



# Measuring carbon performance for sustainable green supply chain practices: a developing country scenario

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## Abstract

Carbon emissions due to economic activities are recognized to be global problem. Governments of all countries need to evolve environmental policies and practices for large-scale collective actions to regulate green house gas emission. Fuel quality standards for vehicles, stricter codes for construction, emission limits for industrial units and power plants are some of measures advocated to speed up emission control. This study investigates how far different sectors of a developing economy are able to manage green supply chain with respect to 4 aspects of environmental practices viz. Green procurement, green logistics, green products and process designs and regulatory framework. Globally, corporate social responsibility (CSR) assumes significance in recent years not only with respect to societal issues but also for environmental protection. Research suggests that CSR department creates culture for implementation of CSR activities. We investigate whether CSR departments in the sample organizations have made any difference in achieving emission control objectives. Data are from manufacturing organizations in a congested industrial region of India. We apply non-parametric Kruskal–Wallis and Mann–Whitney tests; then regression analysis is carried out to ascertain predictability of carbon reduction performance with respect to 4 environmental constructs. Results highlight positive roles of inclusion of green enablers—green procurement, green logistics, green product and process design as contributory factors for improvement in carbon performance and reveal that green logistics in the given scenario need major improvement in carbon performance. Our model also considers the impact of size of the organization on carbon performance in terms of workforce.

**Keywords** Green supply chain · Green enablers · Corporate social responsibility · Carbon emissions · Organizational performance · Multiple linear regression

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## 1 Introduction

Population growth, urbanization and consequent expansion of infrastructure have been reducing geographical land scape of the globe in one way and on the other due to rapid increase mobility, vehicular emission severely damaging environment across the world. While globalization has brought communities closer through business connects resulting into rapid economic growth, modern business must deal with supplies in different geographical regions with diverse tastes, cultural and social values (Choi and Krause 2006). In addition, organizations must deal with economic interests of stakeholders as well as create competitive advantage for their business. In this scenario, global warming has been posing a serious threat to the climate and mankind which urgently calls for appropriate awareness and actions. Now, technology is available to decarbonize sectors such as manufacturing, energy and transportation which are at present major sources of GHG (de Pee et al. 2018) Global organizations such as HP, IBM, and GE have already been introducing green initiatives in both product chains and transportation to improve their global branding (Pacala and Socolow 2004). Countries and global organizations should introduce as many as fourteen strategies (Melnik et al. 2014) through new design, execution policies, adaptation of new technology and capital investments, supply network pooling (Pan et al. 2013) for different economic activities to reduce GHG emission in future (Norton et al. 2015).

In subsequent section we wish to explore linkage between different economic sectors and their intensity of carbon emissions. Therefore, we propose our first research question:

*RI: how do different sectors of economic activities vary in their practices for low carbon emissions?* Every country has its own category of dominant carbon intensive sectors depending on varying operational practices and production processes; thus, the bigger challenge here is to identify sectors responsible for more emissions and then draft sector specific policies accordingly. Overall, emissions from energy and industrial sectors are expected to increase every year (Oliver et al. 2012). Furthermore, research conducted by Alcantara and Padilla (2009) in Spain indicates that a number of sectors such as electricity and gas, land transport, manufacture of basic metals and non-metallic mineral products, manufacture of chemicals, coke, refined petroleum products and nuclear fuel, wholesale and retail, and agriculture are associated with high emission issues; hence, they require more attention. Similarly, in Brazil, the major emission contributing sectors have been identified as the industrial sector especially, machinery, electric equipment, transportation equipment, textiles and construction sectors (Imori and Guilhoto 2010). Ideally, industrial activities related to every sector should be scrutinized and efforts should be made to reduce carbon intensive activities.

Supply chain is the nodal connect between the customer and the supplier having a vital role to regulate emission through direct and indirect influences on the

customers' preferences of green products. Yet, supply chains have been identified as a major contributor towards carbon emissions. Therefore, while remodeling low carbon supply chain, emphasis should be on lower carbon emission (Norton et al. 2015). Studies on climate change by researchers like Kolk and Pinkse (2005), Jeswani et al. (2008), Weinhofer and Hoffmann (2010), Sprengel and Busch (2011) and Backman et al. (2017) have contributed in the segment of green supply chains and mentioned about need of lower carbon emission by this sector.

Socolow et al. (2004) point out that global CO<sub>2</sub> emissions are mainly from three broad end-use sectors in 2000: power generation (42% of emissions), transportation (22%), and direct uses of fuel in industry and buildings (36%). According to Gupta et al. (2017). Indian energy sector is contributing 65–70% of country's total greenhouse gas emissions (GHG's) followed by agricultural sector (18%), Industrial processes and products Use (IPPU) sector (8%) and waste sector (3%). As per Data of UNDP (2018) on sector wise GHG emission in India, transport sector was one of major contributors of GHG in 2011 after energy sector (<https://www.downtoearth.org.in/news/energy-sector-biggest-greenhouse-gas-emitter-in-india-says-national-communication-to-unfccc-38150>). The energy intensive industries are under the critical observation of environmental fundamentalist, which brings the agendas of carbon reduction for sustainable development to the forefront (Canadell and Schulze 2014; Canadell et al. 2007).

Backed by technological experienced and educated population, skilled labor, robust legal and intellectual property rights (IPR) regime, and a strong commitment to calibrated liberalization, Indian manufacturing sector is expecting a promising growth of US\$ 1 million and job creation of 90 million by 2025 (<http://www.mckinsey.com/business-functions/operations/our-insights/fulfilling-the-promise-of-india-s-manufacturing-sector>). In September 2016, foreign direct investment (FDI) in electronic manufacturing in India witnessed the entry of global giants like GE, Siemens, HTC, Toshiba, and Boeing for setting up their manufacturing plants (<http://www.ibef.org/industry/manufacturing-sector-india.aspx>). At present, food products, basic metals, rubber and petrochemicals, chemicals, and electrical machinery are top contributors with 66.0% of total revenue from manufacturing sector (<http://www.tradingeconomics.com/india/gdp-from-manufacturing>). To bring resilience and sustainability in its framework, the traditional supply chain of the organizations must pave the way for low carbon chain or more commonly called green supply chains (Norton et al. 2015; Fahimnia and Jabbarzadeh 2016). It is a daunting task as supply chains have their own unique concerns like geographic distribution, multiple suppliers, information and product flow and sector specific mode of operations. Dedicated efforts should be made to bring uniformity in the supply chain practices adopted by organizations for carbon reduction. Moreover, it requires the presence of an internal centralized body also known as CSR (Damert and Baumgartner 2018) with a clear focus on aligning environmental issues with the corporate and organizational agenda.

This leads us to our next research question:

*R2: do corporate social responsibility (CSR) departments contribute towards low carbon emissions?* It is now an established fact that radical innovations should

be introduced for low carbon emissions; but most of the time, organizations are more interested in making marginal changes (Huesing et al. 2015), rather than going for emission prevention innovations (Berrone et al. 2013). Furthermore, cost minimization being a significant economic objective for these organizations, they focus more on their budget constraints instead of focusing on low carbon emission front by making minor changes to their existing working styles, regimes and functions (Neuhoff 2005; Jones and Levy 2007). Nations being aware of profiteering of the business sectors, have introduced corporate social responsibility (CSR) Act to align environmental protections clause with expanding future economic activities in order to reduce GHG emission along the value chain. The report by Kleemann and Murphy-Bokern (2014) on agriculture and agro based firms shows that efficiency benefits of training, awareness and networking of producers have considerably improved the process of implementation of CSR. Reduction of GHG emission and corporate social responsibility have high correlations in Korea especially for big firms (Yu and Lee 2017). In the UK, the Companies Act 2006 makes CSR an integral part of good governance especially for the big firms; in USA the corporate social responsibility (CSR) team in the Bureau of Economic and Business Affairs directs businesses in the promotion of responsible and ethical business practices. France, Denmark, South Africa and China have a mandatory reporting obligation on the amount spent on CSR activities. Alternately, it has also been observed that organizations are pushed to come out of their old established manufacturing mindsets by the competitive society and demanding customers to improve their environmental performance (Shultz and Holbrook 1999). Besides these societal and customer pressures, there are regulatory pressures also (Qu et al. 2013; Okereke and Russel 2010; Reid and Toffel 2009). Consequently, the managements tend to channelize the organizational sources and abilities towards complex climate change issues (Reid and Toffel 2009; Howard-Grenville et al. 2014). However, the reality is sometimes far from theoretical assumptions; in fact, the big question here is: are organizations doing enough to face this problem. Subsequently, we will explore the role of internal forces of an organized body, aiming an undertaking corporate social responsibility and following set rules for low carbon emissions.

This study analyses the complexity of sectorial divisions of organizations (R1) and their responsibility towards environment through integration of CSR activities by evaluating how their supply chain processes, production systems and organizational resources contribute towards carbon emission control sustainable development (R2).

The study proceeds with a comprehensive review of literature in Sect. 2 to identify dynamics based on various elements and their role for successful carbon reduction by organization for environmental protection. Based on these identified elements, a theoretical framework is drawn to frame hypotheses. A questionnaire method is adopted to collect data from organizations situated in Pune Nashik area of Maharashtra in proximity to the financial capital of India, Mumbai in Sect. 3. Collected data are analyzed using a number of statistical techniques for reliability and validity tests and then regression analysis is applied in Sect. 4. The paper in

conclusion draws major findings, managerial implications, limitations and future research perspectives.

## 2 Literature

### 2.1 Basic information

In response to governmental policies and general awareness on environmental issues among all stake holders, companies have been incorporating environmental ecosystem within the organization for better carbon performance and sustainability (Seuring and Müller 2008). Organizations need to move beyond economic objectives of minimizing cost, saving water and energy (Pinto-Varela et al. 2011). Environmental objective (Chaabane et al. 2010) are to be imbibed deeply in organizations. Green transformations happen when organizations remodel their supply chains to reduce their carbon footprint through redesigning and integrating entire supply chain networks starting from manufacturers, distribution centers up to dealers (Memari et al. 2015). Green supply chain management (GSCM) encompasses best environmental practices (Mishra and Suar 2010) starting from green procurement, product design, to green production, to green logistics and ending with reverse logistics (Zhu et al. 2008; Gardas and Narkhede 2013). GSCM is just not about integrating an innovative and environmentally friendly approach while designing the supply chain process, it is an effective route to generate goodwill among all stakeholders. Multiple business operations like sourcing, manufacturing and logistics have been found to be actively responsible for environmental problems (Beamon 1999). For improved carbon performance, therefore, environmental practices that should be implemented all along the supply chain are:

- (1) Performance measurement and management along the line of supply chain and optimization of objective functions subject to capacity constraints with respect to supply chain (Roy et al. 2017a, b; Das et al. 2019);
- (2) Green design (Mitra and Datta 2014; Hu Allen and Chia-Wei 2010; Green et al. 2012; Diabat and Govindan 2011; Yu et al. 2014; Kirchoff et al. 2016; Younis et al. 2016);
- (3) Green procurement for certifying suppliers (Min and Galle 2001; Zsidisin and Siferd 2001; Eltayeba et al. 2011).
- (4) Green production (Yu et al. 2014; Perotti et al. 2012; Cosimato and Troisi 2015).
- (5) Green packaging (Yu et al. 2014; Cosimato and Troisi 2015).
- (6) Purchasing environmentally sound materials and products (Green et al. 2012; Diabat and Govindan 2011; Yu et al. 2014; Kirchoff et al. 2016; Younis et al. 2016).
- (7) Green manufacturing process, warehousing and transportation and end-of-life of the product (Perotti et al. 2012).
- (8) Green distribution (Cosimato and Troisi 2015; Mutingi et al. 2014).
- (9) Green reverse logistics (Zhu et al. 2008; Green et al. 2012; Diabat and Govindan 2011; Perotti et al. 2012; Hervani et al. 2006).
- (10) Total quality environmental management viz internal performance measurement, pollution prevention and transportation to various end-of-life practices, defined by 4 R's of reduction, reuse, remanufacturing and recycling (Zhu and Sarkis 2004; Zhu et al. 2008).
- (11) Cooperation with customers (Zhu et al. 2008; Cosimato and Troisi 2015; Zhu and Sarkis 2004).

Among optimization models of supply chains, the study of Das and Roy (2019) used two stage optimization model to selected potential sites in addition to existing ones that minimize transport costs subject to constraints of both sites (starts and destinations) in terms of their capacities. The model is robust as it has been tested with real data, is applicable for a large company and also opens up possibilities of further research in the field (Roy et al. 2017a, b; Das et al. 2019; Das and Roy 2019). Authors here, replace their earlier models with multi choice transportation model using interval scalable variables and objective functions, which are able to incorporate multiple objects with appropriate weightage for each. Feasibilities of their models Roy et al. (2017a, b) are tested on the basis of numerical examples of both gray (not so real) and real-world data.

Continuous research on new green practices, introduction of new technology and new business models in all processes and multiple tiers of supply chains are required (Garetti and Taisch 2012) to be introduced. For example, Das and Roy (2019) developed two stage optimization model of MOT-p-FLP networks (p 313) introducing carbon emission as one of variables in the objective functions and assigning weights to all variables. The model is useful for facilitating decisions to choose optimal combination of various costs related to carbon emission such as carbon tax, cap and trade policy in emission. The study is also useful for the present research as it supports our research question, e.g., managers are to choose weights for carbon emission variables. As the entire range of supply chain involves different business partners, collaboration among all, not coercion (Tachizawa et al. 2015) is more effective to operationalize green practices. Integration of environmental thinking should be imbibed into supplier's selection, supplier training and education across all business enterprises involved in supply chain. Collaborative joint processes are recommended in product design, with suppliers, recycling, transportation, reduced consumption of material/energy, joint waste reduction and standardizing environmental audits of each process (Garetti and Taisch 2012; Opetuk et al. 2010; Hashim et al. 2017). Better carbon performance through GSCM practices could be reached through aligning incentives and rewards schemes (Narayanan and Raman 2004) for each partner of supply chain and establish contracts with suppliers for prevention, mitigation and remediation of significant environmental impacts. However, implementation of GSCM practices is a strategic approach and thus vary according to specific organizational resources (Barney 1991). Also, organizational targets of sustainability must cope with diverse demands of stakeholders (Okereke and Russel 2010; Martin and Rice 2010) as well as shifting business priorities. While multitudes of alternatives exist to deal with environmental issues so also there are major challenges too. Dealing with these sustainability challenges requires strong internal drivers like leadership, employee's awareness and organizational learning capacities (González-González and Zamora-Ramírez 2013). Societal concerns (Ihlen 2009), loss of the corporate reputation (Hrasky 2011) pushes organizations to draft sustainable policies for low-carbon products and services to gain legitimacy and competitiveness (Yu and Lee 2017). Sustainable products and projects provide for organizations an optimal route towards establishing a better relationship with stakeholders, positive financial performance (Álvarez et al. 2015), winning an

edge over competition and more loyalty from consumers who bond more with organizations having CSR positioning (Kim et al. 2014).

Responsibilities to senior managers and establishing performance-based incentive mechanisms (Backman et al. 2017; Damert and Baumgartner 2018; Kim et al. 2014; Skjærseth and Skodvin 2001; Yunus et al. 2016) would ensure that environmental policies are properly implemented. Managers should be the disseminator of information on sustainability of environment (Frias-Aceituno et al. 2014); they should incentivize which environmental performances of organizations (Oberhofer and Furst 2013). Eventually “Top managers” have been the drivers who could shape the environment friendly culture of a company (Tang and Luo 2014) along with other drivers such as consumers (Smith 1990), the government and civil society (Moon and Vogel 2008) by promoting corporate social responsibility (CSR) principles in organizations. The role of leadership is significant too for CSR as leaders shape the organizational culture with their benign and constructive vision for the welfare of organizations, employees, society, mankind and environment (Nambiar and Chitty 2014). Some other drivers worthy of research are: presence of multinational organizations in a region (Garcia-Rodriguez et al. 2013); sustainability reports of organizations as means of communication, transparency, compliance and governance within organizations (Garcia-Rodriguez et al. 2013; Fifka and Drabble 2012); organization’s dependence and impact on their resources-external and internal (Kolk and Van Tulder 2010).

## 2.2 Literature on corporate social responsibility for green environmental management

CSR (Elkington 1997) is now associated with the triple bottom line (Siegel and Vitaliano 2007) for three performances viz. Environmental, social and economic. researchers have found that CSR is considered as a tool to create economic benefits (Siegel and Vitaliano 2007) and favorable stakeholder’s perception (Palazzo and Richter 2005; Yoon et al. 2006). For example, CSR creates accountability among internal stakeholders of organization. It is also observed that ethical, and social business practices enhance project finance capabilities social and economic. Researchers have found that CSR is considered as a tool to create economic benefits (Epstein and Schnietz 2002). Many organizations take on CSR as a philanthropic activity to serve the best interest of community along with their own economic interest, whereas others believe that the social aspect of this is equally important as making profit for the organization (Benn and Bolton 2011). Damert and Baumgartner (2018) find that there is strong relationship between corporate governance and CSR. Research outlines that multiple pressure groups starting from stakeholders like the civil society, activists, NGOs, clients and peer groups (Mzembe and Meaton 2014; Mahmood and Humphrey 2013; Ingenbleek and Reinders 2013; Burchell and Cook 2013; Aggarwal and Jha 2018) that drive corporate governance to develop orientation for CSR. As there are many drivers of CSR, likewise the dimensions of its performance evaluation show a rich variety too. However, the relationship between the organizational performances in the context of economic, environmental and social issues have been

debated by many researchers with varying outcomes, but there are no conclusive results (Damert and Baumgartner 2018). Some researchers have stated that presence of CSR may have economic benefits (Callan and Thomas 2009; Wolf 2013; Eisenbach et al. 2014; Delmas et al. 2015); while others declared that it might be economical for short periods (Freedman and Jaggi 2009) or not at all profitable (Elijido-Ten 2017). In the context of environment, researchers have stated that organizations accomplish a desirable market value (Elijido-Ten 2017) or profitability in terms of stringent energy saving and pollution control through technological advancements (Caracuel and Ortiz-de-Mandojana 2013).

Literature review done in two parts finds that success of GSCM needs wide coverage of intertwined green processes and deep commitments of leadership to the cause. Yet, research on relationship between implementation of green practices and existence of CSR as the department in the organization for GSCM is still inadequate. The present research undertakes to resolve this part of the insufficiency taking samples from corporates from one of Indian states.

### 3 Research framework

#### 3.1 Research framework and hypothesis development

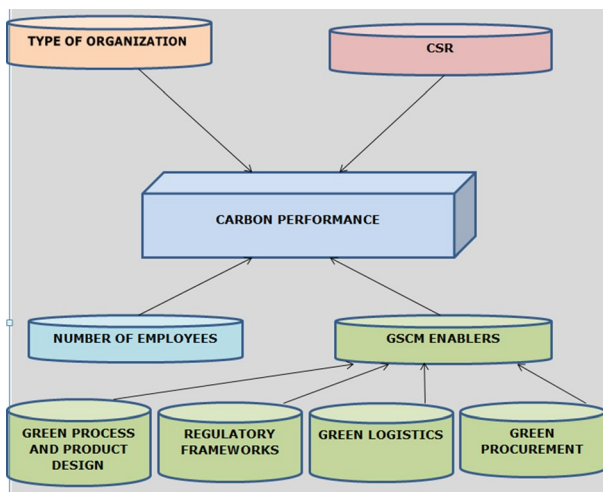
Based on discussions and review of the literature in Sect. 2, we propose that carbon reduction performance can be achieved through integration of green practices in the supply chain and these practices are contingent upon the nature, size, and sectors to which the organizations belong. Green supply chain practices vary according to the sector of the organizations. Furthermore, it has been proposed that multiple external pressures are required for altering supply chains to improve carbon reduction performance; thus, the impact of environmental regulations is also investigated in our study by exploring various sub-categories of environmental regulations/regulatory frameworks at policy level. Appropriate constructs identified from a comprehensive review of literature in Sect. 2 are shown in Table 1. These constructs have been taken from authors' own work (Caracuel and Ortiz-de-Mandojana 2013; Ali et al. 2018, 2019). There are five constructs namely GP (green procurement), GL (green logistics), SRM (green product and process design), IF (regulatory framework), P (carbon reduction performance) of which four independent variables and the last one is dependent variable (Caracuel and Ortiz-de-Mandojana 2013; Ali et al. 2018, 2019). Moreover, the GSCM-related carbon reduction efforts of organizations need to be monitored, recorded and revised from time to time which requires a dedicated separate department such as CSR. In the statistical analysis, carbon reduction performance is the dependent variable which is influenced by four GSCM enablers such as green procurement, green logistics, green process and product design, and regulatory framework. Here, multiple descriptive statistics (based on surveys/interviews) and inferential statistics (hypothesis) and linear regression approach to modelling relationship between dependent variable (P: carbon reduction performance) and four constructs (independent variables) are intended to be carried out. IBM SPSS statistics and IBM SPSS modeler (data mining) software packages have been used for



**Table 1** Organization’s CSR departments

| Sector of organizations           | Total number of organizations | Number of organizations having CSR (percentage in parenthesis) |
|-----------------------------------|-------------------------------|--|
| Automotive                        | 14                            | 11 (78.6)  |
| Basic metals and fabricated metal | 1                             | 1 (100)  |
| Cement                            | 2                             | 2 (100)  |
| Electrical good manufacturing     | 5                             | 5 (100)  |
| Electronics industry              | 2                             | 1 (50)   |
| Food and beverages                | 1                             | 1(100)   |
| Food products                     | 3                             | 2 (66.6)   |
| Graphite electrodes               | 1                             | 1 (100)  |
| Lubricants                        | 1                             | 1 (100)  |
| Machinery                         | 6                             | 5 (83.3)   |
| Optical instruments               | 1                             | 1 (100)  |
| Pharma                            | 4                             | 4 (100)  |
| Plastic products                  | 3                             | 2 (66.6)   |
| Rubber                            | 3                             | 3 (100)  |
| Steel units                       | 2                             | 1 (50)   |
| Textile products                  | 1                             | 1 (100)  |
| Wood and wood products            | 4                             | 3 (75)   |
| Total                             | 54                            | 45 (83.3)  |

input, interface and computations. Also, a separate statistical analysis has been carried out on carbon reduction performance being affected by the type of organization and CSR department, as shown in Fig. 1.



**Fig. 1** Flow diagram of proposed research framework

The above research framework in Fig. 1 illustrate twofold analytical directions; hence, two null hypotheses are derived to examine statistically:

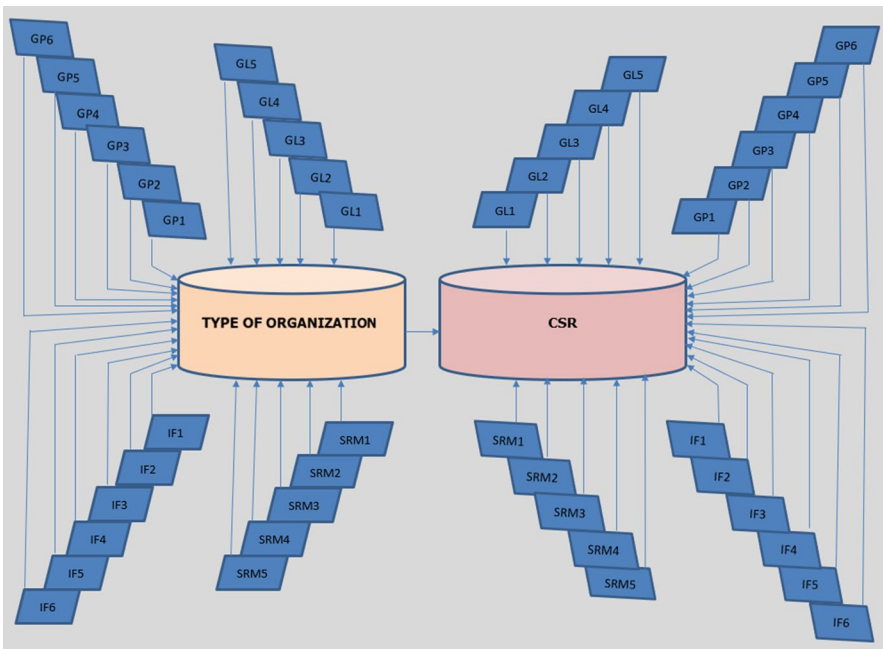
**H<sub>11</sub>** There are differences in the level of implementation of GSCM practices according as the sector/type of organizations.

**H<sub>12</sub>** There are differences in the level of implementation of GSCM practices according as existence of CSR/sustainability department of organizations.

Further, statistical test is also carried out for all GSCM enablers and types of organisation as another enabler (Fig. 2).

**3.2 Research methodology: questionnaire development, response scale and area identifications**

In the next step, data were collected through a questionnaire-based survey instrument (Zhu and Sarkis 2004). This questionnaire was prepared after deliberations with academic and industry experts having questions related to the size, area of operations, sectors, number of employees, type of industry such as manufacturing or production processes, life cycle of products, green strategies, major decision makers, new initiatives, awareness about GSCM, corporate social responsibility (CSR),



**Fig. 2** Hypotheses framework is presented

ISO certifications and demographics of the respondents. Most of the items/questions of various sections in questionnaire were in Likert scale, refer to author's work for more details (Caracuel and Ortiz-de-Mandojana 2013; Ali et al. 2018, 2019). For better responses, serious discussions and deliberations were taken up with the select plant manager, operations manager or equivalent decision makers like General Manager and the Vice President (Klassen and Vachon 2003) and purpose of research was explained to them in details. These respondents were expected to have expertise, in-depth knowledge and experience in organization's green practices implementation. Respondents were selected from different range of work experience (such as 10–15, 15–20, and 20–25 years and more than 25 years) as well as from different types of educational background, i.e., engineering as mainstream, and few with MBA as additional degree. Our data also show that the organizations in energy and automotive sectors usually have a larger number of employees to help establish sustainability environmental goal (Caracuel and Ortiz-de-Mandojana 2013; Ali et al. 2018, 2019).

### 3.3 Sample area selection

The area selected for data collection was the golden belt of Maharashtra covering industrial cities of Pune–Nashik–Mumbai areas. A map of the area is show in Epstein and Schnietz (2002). Since this area had a high concentration of manufacturing units with infrastructural facilities for industrial growth, it became an obvious choice for research focus. A total of 175 questionnaires were issued out to respondents (Please refer to author's previous work's (Caracuel and Ortiz-de-Mandojana 2013; Ali et al. 2018, 2019).

## 4 Data analysis and results

These items were put in questionnaire and respondents were asked to respond in preference scale as  $1 < 2 < 3 < 4 < 5$ . Please refer to author's previous work's (Epstein and Schnietz 2002; Benn and Bolton 2011; Damert and Baumgartner 2018), dimensions of all five constructs are presented in Caracuel and Ortiz-de-Mandojana (2013), Ali et al. (2018, 2019) and Ali (2015).

*CSR departments* Out of 54 organizations, in total 45 organizations had working CSR departments. All the responding organizations had information and knowledge about the working of CSR and sustainability concepts; all organizations were ISO 9000 certified. As being evident from Table 1, most respondents belonged to the automotive sector, which had the maximum number of organizations with CSR.

Table 1 presents information about existence/non-existence of CSR department in the organization according as sectorial classification. While 45 out of 54 organization had CSR department to lead, manage and monitor carbon performance, sector wise all firms belonging to cement, electronic, food and beverage, pharma had CSR department while not all firms in automotive machinery and wood and wood products had CSR department.

#### 4.1 Variables and their coding

Variables and their coding is discussed in author's previous work. For more details, please refer to author's previous work's (Caracuel and Ortiz-de-Mandojana 2013; Ali et al. 2018, 2019).

- GP is green design.
- GL is green logistics.
- SRM is designing products.
- IF is Govt. environmental regulations.
- P is reduction of carbon emission.

#### 4.2 Identification of critical factors using factor analysis

The questionnaire items (questions) were developed to represent each variable in the research. A pre-test was done on the items and their measurement by checking results obtained from the focus groups. The reliability of the survey was investigated. To ensure reliability of data collection procedure, Cronbach alpha coefficient was analyzed using IBM SPSS Statistics version 22.0. A value of 0.918, higher than the threshold of 0.70 was obtained showing acceptable level of internal consistency. Factor analysis was performed to examine the validity of the questionnaire, the status of the sub-dimensions of the questions and to extract factors based upon the principal component analysis with varimax rotation (Table 2). The variables used in the study were found to be suitable for analysis ( $p=0.00 < 0.05$ ). Likewise, Kaiser–Meyer–Olkin (KMO) sampling adequacy tests the correlation of variables between factors for factor analysis. The KMO value ranged from 0 to 1 and the KMO value of 1 indicated that variables can predict each other perfectly. The minimum acceptable limit for the KMO sampling adequacy was 0.50. Bartlett's test of sphericity and the Kaiser Meyer–Olkin (KMO) measure of sampling adequacy were employed to test the appropriateness of the data for factor analysis (Kaiser 1974).

In the study, KMO Bartlett test, which showed the following value: *Kaiser–Meyer–Olkin*: 0.846, *Bartlett test significance*:  $\chi^2 = 1451, 260, df = 435, p = 0.00 < 0.001$  (Tobias and Carlson 1969). Looking at the results obtained from the pilot study above, the questionnaire used in the field study can be said to be a reliable and valid survey.

**Table 2** KMO and Bartlett test

| Kaiser–Meyer–Olkin measure of sampling adequacy | Bartlett's test of sphericity |     |      |
|---|-------------------------------|-----|------|
|   | Approx. $\chi^2$              | Df  | Sig. |
| 0.701   | 1451.260                      | 435 | 0.00 |

### 4.3 Descriptive statistics results

Descriptive statistics was given Table 3 which shows all response were above average and three (GL, SR and PT) scores were satisfactory. When the average was examined; the highest level was for PT. This was followed by GP, GL, and IF, respectively.

### 4.4 Inferential statistics (hypothesis tests)

When using parametric methods for any statistical analysis, it is important to validate the assumption of normality; thus, Kolmogorov–Smirnov test was used for this purpose. For testing homogeneity of variance, Levene test (Hair et al. 1998) was employed. The result of the Kolmogorov–Smirnov test Levene test was significant having  $p$  value below 0.05, so that the normality of distribution cannot be verified. Hence, we had applied Kruskal–Wallis tests for testing hypothesis  $H_{11}$ . These tests were used for checking variations of sample response. Our findings are presented in Table 4.

$H_{11}$  There are differences in the level of implementation of GSCM practices according as the type of organizations.

In Table 5, we find that  $\chi^2$  value is significant at 5% level and hence we reject null hypothesis and accept that there is significance difference in practices among different sectors.

### 4.5 Data analysis on existence of CSR/sustainable development on environmental constructs

A careful introspection at this point drew the attention to critical points such as: poor performance could be attributed to poor management or dealings with suppliers. Collaborations with suppliers should be more towards improving environmental performance of the parent as well as the supplier's organizations. Attention should be paid to some of the critical points; suppliers must be given clear and specific information about *designs with environmental focus integrated within it*. Timely audits of supplier firms for checking their environmental performances must be

**Table 3** Descriptive statistics

|         | N  | Mean $\pm$ SD   | Mean rank |
|---------|----|-----------------|-----------|
| GP      | 54 | 2.98 $\pm$ 0.71 | 131.73    |
| GL      | 54 | 3.37 $\pm$ 0.80 | 118.76    |
| SRM     | 54 | 3.01 $\pm$ 0.88 | 90.51     |
| IF      | 54 | 2.80 $\pm$ 0.72 | 114.71    |
| PT      | 54 | 3.27 $\pm$ 0.71 | 221.79    |
| General |    | 3.09 $\pm$ 0.23 |           |

**Table 4** Result of Kruskal–Wallis test for all variables

| Hypothesis  | GSCM codes | $\chi^2$ | Asymp. sig. | Significant–insignificant |
|---|------------|----------|-------------|---------------------------|
| $H_{01}$ : there are no differences in the level of implementation of GSCM practices according to the sector of organizations | GP1        | 26.952   | 0.042*      | S                         |
|   | GP2        | 20.981   | 0.179       |                           |
|   | GP3        | 23.706   | 0.096**     | S                         |
|   | GP4        | 18.787   | 0.280       |                           |
|   | GP5        | 17.958   | 0.326       |                           |
|   | GP6        | 14.929   | 0.530       |                           |
|   | GL1        | 19.897   | 0.225       |                           |
|   | GL2        | 20.740   | 0.189       |                           |
|   | GL3        | 20.821   | 0.186       |                           |
|   | GL4        | 16.111   | 0.445       |                           |
|   | GL5        | 20.006   | 0.220       |                           |
|   | SRM1       | 25.188   | 0.067**     | S                         |
|   | SRM2       | 22.274   | 0.135       |                           |
|   | SRM3       | 19.465   | 0.245       |                           |
|   | SRM4       | 20.713   | 0.190       |                           |
|   | SRM5       | 22.928   | 0.116       |                           |
|   | IF1        | 23.431   | 0.103       |                           |
|   | IF2        | 11.335   | 0.88        |                           |
|   | IF3        | 18.777   | 0.280       |                           |
|   | IF4        | 17.857   | .332        |                           |
|   | IF5        | 10.441   | 0.843       |                           |
|   | IF6        | 18.432   | 0.299       |                           |
|   | P1         | 14.990   | 0.525       |                           |
|   | P2         | 14.950   | 0.528       |                           |
|   | P3         | 13.709   | 0.620       |                           |
|   | P4         | 19.409   | 0.248       |                           |
|   | P5         | 27.116   | 0.040*      | S                         |
|   | P6         | 20.916   | 0.182       |                           |
| P7  | 21.912     | 0.146    |             |                           |
| P8  | 15.818     | 0.466    |             |                           |

\*Significant for a significant level of 5%

\*\*Significant for a significant level of 10%

These values indicated that GP1, GP3, SRM1, and P5 had impacts on improving the carbon or environmental performances of organizations but other factors weren't so much of help

made mandatory. Attention should also be given on the *design* of the product with features of *quick assembly* integrated in it. Our survey attempted to collect information between existence of CSR department and degree of implementation of environmental practices measured in four constructs mentioned before (Table 6).

**Table 5** Test statistics

|             | Groups means |
|-------------|--------------|
| $\chi^2$    | 90.607       |
| <i>Df</i>   | 4            |
| Asymp. sig. | 0.000*       |

\* $p < 0.05$

The Kruskal–Wallis test ( $\chi^2 = 90.607$ ;  $p = 0.00$ ) found a significant difference between variables

$\chi^2$  value is significant implying mean differences in sample responses among variables

**Table 6** Test statistics on Mann–Whitney U and Wilcoxon W

|                        |          |
|------------------------|----------|
| Mann–Whitney U         | 176.000  |
| Wilcoxon W             | 1166.000 |
| Z                      | −0.984   |
| Asymp. sig. (2-tailed) | 0.325    |

The Mann–Whitney U test ( $U = 176.0$ ;  $p = 0.325$ ) was found not significant difference between variables

Data corresponding to CSR/sustainability department were analyzed using Mann–Whitney test for variables pertaining to all constructs. Since sample data were not normally distributed, Mann–Whitney was used for independent samples for significance level checked at 5%. Our hypothesis for this problem is as follows:

**H<sub>12</sub>** There are differences in the level of implementation of GSCM practices according as existence of CSR/sustainability department of organizations.

Hence null hypothesis that there was any significant difference in environmental practices among two groups of existence or nonexistence of CSR Department and shown in Table 7.

#### 4.6 Pearson coefficients

Correlation coefficient between variables were identified at 0.05 level of confidence (Table 8). The value of correlation between the variables were as shown in Table 8 and their relation was significant at the 0.05 level. The sign of the correlation coefficient indicated the direction of the relationship (positive or negative). The absolute value of the correlation coefficient indicated the strength, with larger absolute values indicating stronger relationships.

As we further see in Table 9, the sign of the correlation coefficients reflected a direct and positive relationship and alternatively a negative and inverse relationship. The absolute value of the correlation coefficients were indicators of strength

**Table 7** Result of Mann–Whitney test for all constructs

| Hypothesis  | GSCM codes | Mann–Whitney U | Asymp. sig. (2-tailed) | Significant–insignificant |
|---|------------|----------------|------------------------|---------------------------|
| H <sub>02</sub> : there are no differences in the level of implementation of GSCM practices according as existence of CSR/sustainability Dept. of organizations | GP1        | 189.500        | 0.755                  |                           |
|   | GP2        | 178.000        | 0.547                  |                           |
|   | GP3        | 183.500        | 0.644                  |                           |
|   | GP4        | 167.000        | 0.389                  |                           |
|   | GP5        | 130.500        | 0.079**                | S                         |
|   | GP6        | 166.000        | 0.374                  |                           |
|   | GL1        | 154.000        | 0.231                  |                           |
|   | GL2        | 136.500        | 0.107                  |                           |
|   | GL3        | 138.000        | 0.108                  |                           |
|   | GL4        | 147.000        | 0.163                  |                           |
|   | GL5        | 125.500        | 0.055**                | S                         |
|   | SRM1       | 101.500        | 0.012*                 | S                         |
|   | SRM2       | 178.500        | 0.561                  |                           |
|   | SRM3       | 141.000        | 0.135                  |                           |
|   | SRM4       | 181.500        | 0.615                  |                           |
|   | SRM5       | 201.000        | 0.971                  |                           |
|   | IF1        | 151.500        | 0.226                  |                           |
|   | IF2        | 158.500        | 0.282                  |                           |
|   | IF3        | 164.000        | 0.353                  |                           |
|   | IF4        | 173.000        | 0.460                  |                           |
|   | IF5        | 151.000        | 0.211                  |                           |
|   | IF6        | 171.500        | 0.445                  |                           |
|   | P1         | 79.000         | 0.002*                 | S                         |
|   | P2         | 164.000        | 0.331                  |                           |
|   | P3         | 175.000        | 0.484                  |                           |
|   | P4         | 166.500        | 0.377                  |                           |
|   | P5         | 142.000        | 0.146                  |                           |
|   | P6         | 181.000        | 0.608                  |                           |
| P7  | 152.500    | 0.232          |                        |                           |
| P8  | 160.500    | 0.313          |                        |                           |

Detail of the Mann–Whitney U test, Wilcoxon W and Z on all elements of four constructs grouped as—existence and non-existence of CSR department are given in Table 7. Conclusion of the results in Table 7 by  $p$  value:  $p < 0.05$ : importance of *GP5* and *P1*,  $p < 0.10$ : importance of *GL5* and *SRM 1*. Hence indicated that there was no difference between two groups existence and nonexistence of CSR) in practices of variables *GP5*, *GL5*, *SRM1*, *P1* which are: *Choice of Transport by Environmental Criteria*; *Strategic Factors of Cost Quality*, *Customer Service*, *Environmental Concerns in Reverse Logistics*, *Designing Products for Quick Assembly*, *Reduction Of Carbon Emission*. For other variables difference in practices do exist between two groups

\*Significant for a significant level of 5%

\*\*Significant for a significant level of 10%



**Table 8** Pearson correlation analysis

|                            | PT     | GP     | GL    | SRM    | IF    | NE     |
|----------------------------|--------|--------|-------|--------|-------|--------|
| <i>Pearson correlation</i> |        |        |       |        |       |        |
| P                          | 1.000  | 0.629  | 0.332 | 0.487  | 0.328 | -0.211 |
| GP                         | 0.629  | 1.000  | 0.633 | 0.663  | 0.648 | -0.169 |
| GL                         | 0.332  | 0.633  | 1.000 | 0.453  | 0.583 | 0.026  |
| SRM                        | 0.487  | 0.663  | 0.453 | 1.000  | 0.520 | -0.176 |
| IF                         | 0.328  | 0.648  | 0.583 | 0.520  | 1.000 | 0.003  |
| NE                         | -0.211 | -1.169 | 0.026 | -0.176 | 0.003 | 1.000  |
| <i>Sig. (1-tailed)</i>     |        |        |       |        |       |        |
| P                          | -      | 0.000  | 0.007 | 0.000  | 0.008 | 0.063  |
| GP                         | 0.000  | -      | 0.000 | 0.000  | 0.000 | 0.111  |
| GL                         | 0.007  | 0.000  | -     | 0.000  | 0.000 | 0.425  |
| SRM                        | 0.000  | 0.000  | 0.000 | -      | 0.000 | 0.102  |
| IF                         | 0.008  | 0.000  | 0.000 | 0.000  | -     | 0.491  |
| NE                         | 0.063  | 0.111  | 0.425 | 0.102  | 0.491 | -      |
| <i>N</i>                   |        |        |       |        |       |        |
| P                          | 54     | 54     | 54    | 54     | 54    | 54     |
| GP                         | 54     | 54     | 54    | 54     | 54    | 54     |
| GL                         | 54     | 54     | 54    | 54     | 54    | 54     |
| SRM                        | 54     | 54     | 54    | 54     | 54    | 54     |
| IF                         | 54     | 54     | 54    | 54     | 54    | 54     |
| NE                         | 54     | 54     | 54    | 54     | 54    | 54     |

*NE* number of employees which indicates size of the organization

All correlation values are significant at 5%

relationships: higher the absolute value, stronger the relationship. It should be noted that each variable was having perfect positive linear relationship with itself as seen at the main diagonal and have value=1. Table 9 showed that all the variables (GP, GL, SRM and IF) had significant positive relationships (i.e. their sig. < 0.05). *SRM* and *GP* reflects positive relationship with  $r = 0.663$ , which meant that integrations of green product and process design and green procurement have a positive impact on the carbon performance of the organizations. Furthermore, *IF* and *GP* reflected positive relationship with  $r = 0.648$ , which indicated that the integrations of green procurement and regularity framework have also a positive impact on carbon performance. On the other hand, the Number of Employee (*NE*) had insignificant relationship with P, GP, SRM and IF (i.e., sig. > 0.05) which indicated that carbon performance of the organization was not affected by the size of the firm.

**Table 9** Means of carbon performance constructs

| Grouping field: CSR sustainability dept |         |         |        |      |             |
|---|---------|---------|--------|------|-------------|
| Field                                   | N*      | Y*      | F test | Df   | Importance  |
| <i>Green procurement</i>                |         |         |        |      |             |
| Mean                                    | 3.167   | 2.948   | 0.707  | 1.52 | 0.596       |
| Standard deviation                      | 0.932   | 0.664   |        |      | Unimportant |
| Standard error                          | 0.311   | 0.099   |        |      |             |
| Count                                   | 9       | 45      |        |      |             |
| <i>Green logistics</i>                  |         |         |        |      |             |
| Mean                                    | 3.800   | 3.293   | 3.108  | 1.52 | 0.916       |
| Standard deviation                      | 0.374   | 0.841   |        |      | Marginal    |
| Standard error                          | 0.125   | 0.125   |        |      |             |
| Count                                   | 9       | 45      |        |      |             |
| <i>Green product process design</i>     |         |         |        |      |             |
| Mean                                    | 3.400   | 2.933   | 2.111  | 1.52 | 0.848       |
| Standard deviation                      | 0.970   | 0.862   |        |      | Unimportant |
| Standard error                          | 0.323   | 0.129   |        |      |             |
| Count                                   | 9       | 45      |        |      |             |
| <i>No of employees</i>                  |         |         |        |      |             |
| Mean                                    | 168.889 | 267.000 | 3.083  | 1.52 | 0.915       |
| Standard deviation                      | 48.139  | 165.091 |        |      | Marginal    |
| Standard error                          | 16.046  | 24.610  |        |      |             |
| Count                                   | 9       | 45      |        |      |             |
| <i>Carbone reduction performance</i>    |         |         |        |      |             |
| Mean                                    | 3.375   | 3.253   | 0.217  | 1.52 | 0.356       |
| Standard deviation                      | 0.899   | 0.681   |        |      | Unimportant |
| Standard error                          | 0.300   | 0.102   |        |      |             |
| Count                                   | 9       | 45      |        |      |             |
| <i>Regulatory framework</i>             |         |         |        |      |             |
| Mean                                    | 2.778   | 2.807   | 0.013  | 1.52 | 0.089       |
| Standard deviation                      | 0.471   | 0.761   |        |      | Unimportant |
| Standard error                          | 0.157   | 0.113   |        |      |             |
| Count                                   | 9       | 45      |        |      |             |

\*Cells contain mean, standard deviation, standard error, count

#### 4.7 Multiple linear regression analysis

Multiple linear regression analysis was conducted to determine predictors of carbon reduction performance (dependent variable P). The results were as shown in Table 10.

From Table 10,  $R^2$  value indicates the explanatory power of the regression model. It is the percentage of variance of the dependent variable (P) explained by the independent variables (green supply chain management). The value of adjusted  $R^2$  indicated that green supply chain management explains 0.428 carbon reduction performance. The adjusted  $R^2$  value adjusts only if a new independent

**Table 10** Model summary-regression values<sup>b</sup>

| Model | R                  | R <sup>2</sup> | Adjusted R <sup>2</sup> | Std. error of the estimate | Change statistics     |          |               | Durbin Watson |       |       |
|-------|--------------------|----------------|-------------------------|----------------------------|-----------------------|----------|---------------|---------------|-------|-------|
|       |                    |                |                         |                            | R <sup>2</sup> change | F change | Sig. F change |               |       |       |
| 1     | 0.654 <sup>a</sup> | 0.428          | 0.368                   | 4.53799                    | 0.428                 | 7.184    | 5             | 48            | 0.000 | 1.144 |

<sup>a</sup> Predictors: (Constant), No of\_Employees, IFT, SRMT, GLT, GPT

<sup>b</sup> Dependent variable: PT

**Table 11** Significance of the effect of GSCM on carbon reduction performance

| ANOVA <sup>a</sup> |                |    |             |       |                    |
|--------------------|----------------|----|-------------|-------|--------------------|
| Model              | Sum of squares | Df | Mean square | F     | Sig.               |
| Regression         | 739.669        | 5  | 147.934     | 7.184 | 0.000 <sup>b</sup> |
| Residual           | 988.479        | 48 | 20.593      |       |                    |
| Total              | 1728.148       | 53 |             |       |                    |

<sup>a</sup>Dependent variable: P<sup>b</sup>Predictors: (constant), No. of\_Employees, IF, SRM, GL, GP

variable brings an accuracy improvement in the model. The  $R^2$  is not  $> 0.70$  which implies that variables in the model cannot explain entire reduction of carbon performance and hence there is scope for adding more constructs to improve the model. ANOVA was conducted to test the statistical significance of the effect of GSCM on carbon reduction. The results are as shown in Table 11.

From Table 11 the significance value ( $p$ ) of 0.0 gives the test on the entire model. Since the value of  $p < 0.05$ , this implies that though there is positive effect of Green supply chain management on carbon performance, the effect is statistically significant.

From Table 12, it can be concluded that carbon performance will be increased by 0.869 due to significant positive green procurement coefficient (i.e.,  $p = 0.001$ ). Furthermore, the carbon performance will be increased by 0.178 due to positive green process and product design. On the other hand, the carbon performance will be decreased by 0.094 due to negative Green logistics coefficient and by 0.166 due to negative coefficient of regulatory frameworks. It will also be decreased by 0.003 due to negative number of employees. So clearly the results indicate that regression coefficient is positively related with  $GP$  and hence,  $GP$  is statistically significant, whereas  $GL$ ,  $SRM$ ,  $IF$  and Number of Employees are insignificant in the model (Table 12). Often in multiple Linear regression model, the relationship between variables can sometimes have to multicollinearity when the variables are highly related. The correlation coefficients for each pair of continuous (scale) variables are checked. If VIF (variance inflation factor) between variables is high, i.e. 10 or above, then it causes problems. Since all the values in our model are in the range of  $\{1-3\}$ , the possibility of multicollinearity is within acceptable limit. Thus, from above analysis, the equation for the regression model is as:

$$Y = 13.014 + 0.869X_1 - 0.094X_2 + 0.178X_3 - 0.166X_4 - 0.003X_5 + \varepsilon,$$

where  $Y$ , carbon reduction performance;  $\beta_0$ , constant;  $\beta_1$ – $\beta_5$ , regression coefficients;  $X_1$ , GP;  $X_2$ , GL;  $X_3$ , SRM;  $X_4$ , IF;  $X_5$ , NE;  $\varepsilon$ , error term.

From regression analysis, the most important variable affecting carbon reduction performance is GP (green procurement). This is followed by SRM (green product and process design), IF (regulatory framework) and GL (green logistics) in sequence. Negative value GL and IF imply that green logistics and regulatory framework for the sample area are not in desired directions and need systematic change.

**Table 12** Regression coefficients of constructs

| *Model          | Unstandardized coefficients |       | Standardized coefficients | t      | Sig.  | Correlations |            |         | Collinearity statistics |           |     |
|-----------------|-----------------------------|-------|---------------------------|--------|-------|--------------|------------|---------|-------------------------|-----------|-----|
|                 | B                           | SE    |                           |        |       | Beta         | Zero-order | Partial | Part                    | Tolerance | VIF |
|                 |                             |       |                           |        |       |              |            |         |                         |           |     |
| Constant        | 13.014                      | 3.300 | -                         | 3.944  | 0.000 | -            | -          | -       | -                       | -         |     |
| GP              | 0.869                       | 0.242 | 0.648                     | 3.586  | 0.001 | 0.629        | 0.460      | 0.391   | 0.365                   | 2.738     |     |
| GL              | -0.094                      | 0.212 | -0.066                    | -0.444 | 0.659 | 0.332        | -0.064     | -0.048  | 0.536                   | 1.864     |     |
| SRM             | 0.178                       | 0.191 | 0.139                     | 0.933  | 0.355 | 0.487        | 0.133      | 0.102   | 0.538                   | 1.858     |     |
| IF              | -0.166                      | 0.203 | -0.125                    | -0.820 | 0.416 | 0.328        | -0.118     | -0.090  | 0.511                   | 1.956     |     |
| No of employees | -0.003                      | 0.004 | -0.075                    | -0.658 | 0.514 | -0.211       | -0.095     | -0.072  | 0.919                   | 1.088     |     |

\*Model:  $F = 7184$ ;  $df = 5$ ;  $P = .000$

## 5 Discussions

The prime investigation of this paper is carbon reduction performance of organizations of different sectors grouped as existence/nonexistence of CSR department and number of employees. The green enablers/constructs namely, green procurement, green logistics, green process and product design, regulatory frameworks, are statistically verified for their roles in carbon reduction performance for two groups. From results, inferences are made that regulatory frameworks and practices of green supply chains have been ignored or underutilized leading to negative carbon performance by organizations. Results, however, suggest that implementation of green procurement, green process and product design and presence of relatively small number of employees to an extent help the organizations to achieve their emission control goals. However, green practices adopted by organizations have not yielded the expected results for several reasons. There are much to be desired from organizations in controlling green gas emission. Though organizations have declared emission reduction targets, these may not be authentic. Many organizations do have CSR departments for implementing “green practices”, but they have little influence on organization’s carbon performance beyond demonstrating compliance with regulations and filing reports. This is an area of concern and requires deep research needed to find out why they are failing to have expected results. Is carbon performance the sole responsibility of the CSR departments? How do organizations ensure that policies drafted for carbon performances are duly implemented? Who is responsible for the execution of these policies?

The green enablers (green procurement, green logistics, green process and product design, regulatory frameworks and nu of employees) have been tested for their contribution in improving carbon performances of our sample organizations using linear regression analysis. These variables explain a little more than 36% of emission reduction. The findings clearly indicate that lack of accountability, non-implementation or irresponsible implementation of corporate policies on the part of CSR departments, could be the reason for poor carbon performances of organizations.

## 6 Conclusion

The failures on the regulations could be for several reasons. First, environmental codes of conducts and policies have set extremely difficult targets. Second, the standard of practices should be moderately difficult to achieve but measurable. Third, sustainability programs are not one-time attempt, they require continuity and dedicated efforts over a long period of time for which employees/managers play an important role. The organization with a larger number of employees in our study is found to have less compliance with the regulations.

Regulatory system should be embedded with (1) regular training of task force at all levels; (2) reward and incentive systems for promoting and implementing

sustainable practices. (3) The practice of disclosure of sustainability programs and reports to the stakeholders should be made more effectively to control negative impact on carbon performance. (4) Internationally recognized accreditation and certifications should be introduced so that organizations are forced to reduce and sustain greenhouse gas emission. Our research also points towards the lapses in the logistics management. The problem of logistics is complicated and burdensome for Indian organizations, especially, for those who face challenges of heavy traffic, route changes and poor infrastructure. With globalization and multi-country trade opportunities, there are more complications for logistics issues. Logistics management involves increased air freight and road transport on one hand and on the other increased infrastructural demands like warehouses, roads, for accommodating global sourcing. Sometimes these demands are met by sacrificing or violating some concerned environmental codes. Another point from logistics perspective is the use of vehicles for transport. Old worn-out or sometimes pollution creating vehicles are mostly employed to cover smaller distances. Economic constraints inhibit investment in modern technology, vehicles and infrastructural facilities for many organizations. However, the sustainable solutions for carbon performance must be carefully identified and continuously implemented for a striking difference in the current result. This study has taken two differentiating points: type of organization and presence of CSR and studied the impact of magnitude of workforce on sustainable practices.

## 7 Limitations and future research

The research was conducted in the industrial set up of western zone of India with concentrated traffic. Research focused on the green enablers for carbon reduction performance. There are many other variables like adaptation of technology, disclosure of sustainability reports and international accreditations which could help organizations improve their carbon performance. In future we intend to undertake the powerful modelling and analytical tools of CMARS, RMARS and RCMARS useful for enhanced decision support in addition to data mining software development programme of IBM SPSS Modeler (Clementine).

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