature in some European, Japanese, Chinese and American countries, is still a new concept in India. Thus it is felt essential to undertake this study which targets Indian manufacturing supply chain, keeping in focus environmental and social concerns. The study will tell about adoption level of GSCM practices by Indian industries and impact on organizational performance.

The remainder of this paper is organized as follows. Section 2 discusses literature on selection criteria and methodology for GSCM practices & performances in terms of various companies. Next, Section 3 & 4 debates motivation and research methodology for GSCM. Section 5 is describe hypotheses formulation. Finally, Section 6 presents detail data analysis and result and last section presents conclusions and limitations.

II. LITERATURE REVIEW

Literature review provides the strands of the relevant studies and also motivation behind this research work. From the literature survey, it appears that GSCM practices specifically in Indian Industry domain are complex and requires sound knowledge of business functionalities, organization size, types of sector, market trends, and status of the organizations. The literature reports number of frameworks and models with diversified approaches and notions.

The past decade, there has been many works on GSCM in different countries with different industries. All the researches are based on empirical study or case study. The literature shows various work related to green supply chain,

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green marketing, green supplier/purchasing, green design (Eco-design), green logistics conducted in different countries. In last 10 years, China has been done many research in GSCM practices and its impact on performance in various sector by Zhu and Sarkis (2004), Zhu et al. (2011) etc. The researchers (Mohanty, et al., 2009; Chien and Shih, 2007; Zhu et al., 2011) have implemented GSCM practices in all the sectors like Automobile, Electrical, Manufacturing, IT, Chemical, etc. in various countries like: Netherlands, Germany, UK, USA, Japan, Malaysia, Australia, Brazil South Korea, Taiwan, and Italy. There is little work in GSCM practices and its effect in India by Vijayvargy and Agarwal (2013, 2014), and Shukla, at el. (2009) on Eco-design, green purchasing, and relationship of GSCM practices etc. This study based on literature collected from China, Japan, Malaysia, Taiwan, USA, and UK.

There are many studies which shown positive and negative relationship between GSCM practices and organizational performance. Shukla et al. (2009) suggested positive relationship between GSCM practices and environmental & financial performance. But the study of Zhu et al. (2008) has shown negative relationship between GSCM and financial performance. There is not clear picture of relationship of GSCM and organizational performance.

Above Literature has been mixed on the relationships between environmental performance and practices adoption. Several studies have shown that GSCM practices can improve environmental performance (Florida 1996, Geffen and Rothenberg, 2000). Base on **literature review**, GSCM practices consists of five variables as forerunners and three parameters as consequences. The definition of all these variables is shown in table no. 1.

Table 1: The operational definitions of the research variables

	Variable	Operational definition
1	Eco-design	All activates which aims to minimize environmental impacts of products during their entire life cycle, and more focus on recycling and reusing product.
2	Green purchasing:	Includes activities that objective to purchase that items which have desirable environmental attributes which reducing or eliminating hazardous items, and increase reusability, recyclability in product or services
3	Customer environmental collaboration	Includes activities that aim at improving environmental performance by working with customer in design process and production process that produce sustainable product.
4	Investment recovery	Investment recovery requires the sale of scrap, excess inventories, and excess capital equipment
5	Environmental Performance	The impacts of green supply chain practices or initiatives on environmental performance of an organization like as amenability to environmental reduction of waste water, air emission reductions, waste solid, decrease of frequency for environmental accidents, etc.
6	Financial Performance	The impacts of green supply chain practices or initiatives on financial or economics performance of the organization such as decrease in cost of material purchasing, energy consumption increase in productivity, profitability, and sales.
7	Operational Performance	Operational outcomes include product quality improvements, decrease in scrap rate, cost reductions, improvements in delivery and flexibility.

(Source: Vijayvargy and Agarwal, 2014)

There are different motivators for companies to switch to ‘green’ in their supply chain. Studies have shown that profitability and cost reduction are some of the main motivators for businesses to become ‘green’ in the supply chain (Srivastava & Srivastava, 2006). Tibben-Lembke & Rogers (2002) argues that reusability and recycling were motivated primarily by financial factors (profitability and reduction of waste). Zhu and Sarkis (2004) argued that GSCM practices are only win-win model for financial and environmental performance bass on their study of 186 organizations. There are many reasons to adaptation of GSCM practices like: resource saving, waste eliminates and productivity improving. (Vijayvargy and Agarwal, 2013). These all results are paying attention on adoption of GSCM practices in Indian organization.

III. THE METHODOLOGY

In the light of above discussion, the motive behind this work is to investigate the determinants of green supply chain management practices for Indian Industry and provide the empirical evidences to support decision maker to select appropriate GSCM practices for organization performance. To analyze and resolve the research, the figure 1 shows research procedure.

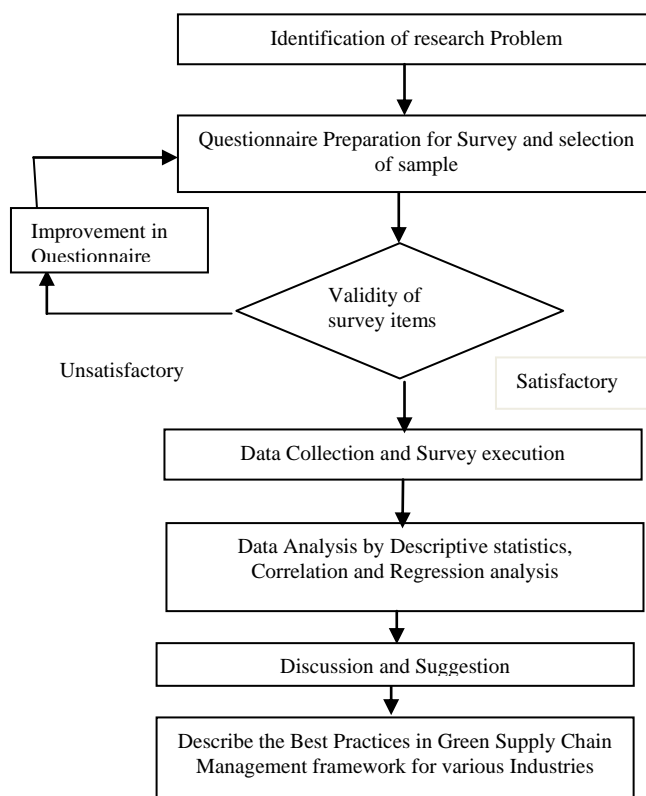


Figure 1: Research Methodology

A. Sampling Selection

The sample was selected from online data bases and questionnaires were sent to 600 identified companies with randomize sampling. The postal and online mailing, telephonic interviews, two follow-ups and personal visits fetch 161 usable responses, yielding the response rate of about 26.8% percent. The data shows that the maximum responses are received from northern region with 32.37% than western region with 28.57%. Further the data

distributes in various sectors like automobile (36%), electrical/electronics (23%), process industry (19%) and manufacturing industry (22%).

B. Questionnaire Development

The questionnaire is designed with two sections. Section A is designed to gather background and demographic information about the respondents. In Section B information regarding GSCM practices and determinants of performance of the firms are gathered. Most of the variables in this study are measured using the scales from Zhu and Sarkis (2004) wherein, respondents assess the concepts by rating them on a five point Likert scale. The precision of measurement is further improved by using several items to measure the same concept (multi-item scaling). View regarding the level of practice implementation were rated a five-point Likert scale, ranging from 1= no consideration, 2 = a little consideration, 3 = moderate, 4= practicing, and 5= actively practicing. Respondent were asked to rate the improvement into organizational performance by GSCM practices on a five-point scale, ranging from 1= Not at all, 2= A little bit, 3= to some degree, 4= relatively significant, and 5= significant.

IV. DATA ANALYSIS

The response of GSCM towards the practices and performances issues is gathered through the question asked. In this research the GSCM practices and its impact on company's performance are analyzed by comparing the opinion of participants regarding the practices and perceptions for sustaining GSCM elements. The research explored the five key factors of GSCM practices namely: *Internal environmental management, green purchasing, customer cooperation with environmental consideration, eco-design, and investment recovery*. The research also explored the three factors of performance determinant namely: *Environmental performance, financial performance, and operational performances*. The detail analyses are followed:

A. Reliability Test

To check reliability of data, the reliability test was performed to find cronbach's alpha value. Zhu et al. (2008) said that if alpha value is more than 0.60 than data have greater acceptability. To see internal correlation of factor, item-total correlation was executed. The value of alpha is from 0 to 1. The table 4 shows the result analysis of reliability analysis of GSCM factors and organizational performance. The reliability for all the factors are found greater than acceptance limit (>0.6), the alpha values are 0.96, 0.91, 0.89, 0.85 and 0.84 for IEM, GP, ED, CCWCC and IR, respectively. The alpha values for performances are 0.95, 0.94, and 0.93 for EP, FP and OP respectively. Thus the data are acceptable for further analysis.

B. Descriptive Analysis for GSCM Practices and Performances

The analysis (Table 2) indicate that out of seven drivers considered in Internal environmental management practice (IEM), the driver "*Commitment of GSCM from senior managers (IEM1)*" is found the highest ranked with mean

value 3.43 in all sectors and difference organization-sizes followed by environmental compliance and auditing programs. It shows their main focus on commitment of involvement level of senior manager in all sectors. The "*Cross functional corporation for environmental improvements (IEM3)*" is found lowest rank with mean value 3.05 and needs to be improved. The training program and awareness campus needs to fill the gap in this area. There is maximum variation in the cross functional corporation for environmental improvements, Support for GSCM from mid-level managers and Environmental compliance and auditing programs.

It can be observed from Table 2 that green purchasing related to "*Cooperative with suppliers for environmental objectives (GP2)* and *providing design specification to suppliers* that include environmental requirements for purchased item" are found with highest mean value 3.11. The area of "*tier-II suppliers environmental friendly practice evaluation (GP5)*" have low mean score of 2.32, that shows the below average initiative in term of work on environmental issues with their suppliers. There is maximum variation in the Second-tier supplier's environmental friendly practice evaluation of 0.95 that indicate the significant variation in environmental practices with second-tier supplier in India.

Table 2 shows the mean value of various practices of customer cooperation with environment consideration (CCWEC). The analysis shows that customer *cooperation for green packaging (CCWEC3)* is major initiative (highest mean 3.09) in Indian industry in CCWEC practice. Table 2 summarizes the answers concerning the level of practicing of eco design in their origination. The results of the survey indicate that the *design of products for reduced consumption of material/energy (ED1)* practices has received the more attention in Indian industry.

The analysis in Table 2 shows that investment recovery (sale) of excess inventories/ materials is used as major contributor (mean value 3.25) in GSCM practices in India. The analysis shows that the mean score of investment recovery practices in India have near 3.00 which is less than to other countries. The United States and European organizations have considered investment recovery as a critical aspect for GSCM (Zsidis and Hendrick, 1998). In India, the government has changed its policies from a focus on resource subsidies to levying taxes for some resources such as coal and natural gas, to improve investment recovery and better design of processes and systems.

After investigating the green supply chain management practices in detail, three performance factors are explored with Indian industry perspectives to identify the potential performance variable. The performance factors are organizational, financial and operational. Based on literature, the six determinants are identified for measuring environmental performance. The results of survey indicate that the *enterprise's environmental situation (EP6)* is more improved determinant in environmental performance (high mean value in all EP variables). Table 3 shows that the waste water reduction and solid waste reduction measures are contributing least for the improvement of environmental. The data analysis shows that the environmental performance of Indian organizations has improved after implementation of GSCM practices.

Table 2: Descriptive statistics of GSCM practices in Indian organizations

Variables of GSCM Practices	Items	Overall	
		(n = 161)	
		Mean	S.D.
Internal Environmental Management	IEM	3.28	0.87
Commitment of senior managers towards GSCM	IEM1	3.43	0.97
Support from mid-level managers For GSCM	IEM2	3.16	1.01
Cross functional corporation for environmental improvements	IEM3	3.05	1.03
Total quality environmental	IEM4	3.35	0.93
Environmental compliance and auditing programs	IEM5	3.42	1.01
ISO 14001 certification	IEM6	3.27	0.89
Environmental Management System exist	IEM7	3.31	0.94
Green Purchasing	GP	2.89	0.68
Providing green design specification to suppliers	GP1	3.11	0.88
Cooperative with suppliers for environmental aims	GP2	3.11	0.90
Environmental audit for supplier	GP3	3.03	0.82
Suppliers ISO 14001 certification	GP4	2.88	0.86
Tier-II suppliers environmental friendly practice evaluation	GP5	2.32	0.95
Customer Cooperation with Environmental Considerations	CCWEC	3.06	0.79
Cooperation with customer for eco-design	CCWEC1	3.05	0.81
Cooperation with customer for cleaner production	CCWEC2	3.01	0.89
Cooperation with customer for green packaging	CCWEC3	3.09	0.89
Eco-Design	ED	3.09	0.81
Design of products for reduced consumption of material/energy	ED1	3.20	0.82
Design of product for reuse, recycle	ED2	3.03	0.89
Design of products to avoid use of hazardous products and /or their manufacturing process	ED3	3.02	0.99
Investment Recovery	IR	3.14	0.77
Recovery (sale) of excess inventories/ materials	IR1	3.25	0.87
Sale of scrap and used materials	IR2	3.02	0.88
Sale of excess capital equipment	IR3	3.16	0.84

The study depicted that the *cost for energy consumption* has decreased more (Mean 3.53) after implementation of GSCM which leads to major contribution in term of improvement in financial performance of organization (Table 3). The decrease of fee for waste discharge (Mean 3.26) is least affect by implementation of GSCM in organization. The decrease of fee for waste treatment determinant has maximum standard deviation in all determinants of financial performance.

Table 3 shows the descriptive statistics of operational performance into various sectors and different type's organization-size. It seems that the *capacity utilization (OP6)* has mostly contributed in operational performance of organization, (Mean 3.86) followed by on time delivery and product quality (mean 3.80). The increased product line has

observed least contributor into operational performance of Indian organization in GSCM. The all determinant of OP are above the 3.5 mean score which is significant improvement in operation performance after implementation of green supply chain management in an organization. For example Castrol, a lubricant producer, supplying the automobile industry, Castrol worked with one of its customer's plants to insure proper use of its chemical. This interaction resulted in process modification leading to significant saving through less chemical use at the customer's plant, helping the environment.

Table 3: Descriptive statistics of various performances in Indian organizations

Variables of organizational Performance	Items	Overall	
		(n = 161)	
		Mean	S.D.
Environmental Performance	EP	3.77	0.84
Reduction of Air Emission	EP1	3.91	0.91
Reduction of Waste Water	EP2	3.65	0.94
Reduction of Solid Wastes	EP3	3.65	0.99
Decrease the Consumption for Hazardous Materials	EP4	3.71	0.97
Decrease the Frequency of Environmental Accidents	EP5	3.73	0.95
Improve an organization's Environmental Situation	EP6	3.93	0.88
Financial performance	FP	3.34	0.79
Decrease of cost for materials purchasing	FP1	3.30	0.86
Decrease of cost for energy consumption	FP2	3.53	0.88
Decrease of fee for waste treatment	FP3	3.27	0.97
Decrease of fee for waste discharge	FP4	3.26	0.82
Decrease of fine for environmental	FP5	3.35	0.92
Operational Performance	OP	3.74	0.80
Increase amount of goods delivered on	OP1	3.80	0.91
Decrease inventory's levels	OP2	3.66	0.97
Decrease scrap rate	OP3	3.67	0.96
Promote products quality	OP4	3.80	0.95
Increased product line	OP5	3.66	0.90
Improved capacity utilization	OP6	3.86	0.86

C. Correlation between GSCM Practices

To know the correlation among all the factors of GSCM model like GSCM practices, the correlation analysis is performed. The Pearson correlation coefficients are shown in Table 4. Results show that most of factor are a significant relationship ($p < 0.01$) among practices. The analysis shows that strong correlation between internal environmental management, green purchasing, customer cooperation with environmental consideration, eco-design.

Table 4: Correlation between GSCM practices and performances

	IEM	GP	CCWCC	ED	IR
IEM	1	0.75**	0.66**	0.74**	0.72**
GP		1	0.64**	0.63*	0.63**
CCWCC			1	0.58**	0.57*
ED				1	0.69**
IR					1

Note: ** $p < 0.01$ level (2-tailed), * $p < 0.05$ level (2-tailed).

D. Regression Analysis between GSCM Practices and Various Performances

It is interesting to investigate the inter-relationships between the GSCM practices and organizational performance. The previous section is indicated positive correlation between GSCM practices and performances of company. To see impact of GSCM practices on performances, three regression models built by considering performance variables as dependent variables, five variables of GSCM practices as independent variables as shown in Table 5. The table 5 indicates that all regression lines are significant at p-value <0.0001. Almost all the coefficient of GSCM practices are positive and significant at p-value<0.05 for organizational performance. The regression analysis has proved that there is significant positive relationship between GSCM practices and organizational performance. The variance explained in each of the regression models are: 61% of the variance in environmental performance, 52% of the variance in financial performance, and 50% of the variance in operational performance.

Table 5: Summary of Regression analysis between organizational performance and GSCM practices

Independent Variables	Dependent variables					
	EP		FP		OP	
	Coeff. value	t-value	Coeff. value	t-value	Coeff. value	t-value
IEM	0.20*	1.98	0.17*	1.95	0.15	1.50
GP	0.12	1.18	0.20*	1.98	0.03	0.33
CCWEC	0.25**	3.37	0.21**	2.72	0.19*	2.36
ED	0.18*	2.21	0.17*	1.95	0.33**	3.77
IR	0.35***	4.20	0.14	1.61	0.13	1.41
R ²	0.62		0.53		0.52	
Adjusted R Square	0.61		0.52		0.50	
F-VALUE	50.69***		35.30***		32.30***	

Note: *p < 0.05; **p < 0.01; ***p < 0.001.

Regression analysis shows that improvement in Environmental performance will more dependent on IEM, CCWEC and IR practices of GSCM. The improvement in EP is least dependent on GP and IEM practices.

V. MANAGERIAL IMPLICATIONS

The analysis shows that Indian industries have experienced significant pressures and incentives to implement GSCM, with mean values over 3.72 for the four driver factors. Figure 2 indicate that GSCM practices’ adoption rate lagged, with mean values below 3.28 for all the five GSCM factors, especially for *green purchasing* with the lowest mean value of 2.89. The relatively higher standard deviations for the GSCM practices, i.e. over 0.80, indicate that the implementation level of GSCM is imbalanced, with organizations covering the spectrum of innovation from pioneering firms at the cutting edge of practice to those who are lagging considerably. The highest mean value is 3.28 for internal environmental management. Other three practices have near about 3.00 mean values. The study define benefits gained through GSCM as positive financial improvements, including decrease of cost for materials purchasing, decrease of cost for energy consumption, decrease of fee for waste

treatment and waste discharge, and decrease of fines for environmental accidents. The analysis indicates that financial performance with a mean value of 3.34 is slightly lower than environmental and operational performance of industry. The environmental performance gained highest mean value 3.77 after GSCM practices implementation in Figure 3. Figure 3 indicates that the operational performance has highest mean value 3.95 in electrical/electronic industry compare to all other sector in India, environmental and financial performance lead by process industry in India. Figure 3 also shows that the manufacturing industry has least improvement in all performances after implementation of GSCM. The perceptions of Indian organizations towards the GSCM practices and their performances are also examined. The correlation and regression analysis found positive impact of GSCM practices on organizational performance which give positive indication to industry for adopting GSCM practices in their process.

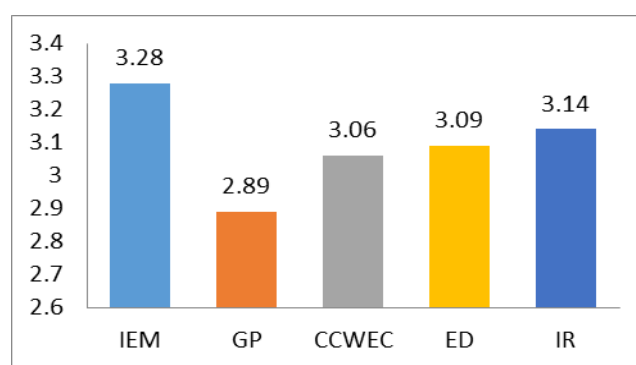


Figure 2: Elements of GSCM practices

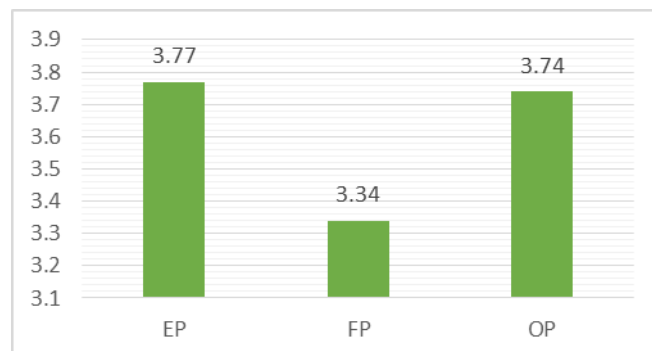


Figure 3: Elements of performances

VI. FINDING

To provide the fine-grained analysis of GSCM, this research explored the key determinants of GSCM practices and performance measures. The study come with top 10 GSCM practices out of 21 which shown in Table 6. The commitment of Top management towards to GSCM has come top ranked in all GSCM practices

Table 6: List of top 10 GSCM practices

GSCM Practices	Rank
Commitment of senior managers towards to GSCM	1
Environmental compliance and auditing programs	2
Total quality environmental management	3
Environmental Management System exist	4
ISO 14001 certification	5
Recovery (sale) of excess inventories/ materials	6
Design of products for reduced consumption of material/energy	7
Support from mid-level managers For GSCM	8
Sale of excess capital equipment	9
Providing green design specification to suppliers	10

(Source: Computed)

The Regression analysis indicates that the GSCM practices have positive relationship with performance determinants. Their relationships are very promising with environmental and operational performance expectations. There seems to be significant ‘win-win’ opportunities that exist for Indian manufacturing organizations that seek to implement GSCM practices. The GSCM practices seem to be doing what is expected of them in terms of positive environmental performance and overall organizational performance. The competitive advantage generated by environmental cooperation. The industry adopting cooperative activities with their supplier and customers can develop organizational capability which will be reflected not only in environmental performance but also in other performance dimensions such as cost, quality, and flexibility with lead operational performance of an organization.

VII. CONCLUSIONS AND FUTURE RESEARCH

The results of the study reveal that the Indian organizations are actively implementing all the items in the internal environmental management and investment recovery practice sets but they are not that active with green purchasing, eco design and customer cooperation. The results further indicate that Tier-I and Tier-II suppliers are to be paid attention as regards environmental management. The study reveals that Indian companies need to focus on financial performance, as companies are not able to garner the financial benefits from GSCM. They need to work on reduction in cost of raw materials and energy consumption, and expenses on waste treatment and waste discharge. Other than this, the performance of Indian companies is observed to be relatively significant in terms of environment and operations. Further, the organizational size and sectorial analysis has influenced implementation of GSCM practices. Finally, GSCM practices in India has been adopted quite late as compared to USA and Japan, despite that Indian organizations has received score of around 3.00, indicating that Indian organizations have realized the benefits of GSCM and have started taking proactive approach towards environmental responsiveness.

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