Benchmarking: An International Journal

Exploring antecedents of extended supply chain performance measures: An insight from Indian green manufacturing practices

Rameshwar Dubey Sadia Samar Ali

Received 10 April 2013
Revised 2 September 2013
30 September 2013
Accepted 5 October 2013

Exploring antecedents of extended supply chain performance measures

An insight from Indian green manufacturing practices

Rameshwar Dubey
Department of Operations Management, Symbiosis International University, Nashik, India, and
Sadia Samar Ali
New Delhi Institute of Management, New Delhi, India

Abstract

Purpose – The purpose of this paper is to explore the antecedents of Indian firms practicing green manufacturing practices and their impact on extended supply chain performance.

Design/methodology/approach – In this paper the authors have adopted systematic literature review (SLR) to derive research objectives and questions. In order to answer research questions the authors have proposed a theoretical framework and derived research hypotheses. The authors identified constructs and items through extant literatures and developed a structured questionnaire which was pretested before using for final survey. The data were collected in two phases and also performed wave analysis to check non-response bias to avoid any significant impact of non-response bias on statistical analysis. The data has been used to conduct exploratory factor analysis using varimax rotation which reduces variables into five parsimonious and orthogonal factors. The factor analysis output was further used as an input of regression analysis.

Findings – The factor analysis output has further validated the findings from literature review. The factor analysis output suggests that total quality management (TQM), supplier relationship management (SRM), R&D and technology and lean manufacturing practices are important determinants of Indian firms practicing green manufacturing practices which impact extended supply chain performance. The regression analysis output has further established that TQM and R&D and technology are strong determinants of extended supply chain performance. However, present study does not support SRM and lean manufacturing practices from respondent's perspective. However, it further needs to be explored.

Research limitations/implications – The present study is limited to medium-sized manufacturing firms. Second, the conclusive model explains only 31.9 percent of the total extended supply chain performance. The study provides an insight to managers that those companies which have implemented TQM and green technology have realized superior performance in comparison to those which have not successfully implemented.

Originality/value – The present study is toward understanding Indian green manufacturing practices.

Keywords Performance management, Manufacturing, Supply chain management

Paper type Research paper

Benchmarking: An International Journal
Vol. 22 No. 5, 2015
pp. 752-772

1463-5771
DOI 10.1108/BIJ-04-2013-0040

The authors are extremely grateful to Professor Angappa Gunasekaran, three referees for their structured and valuable comments, managing editor Sophie Barr and Emerald publishing team for their excellent support and cooperation in enhancing quality of paper. The authors are equally grateful to the respondents who participated in the survey.

1. Introduction

Supply chain management was earlier viewed as a mean of movement of materials and goods. It was just considered as a process by means of which the organizations used to strategize. The best value supply chains focusses on increasing key results and not just merely movement of the product from manufacturing unit to customer. Mehra (2005) suggested that due to the rapidly changing global market there is a great demand to analyze the emerging trends that can impact the business. The supply chain is a key component of planning in all types of business; hence it must be constantly observed. The activities like developing, manufacturing and marketing a product may throw a serious challenge before any organization. In order to ensure a sustainable competitive advantage the companies should strive for supply chain excellence and should constantly monitor their current processes. The following aspects are some of the emerging trends in supply chain management:

- planning and demand forecast;
- enhanced competition both from local and global players;
- outsourcing;
- reduced product life cycles;
- trust and mutual cooperation between stakeholders; and
- globalization.

Besides, some other emerging trends in supply chain management are those of green supply chain, emphasis on the corporate social responsibility and the role of IT as a key player through the implementation of ERP system which enables a smooth and easy control over the different segments of supply chain. Green supply chain management is becoming important due to the following reasons:

- rapidly exhausting raw materials;
- environmental degradation; and
- enhanced pollution levels.

The growing concern toward protecting environment has resulted into green policies. Today green manufacturing has become common jargon used by almost one-third of manufacturing specialists and researchers. Why not? There is a dire need for the companies especially engaged in manufacturing activities, to take a proactive approach rather than reactive approach in this aspect. In one of the report released by UNEP (2011), global manufacturing industry consumes 35 percent of the total electricity consumed worldwide and responsible for 20 percent of the world's CO_2 emissions, which is detrimental to lives on the earth. The only purpose of the above argument is to draw attention toward "cleaner production" or simply say "green manufacturing." If economies like India and China want to sustain their manufacturing prowess's, then they need to implement green manufacturing policies religiously.

The USA and European Union are very high in terms of CO_2 emissions per-capita (United Nations Statistics, 2012). However, in terms of volume (measuring in million metric tons) China is the world leader. The time has come when one need to understand that CO_2 emission is today global threat. Today, European Union and USA might be feeling comfortable by adhering to their green policies but in this process they have outsourced CO_2 emissions to China and India. Can outsourcing of manufacturing be

sustainable solution? This question needs serious attentions from policy makers. Today, no large economy can sustain without manufacturing (Pisano and Shih, 2009); therefore there is need for innovative manufacturing practices which are compatible to environment.

2. Literature review

We have adopted "SLR" in our paper as suggested by Tranfield *et al.* (2003). The present section is divided into two stages and its phases.

2.1 Stage1: planning the review

2.1.1 Phase 0: identification for the need for a review. The field of manufacturing and operations has seen radical changes through the years. It started with the "The Industrial Revolution" in the late 1700s, and has been through several phases but real challenge emerged in front of manufacturing was its sustainability. The major issues that have forced developed economies like USA, Canada, Great Britain and European countries to shift their manufacturing base to China and India was cost and other was to put check on greenhouse gas emissions. However, the approach of these developed economies was questionable. Shifting the location of manufacturing hubs is never going to solve problems but there is need for more sustainable solution which can optimize between cost and environment. The search of amicable solution has led to the growth of green manufacturing term. Green manufacturing is defined as elimination of wastages and redefining existing process to minimize the carbon emissions during each process without increasing cost and affecting production targets (Balan, 2008; Azzone and Noci, 1998). In our present work we will discuss theoretical concept used for building research hypothesis and develops a theoretical model. We will review latest research works related to evolution of green manufacturing; supply chain dimensions in green manufacturing, green manufacturing as a source of competitive advantage and performance measures.

2.1.2 Phase 1: preparation of a proposal for a review. In this section we will identify reputable journals which publish potential works related to supply chain management, green supply chain, green manufacturing and its related areas. These journals include *International Journal of Production Economics*, *Journal of Cleaner Production*, *Energy Policy*, *International Journal of Production Research*, *World Journal of Science, Technology and Sustainable Development*, *Production Planning & Control*, *Benchmarking: An International Journal*, *International Journal of Operations and Production Management*, *Supply Chain Management: An International Journal*, *Journal of Business Logistics*, *International Journal of Logistics*, *Transportation Research* and other related journals.

To begin with, it is very important to understand "Green Manufacturing" or "Cleaner Production" and its dimensions. Though there are lots of definitions and arguments, but from various literatures it can be derived that during manufacturing or production, lot of wastes in the form of solid, liquid and gas are released, which are harmful to earth and to lives supported by the earth. In order to minimize the harmful effect of these wastes, innovative manufacturing practices need to be deployed which are blend of technology, culture, leadership and policies, at economical cost so that firm should not overburdened with excessive cost of production that may force them to outsource as it is the present scenario in the western part of the world (World Commission on Environment and Development, 1987; Porter and Van der Linde, 1995; Azzone and Noci, 1998; Deif, 2011; Giovanni, 2012; Zhu *et al.*, 2012).

2.1.3 Phase 2: development of review protocol. We decided initially to review all published work. In order to eliminate our biasness toward any work we reviewed all possible articles published in past five years in all mentioned journals related to supply chain management, sustainable manufacturing and related concepts so that we do not end up with sketchy literature or irrelevant literature.

2.2 Stage 2: conducting a review

2.2.1 Phase 3: identification of research. We reviewed over 275 articles related to SCM, manufacturing, green manufacturing, strategy and methodologies.

Based on review, we have derived three important questions which will further drive our investigation.

2.3 Research questions

In order to meet the above mentioned research objective, we have formulated some research questions and have identified appropriate research strategies for each research questions which will help us to provide a structured platform to carry out our empirical investigation. The list of research questions are as follows:

RQ1. What are the critical success factors for green manufacturing/cleaner manufacturing?

RQ2. What are the dimensions of each constructs?

RQ3. Can we propose a theoretical framework in which we can develop extended supply chain performance framework?

2.3.1 Phase 4: selection of studies. We have identified areas which will be building unit of our present research.

2.4 Dimensions of cleaner production/green manufacturing

Green manufacturing is related to the manufacturing practices of product which use more environmental friendly resources and provides maximum output with little or no waste or pollution in production (Baines *et al.*, 2012). Green manufacturing includes implementing best available resources in industry to be efficient. These best resources also give competitive advantage in a long run by optimally utilizing to increase in production quality, output, with optimum cost (Fullerton *et al.*, 2008). Green can lead to low raw usage of material, reduction in energy consumption, fewer manufacturing steps, reduced environmental and occupational safety expenses with improved corporate image (Porter and van der Linde, 1995). Challenges associated with green manufacturing include meeting customer demands for environmentally sound products, development of recycling schemes, minimization of materials use and selection of materials with low environmental impacts.

The variables that constitute green manufacturing, identified through literature review are:

- lean manufacturing (Farish, 2009; Franchetti *et al.*, 2009; Deif, 2011; Dues *et al.*, 2013);
- total quality management (TQM) (Prajogo *et al.*, 2012; Pereira-Moliner *et al.*, 2012; Gavronski *et al.*, 2013);
- supplier relationship management (SRM) (Vachon and Klassen, 2006; Hsu and Hu, 2009; Bai and Sarkis, 2010); and

- technologies for cleaner production/green manufacturing (Sikdar and Howell, 1998; Xu and Beamon, 2006; Zhang *et al.*, 2013; Hoof and Lyon, 2013).

2.4.1 Phase 5: study quality assessment. However, in past several literatures are devoted to green supply chain practices which includes green manufacturing as a source of competitive advantage for a company (Bjorklund *et al.*, 2012; Vachon and Klassen, 2008; Zhu *et al.*, 2008; Markley and Davis, 2007; Hervani *et al.*, 2005). However, there is lack of commonalities among literature in terms of direct linkage of sustainability practices and competitive advantage. Even Frost and Sullivan developed 11 metrics for evaluating green manufacturing performance only captures environmental performance indices. It somehow does not indicate financial or non-financial measures. From literature survey it is clearly visible that linkage between green manufacturing practices and competitive advantage is the area which is a missing link. Second, there is scope for study on antecedents or dimensions of green manufacturing practices that helps firm to achieve environmental and business performance.

2.4.2 Phase 6: data extraction and monitoring progress. The variables and items from various studies are adopted on four areas that include lean manufacturing, supplier relationship, R&D and TQM (Boyd and Gupta, 2004; Gupta and Boyd, 2011; Parast, 2011; Gonzalez *et al.*, 2003; Feng and Yuan, 2006; Sharma *et al.*, 2007; Micheli *et al.*, 2009).

Ahmad *et al.* (2004) suggests that JIT may not directly impact financial performance of the firm. It is advisable for those firms, which are looking for direct benefits from JIT implementation need to appreciate the limitations of JIT practice. Billesbach and Hayen (1994) study of the impact of JIT on inventory-turn was significant in long term. Kaynak (2003) in his one of the papers, he established that TQM is key enabler to quality performance.

2.4.3 Phase 7: data synthesis. In summary, even though the concepts differ in focus, both shares the idea that resource productivity is at the heart. Waste, no matter what type, should be avoided or preferably eliminated. The comparison between the lean and green manufacturing concept shows that they are complementary and overlapping on each other. Both concepts promote resource productivity in manufacturing. Reduction of waste in terms of inventory, rework, etc., as augmented by the lean concept contributes to resource productivity. Similarly, the green concept asserts reduction of material waste and emissions, fewer production steps which also support high resource productivity.

3. Conceptual model development and research design

3.1 Conceptual model

From various literatures it can be seen that researchers in the past have established the linkage between independent variables and dependent variable. It can be broadly classified in two categories. One is a direct linkage between independent variables and dependent variable. The other, namely, moderating linkage or mediating linkage is added between independent variables and dependent variable, in hope to throw more explanatory light on the direct linkage. Therefore, this study integrates several antecedents derived from literature review and factor analysis to examine the relationship between antecedents and organizational performance.

3.2 Hypotheses formulation

Waste elimination is also one of the key issues of green manufacturing. It concerns reduction or prevention of pollution to air, water and land as well as reduction of waste

at source. Reuse and recycling are also part of the green manufacturing concept to reduce the amount of waste produced. Waste is thus considered in a slightly different manner than in the lean concept, but the concepts share the view that resource productivity (Porter and van der Linde, 1995) is central aspects of a firm's competitiveness. Johansson and Winroth (2009) conducted an empirical study with a new approach to compare lean manufacturing and green manufacturing. Lean manufacturing focusses on value creation for supply chain partners. The basic philosophy of lean manufacturing is to eliminate non-value adding activities from the supply chain, or at least to reduce. This elimination of wastage includes overproduction, waiting, unnecessary transport, over processing, excess inventory, unnecessary movement, defects and unused employee creativity (Liker, 2004). We therefore hypothesize:

H1. There is a positive relationship between lean manufacturing practices and performance measure.

However, in recent years, firms in western countries who have integrated TQM philosophy with green manufacturing practices have shown superior performance (Prajogo *et al.*, 2012; Pereira-Moliner *et al.*, 2012; Gavronski *et al.*, 2013). However, there are few researches done in context to TQM philosophy blended with green manufacturing practices, particularly from Indian manufacturing perspective. We therefore hypothesize:

H2. There is a positive relationship between TQM implementation and performance measure.

Supplier relationship management with partners has played pivotal role in successful implementation of green manufacturing practices in western economies (Vachon and Klassen, 2006; Hsu and Hu, 2009; Bai and Sarkis, 2010; Hoof and Lyon, 2013) and even Indian manufacturers have realized the potential benefits of supplier relationship management (Thakkar *et al.*, 2008). However, supplier relationship management role in successful implementation of green supply chain practices in Indian manufacturing sector is still needed to be explored. We therefore hypothesize:

H3. There is a positive relationship between supplier relationship management and performance measure.

Cost and optimal utilization of resources are the primary area of concern, it is critical to quantify all inputs in the process and wastages as well. Sometimes because of wrong accounting practices revenue generated through recycled wastages is posted to wrong accounts which reflects wrong picture of the organization (Fullerton *et al.*, 2008). Due to rapid concern about global warming and pollutant industrial practices are emerging as a challenge for the global environment. Manufacturers are seeking practical solutions that can be implemented to sustain green practices. To overcome the wrong perception of customer that "we are consuming eco-friendly products," manufacturers (who are in practice) and customers both must have a closer look at manufacturing practices. There is a growing need to understand that certain products and their manufacturing practices are creating danger for environment. As concerned customer will be aware about the wrong practices they will be willing to pay for those products and indirectly give a competitive advantage to firm. We therefore hypothesize:

H4. There is a positive relationship between technologies and performance measure.

The green manufacturing has helped firm to achieve superior performance is supported by literatures. The literature defines performance as combination of environmental performance (e.g. reduction in CO_2, SO_2, NO_x, converting waste into more useful product, reuse or recycling after use, increase in product quality, increase in customer satisfaction) and business performance (e.g. increase in market share, increase in profitability, increase in ROI, increase in ROA, improvement in inventory turnover) (Pereira-Moliner *et al.*, 2012; Dues *et al.*, 2013; Gavronski *et al.*, 2013). We therefore hypothesize:

H5. There is positive relationship between green manufacturing practices and organizational performance.

3.3 Assumptions of our present study

To test hypotheses, we have made certain assumptions which are:

(1) the variables are assumed to be orthogonal in nature;

(2) macro variables are assumed to constant; and

(3) to measure firm performance we have assumed perception of senior manager or plant head of company.

3.4 Questionnaire development

To conduct survey, questionnaire is developed scientifically so that proposed hypotheses can be empirically tested. The questionnaire design begins with literature review. Once a draft is prepared, it is pretested to check the clarity of the statement and check validity, a list of experts are prepared who are authority in their respective field. After incorporating suggested changes or carrying out final refinement in the initial draft the questionnaire is further tested through pilot test to check reliability. After pilot test the questionnaire is ready for final survey.

3.4.1 Measures. The constructs of the instrument in this study were measured multiple items from the questionnaire survey. Here in our instrument we had used multi-item variables, in which respondents had to indicate the extent to which they agreed or disagreed with the statement on a five-point scale (1 – strongly disagree, 5 – strongly agree). The items used to measure each scale were adapted based on existing scales from the various literatures as shown in Table I.

3.5 Sampling design

In this study we have targeted manufacturing firms having less than 250 employees and having invested less than 100 million in INR on equipment (i.e. medium enterprises). In this case researchers have conducted pilot study in Pune region, located in Maharashtra (India) and Pantnagar which is one of the growing manufacturing hubs in India located in Uttarakhand (India). There are over 1,000 manufacturing companies in Pune and over 300 manufacturing companies in Pantnagar. Researchers initially targeted 175 companies from Pune and 100 companies from Pantnagar. However, only 75 questionnaires have been responded by Pune-based companies and only 25 companies have responded to questionnaires from Pantnagar.

3.5.1 Non-response bias test. Non-response bias is one of the serious limitations of survey-based research. Though we took utmost care during data collection, but no one can deny the implications of non-response bias. We performed wave analysis test on collected data during two phases as suggested by Armstrong and Overton (1977).

Items	References
Pull system	Prajogo *et al.* (2012), Pereira-Moliner *et al.* (2012), Gavronski *et al.* (2013)
JIT	Hiltrop (1992), Billesbach and Hayen (1994), Huson and Nanda (1995)
TPM	Schonberger (1986), Brah and Chong (2004)
TQM	Kaynak (2003), Wayhan *et al.* (2013)
Simplicity practice impact on company performance	Schonberger (1986), Hayes and Pisano (1994)
Statistical Quality Control	Koning and Mast (2006), Antony and Desai (2009)
Six-Sigma practice impact on company performance	Schroeder *et al.* (2008), Parast (2011)
Quality benchmarking practice impact on company performance	Camp (1989, 1995), Dragolea and Cotirlea (2009)
Innovation	Chan Kim and Mauborgne (2004)
Green technology	Wagner *et al.* (2012)
Research budget	Hill and Jones (2001)
Research culture	Hill and Jones (2001)
Patent of ideas and technology	Bower and Christensen (1995)
Sourcing	Porter (1985), Ellram and Stanley (2008), Ramsay and Wagner (2009), Dubey *et al.* (2013)
e-Procurement	Essig and Amman (2009), Large and Konig (2009)
Supplier evaluation	Ellram and Stanley (2008), Nollet *et al.* (2008)
Days of payable outstanding	Stefanovic and Stefanovic (2011)
Green purchasing performance	Micheli *et al.* (2009), Ellram and Stanley (2008), Nollet *et al.* (2008), Bakker and Kamann (2007), Dubey *et al.* (2013)
ROA	Dess and Robinson (1984), Kaynak (2003)
Profitability	Hitt *et al.* (1982), Hitt and Irelend (1985), Kaynak (2003)
Customer satisfaction	Yusuf *et al.* (2007)

Table I.
Construct and items of instrument

We performed χ^2 test to measure any statistical difference at 95 percent confidence interval. We found difference is not statistically significant at $p = 0.000$. From this we can conclude that non-response bias has no serious implication in our study.

4. Data analysis and findings

In this section researcher present exploratory factor analysis (EFA) conducted on raw data collected during pilot study to check construct validity and measure reliability of parsimonious and orthogonal factors obtained during second varimax rotation.

4.1 EFA

To begin with EFA, the descriptive analysis of data was carried out i.e., KMO-Bartlett test of sphericity which is also known as data-adequacy test. The KMO value is found to be 0.591 and Bartlett test of sphericity was statistically significant at significance level 0.000 which shows that data are suitable for further EFA. The objective of EFA is to unearth the underlying factors, thereby illustrating the relationships between the latent factors and the observed variables (Hair, 1995). The purpose is to come out with the minimum number of factors that will explain the co-variation among the observed variables. In this research, 20 variables were identified from the literature.

Extracted variables using principal component analysis (PCA) show that six components contribute more than 76 percent of the total variance. The factor loading is

Pearson coefficient which is also termed as PCA loadings. It is also termed as cosine of the angle formed by the vector, i.e. cosα where "α" is the angle formed by the radius vector. Here factor variance can be obtained by calculating, sum of the squared factor loadings of each variables on a factor (*Fi*). To calculate percent of variance in all the variables accounted for by each factor, add the sum of the squared factor loadings for that factor (column) and divide by the number of variables (note the number of variables equals the sum of their variances as the variance of a standardized variable is 1). This is the same as dividing the factor's eigenvalue by the number of variables. Researcher performs two rotations till researcher has obtained parsimonious structure as shown in Table II.

In order to obtain this stable structure researcher have assumed two criteria:

(1) the researcher have eliminated variables having weak factor loadings (less than 0.5); and

(2) variables having cross loadings on two factors or more.

The structure of all eight factor matrix was found to be stable. The sum of square of loadings of each variable on each factor is greater than 1 except for factor 6 whose eigenvalue is less than 1, rest all five factors satisfies the Kaiser criterion that their eigenvalue should be equal or greater than 1. In this case we have dropped factor 6 as it is insignificant and further proceed with five factors. All variables held one significant factor loading with one factor by the standard of greater than 0.5. No case of blurred significant loadings across factor was found. The index of the factor is quite high. Furthermore, all five factors contained variables which were apparently interpretable.

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Pull system			0.797			
JIT practice impact on company performance			0.786			
TPM practice impact on company performance			0.829			
Simplicity practice impact on company performance				0.670		
Statistical Quality Control				0.635		
Six-Sigma practice impact on company performance				0.848		
Quality benchmarking practice impact on company performance				0.852		
Innovation		0.771				
Green technology		0.747				
Research budget		0.914				
Research culture		0.865				
Patent of ideas and technology		0.645				
Sourcing					0.854	
e-procurement					0.756	
Supplier evaluation	0.680					
Days of payable outstanding	0.894					
Green purchasing performance	0.934					
ROA	0.753					
Profitability	0.756					
Customer satisfaction						0.528

Note: Varimax rotation

Table II.
Parsimonious orthogonal factors

4.2 Construct validity and reliability test using confirmatory factor analysis

After, examining all the underlined variables for a particular factor and placing greater emphasis on those variables with higher loadings we will attempt to assign a name or label to a factor that accurately reflects the variables loadings α on that factor as shown in Table III.

The reliability test of new scales shows that the Cronbach's α of new scales are more than 0.75 which satisfy minimum criteria of 0.7 (Hair, 1995). The scale composite reliability (SCR) of each construct, factor loadings of indicators of each construct and average variance extracted (AVE) met (Fornell and Larcker, 1981) minimum criteria, i.e. SCR $\geqslant$ 0.7, AVE $\geqslant$ 0.5 and $\lambda i \geqslant 0.5$. We therefore can conclude that constructs possess convergent validity and further we performed discriminant validity. For checking discriminant validity we have derived inter-factors correlation matrix and converted leading diagonal of inter-factors correlation matrix with AVE and squared the entries of each matrix which represent Pearson coefficient between two factors. The squared values of each coefficient were found to be lesser than AVE (Fornell and Larcker, 1981). From this we conclude that factors possess discriminant validity. We therefore can conclude that constructs of the model possess construct validity. The study has been further carried out in manufacturing firms situated in four regions, namely, northern region, eastern region, southern region and western region. During final survey researcher has collected 680 usable responses out of 1,780 firms which represent 38.20 percent (response rate). The data are further used for regression analysis. The demographic profiles of the companies who have responded to the questionnaire are presented in Table IV.

Factors	Items	Factor loadings (λi)	Cronbach α
Extended supply chain performance	Supplier evaluation	0.680	0.752
SCR = 0.903	Days of payable outstanding	0.894	0.758
AVE = 0.654	Green purchasing performance	0.934	0.762
	ROA	0.753	0.761
	Profitability	0.756	0.763
R&D and technology			
SCR = 0.893	Innovation	0.771	0.765
AVE = 0.630	Disruptive technology	0.747	0.761
	Research budget	0.914	0.758
	Research culture	0.865	0.749
	Patent of ideas and technology	0.645	0.755
TQM			
SCR = 0.841	Simplicity practice	0.670	0.752
AVE = 0.574	Statistical Quality Control	0.635	0.762
	Six-Sigma practice	0.848	0.763
	Quality benchmarking practice	0.852	0.764
Lean manufacturing			
SCR = 0.846	Pull system	0.797	0.777
AVE = 0.647	JIT	0.786	0.774
	TPM	0.829	0.779
SRM			
SCR = 0.788	Sourcing	0.854	0.767
AVE = 0.650	e-procurement	0.756	0.776

Table III. Orthogonal variables matrix

Table IV is represented in form of bar-chart as shown in Figure 1.

Here all the firms which are targeted for present study belong to medium scale enterprises whose employee strength is greater than 50 and less than 250, and with an investment limit of 100 million in INR in equipment. The EFA output will be further subjected to regression analysis using industry as a control variable.

4.3 Regression modeling

Simple multiple regression analysis with four explanatory variables from EFA and firm performance as response variable (refer to Table III) were conducted. A multiple linear regression model is run to test the relationship among predictor variables and response variable. Figure 2 shows the proposed regression model based on output generated using EFA.

Before we carried out multiple regression analysis we have checked the assumptions of regression analysis as:

(1) data should be normally distributed;

(2) the error is a random variable with a mean of zero conditional on the independent variables;

(3) the independent variables are measured with no error; and

(4) the variance of the error is constant across observations (homoscedasticity).

Table IV.
Demographic profile for final survey

Types of manufacturing companies	No. of companies responded	No. of companies targeted	Response rate (%)
Auto components manufacturing companies	250	750	33.33
Cement manufacturing companies	25	100	25
Paper manufacturing companies	25	50	50
Rubber and plastic manufacturing	230	620	37.096
Metal and fabricated metal products	150	260	57.69
	680	1,780	38.2

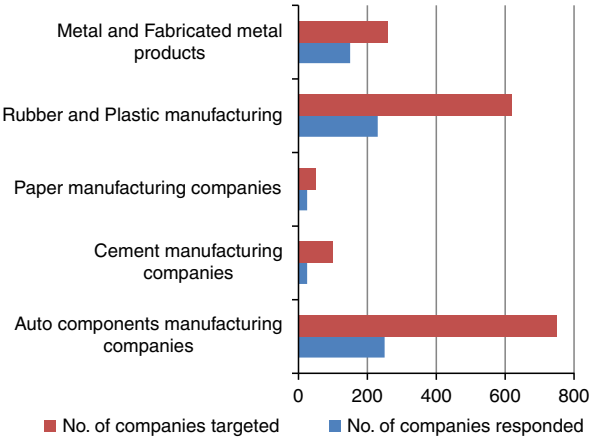

Figure 1.
Responded vs targeted respondents

We have checked above assumptions using residual plots and normal probability plot as shown in Figures 3-7. We found that assumption of regression analysis are satisfied.

The above regression model can be represented in the form of linear regression equation as:

$$Extended\ supply\ chain\ performance = \beta 0 + \beta 1 \times Lean\ Manufacturing + \beta 2 \times TQM + \beta 3 \times R\&D\ and\ Technology + \beta 4 \times SRM + Error$$

Table V shows that regression model is statistically significant. The value of adjusted $R^2 = 0.275$ (without any control variable) and adjusted $R^2 = 0.324$ (with control variable), which indicates that the regression model explain over 45 percent of the total

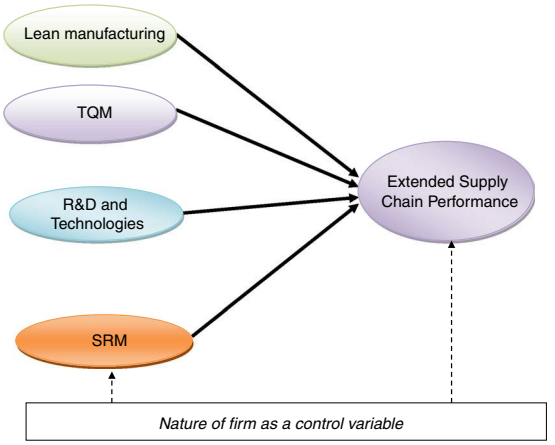

Figure 2.
Regression model

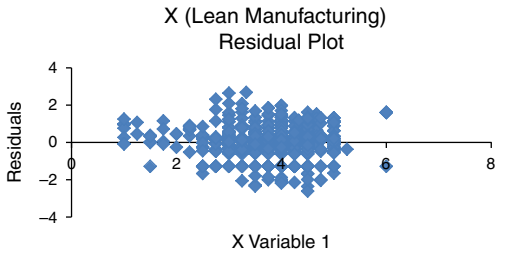

Figure 3.
Residual Plot (LM)

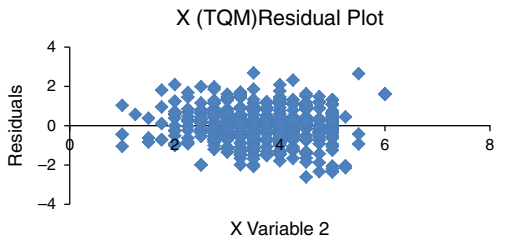

Figure 4.
Residual Plot (TQM)

extended supply chain. The result shows that explanatory power of the model is slightly affected by the type of industry. To further draw conclusive remark regression output will be further analyzed.

From Table VI, we can see the F-statistics = (SSR/df1)/(SSRes/df2) for df1 = 4 and df2 = 675 (model without control variable) and df1 = 5 and df2 = 674 (model with firm nature as control variable).

At 95 percent significance level, the critical value of F for df1 = 4 and df2 = 675 (model without control variable) is computed from standard statistical table as 2.37 and

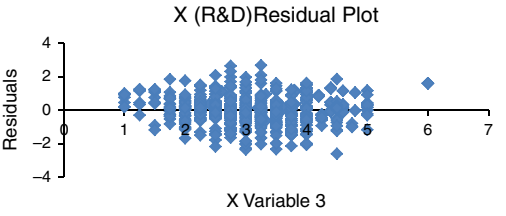

Figure 5.
Residual Plot (R&D)

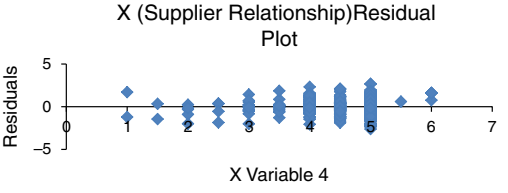

Figure 6.
Residual Plot (SRM)

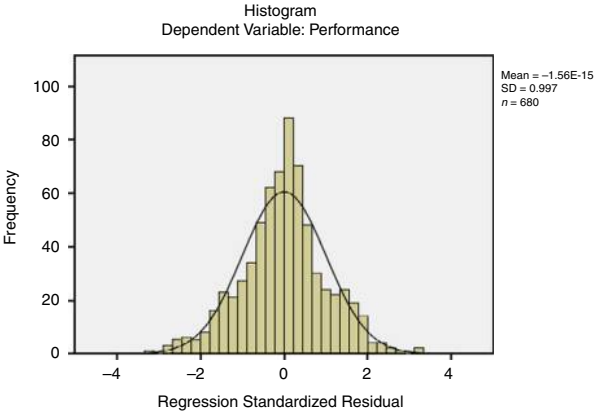

Figure 7.
Histogram Plot (Performance)

Model	R	R^2	Adjusted R^2	SE of the estimate	Durbin-Watson
1	0.524	0.275	0.271	0.82004	
2	0.569	0.324	0.319	0.79256	1.672

Table V.
Model summary

for df1 = 5 and df2 = 674 (model with control variable), the critical value of F is 2.21. We can therefore conclude that our proposed model is statistically significant and have decent explanatory power (Table VII).

4.3.1 For model 1 (without control variable). The regression analysis output suggests the model with lean manufacturing practices whose t-statistics is 1.692 which is between −2 and +2. We therefore can conclude that lean manufacturing practices and its impact on extended supply chain performance were found to be statistically insignificant in our study. Except lean manufacturing, other variables like TQM, R&D and technology and supplier relationship management are found to be statistically significant. The above model (nature of firm is dynamic variable) can be represented in form of linear equation as:

$$\textit{Extended supply chain performance} = 1.851 + 0.074 \times LM + 0.353 \times TQM + 0.286 \times R\&D \text{ and } Tech. - 0.290 \times SRM + Error$$

where LM is found to be statistically insignificant at $p = 0.05$.

4.3.2 For model 2 (with firm nature as a control variable). The regression analysis output suggest the model with lean manufacturing practices whose t-statistics is 1.917 which is between −2 and +2. We can conclude that lean manufacturing practices are found to be statistically insignificant in our study even when we treated nature of the firm constant. Except lean manufacturing, other variables like TQM, R&D and technology and supplier relationship management, are found to be statistically

Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	172.126	4	43.032	63.991	0.000
	Residual	453.910	675	0.672		
	Total	626.036	679			
2	Regression	202.657	5	40.531	64.524	0.000
	Residual	423.379	674	0.628		
	Total	626.036	679			

Table VI.
ANOVA table

Model	Unstandardized coefficients B	SE	Standardized coefficients β	t	Sig.	Collinearity statistics Tolerance	VIF
1 (Constant)	1.851	0.296		6.250	0.000		
Lean manufacturing	0.074	0.044	0.061	1.692	0.091	0.818	1.222
TQM	0.353	0.039	0.314	9.111	0.000	0.903	1.108
R&D and technology	0.286	0.041	0.259	6.959	0.000	0.775	1.290
Supplier relationship management	−0.290	0.050	−0.193	−5.838	0.000	0.986	1.014
2 (Constant)	2.104	0.289		7.291	0.000		
Lean manufacturing	0.081	0.042	0.067	1.917	0.056	0.818	1.223
TQM	0.390	0.038	0.347	10.308	0.000	0.885	1.130
R&D and technology	0.261	0.040	0.236	6.529	0.000	0.769	1.301
Supplier relationship management	−0.203	0.050	−0.135	−4.094	0.000	0.924	1.083
Nature of the firm	−0.196	0.028	−0.232	−6.972	0.000	0.908	1.101

Table VII.
Regression coefficient

significant. The above model (nature of firm is dynamic variable) can be represented in form of linear equation as:

$$\begin{aligned} \textit{Extended supply chain performance} = {} & 2.104 + 0.081 \times LM + 0.390 \times TQM + 0.261 \\ & \times R\&D \text{ and } Tech. - 0.203 \times SRM - 0.196 \\ & \times \textit{Nature of firm} + \textit{Error}; \end{aligned}$$

After comparing both models, we can draw conclusion that "nature of the firm" does not produce significant change in the beta coefficient of explanatory variables.

The performance measure which has items representing supply chain performance items and business performance items are loaded on a single factor which has been renamed as extended supply chain performance.

5. Concluding remarks

The conclusions drawn from factor and regression analyses are as follows.

The EFA reduces 20 items into five factors which are parsimonious and orthogonal represent constructs of our model. We used our literature review and expert opinion to further classify these factors into explanatory or independent variables category and response or dependent variable category. We further checked convergent and discriminant validity of constructs of the model. The confirmatory factor analysis output has validated our variables which we have derived from our literature review.

We further used factor analysis output to perform regression analysis, to predict how these identified explanatory variables impact the extended supply chain performance of the firm. The regression output has been performed by treating nature of the firm constant to further understand descriptive nature of these variables. Our findings has validated studies of scholar(s) in past who have conducted similar kind of studies under different set of conditions and environment. An interesting conclusion that we can draw that Indian manufacturing firms which we have selected are medium scale enterprises and these firms have reflected to missing link in current supply chain practices. According to response of the respondents which represent a senior official of the selected firms, it has been revealed that Indian manufacturing firm's especially medium or small enterprises have not recognized the true worth of lean manufacturing practices and supplier relationship management.

We further interviewed two senior managers of reputed companies and shared the statistical analysis to know their insight(s). They shared some of the important and serious concerns which prevent Indian manufacturing firms to seriously implement lean manufacturing and SRM.

These concerns are:

- poor road;
- high toll tax;
- different tax structure in different parts of the country;
- overloading and poor maintenance of truck resulting in high carbon emissions;
- lack of transparency and mutual trust among manufacturers and supplier(s);
- unpredictable market condition; and
- lack of comprehensive government policy.

The dimensions of sustainable supply practices which are strong predictors of Indian manufacturing firms are TQM, R&D and technologies. The firms which have integrated two important dimensions have realized superior extended supply chain performance.

5.1 Limitations

It is truly said that limitations are the future directions of the research. Researchers though have taken utmost care but there are some limitations which can further be taken care in next level of research. The limitations of the present study are:

(1) The conclusive model of the study explains only 32.4 percent of the total variance of the extended supply chain performance. This limitation can further become future scope of the study where parameters like social, legal, government policies and ethical issues can be used for predicting extended supply chain performance.

(2) We performed non-response bias test to ensure that non-response bias is not a major issue in our study. However, we cannot even deny that in spite of utmost care response error can create difference. In our study if we see that lean manufacturing is not significant at 95 percent confidence error. However, if we can accept up to 10 percent error then lean manufacturing can also become one of the important determinants of extended supply chain performance. In such case study can further corroborate the statistical findings which are based upon sampling survey.

5.2 Future research directions

(1) Our present framework is direct linkage model. However, to further understand mediating nature of the variables we can use Interpretive Structural Modeling (ISM) using MICMAC analysis. In fact ISM and MICMAC analysis technique can be used for model building, when enough supporting literature is not available which further can be statistically validated.

(2) Framework can be further extended by using firm performance. We can further test interrelationships among lean manufacturing, TQM, R&D and technologies, SRM, extended supply chain performance and firm performance.

(3) The proposed framework can also be tested using leadership and organizational culture as a mediating or moderating variable.

References

Ahmad, A., Mehra, S. and Pletcher, M. (2004), "The perceived impact of JIT implementation on firms' financial/growth performance", *Journal of Manufacturing Technology Management*, Vol. 15 No. 2, pp. 118-130.

Antony, J. and Desai, D.A. (2009), "Assessing the status of six sigma implementation in the Indian industry: results from an exploratory empirical study", *Management Research News*, Vol. 32 No. 5, pp. 413-423.

Armstrong, J.S. and Overton, T.S. (1977), "Estimating nonresponse bias in mail surveys", *Journal of Marketing Research*, Vol. 14 No. 3, pp. 396-402.

Azzone, G. and Noci, G. (1998), "Identifying effective PMSs for the deployment of 'green' manufacturing strategies", *International Journal of Operations and Production Management*, Vol. 8 No. 6, pp. 308-335.

Bai, C. and Sarkis, J. (2010), "Green supplier development: analytical evaluation using rough set theory", *Journal of Cleaner Production*, Vol. 18 No. 12, pp. 1200-1210.

Baines, T., Brown, S., Benedettini, O. and Ball, P. (2012), "Examining green production and its role within the competitive strategy of manufacturers", *Journal of Industrial Engineering and Management*, Vol. 5 No. 1, pp. 53-87, available at: http://dx.doi.org/10.3926/jiem.405

Bakker, E.F. and Kamann, D.F. (2007), "Perception and social factors as influencing supply management: a research agenda", *Journal of Purchasing and Supply Management*, Vol. 13 No. 4, pp. 304-316.

Balan, K. (2008), "Introduction to green manufacturing", *The Shot Peener*, Vol. 22 No. 3, pp. 4-6.

Billesbach, T.J. and Hayen, R. (1994), "Long term impact of just-in-time on inventory performance measures", *Production & Inventory Management Journal*, Vol. 35 No. 1, pp. 62-67.

Björklund, M., Martinsen, U. and Abrahamsson, M. (2012), "Performance measurement in greening of supply chains", *Supply Chain Management: An International Journal*, Vol. 17 No. 1, pp. 29-39.

Bower, J.L. and Christensen, C.M. (1995), "Disruptive technologies: catching the wave", *Harvard Business Review*, Vol. 73 No. 1, pp. 43-53.

Boyd, L.H. and Gupta, M.C. (2004), "Constraints management: what is the theory?", *International Journal of Operations & Production Management*, Vol. 24 No. 4, pp. 350-371.

Brah, S.A. and Chong, W.K. (2004), "Relationship between total productive maintenance and performance", *International Journal of Production Research*, Vol. 42 No. 15, pp. 2383-2401.

Camp, R.C. (1989), *Benchmarking: The Search for Industry Best Practices that Lead to Superior Performance*, ASQC Quality Press, Milwaukee, WI.

Camp, R.C. (1995), *Business Process Benchmarking: Finding and Implementing Best Practices*, ASQC Quality Press, Milwaukee, WI.

Chan Kim, W. and Mauborgne, R. (2004), "Blue ocean strategy", *Harvard Business Review*, Vol. 82 No. 10, pp. 76-84.

Deif, A. (2011), "A system model for green manufacturing", *Advances in Production Engineering & Management*, Vol. 6 No. 1, pp. 27-36.

Dess, G.G. and Robinson, R.B. Jr (1984), "Measuring organizational performance in the absence of objective measures: the case of the privately-held firm and conglomerate business unit", *Strategic Management Journal*, Vol. 5 No. 3, pp. 265-273.

Dragolea, L. and Cotirlea, D. (2009), "Benchmarking: a valid strategy for the long term", *Annales Universitatis Apulensis Series Oeconomica*, Vol. 11 No. 2, pp. 813-826.

Dubey, R., Bag, S., Ali, S.S. and Venkatesh, V.G. (2013), "Green purchasing is key to superior performance: an empirical study", *International Journal of Procurement Management*, Vol. 6 No. 2, pp. 187-210.

Dües, C.M., Tan, K.H. and Lim, M. (2013), "Green as the new lean: how to use lean practices as a catalyst to greening your supply chain", *Journal of Cleaner Production*, Vol. 40, pp. 93-100.

Ellram, L.M. and Stanley, L.L. (2008), "Integrating strategic cost management with a 3DCE environment: strategies, practices and benefits", *Journal of Purchasing and Supply Management*, Vol. 14 No. 3, pp. 180-191.

Essig, M. and Amman, M. (2009), "Supplier satisfaction: conceptual basics and explorative findings", *Journal of Purchasing & Supply Management*, Vol. 15 No. 2, pp. 103-113.

Farish, M. (2009), "Plants that are green: Toyota's lean manufacturing", *Engineering and Technology*, Vol. 4 No. 3, pp. 68-69.

Feng, C. and Yuan, C. (2006), "The impact of information and communication technologies on logistics management", *International Journal of Management*, Vol. 23 No. 4, pp. 909-926.

Fornell, C. and Larcker, D.F. (1981), "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, Vol. 18 No. 1, pp. 39-50.

Franchetti, M., Bedal, K., Ulloa, J. and Grodek, S. (2009), "Lean and green: industrial engineering methods are natural stepping stones to green engineering", *Industrial Engineer: IE*, Vol. 41 No. 9, pp. 24-29.

Fullerton, D., Leicester, A. and Smith, S. (2008), "Environmental taxes", prepared for the report of a Commission on Reforming the Tax System for the 21st Century, Chaired by Sir James Mirrlees, available at: www.ifs.org.uk/mirrleesreview/reports/environment.pdf (accessed June 13, 2013).

Gavronski, I., Paiva, E.L., Teixeira, R. and Andrade, M.C.F. (2013), "ISO 14001 certified plants in Brazil e taxonomy and practices", *Journal of Cleaner Production*, Vol. 39, pp. 32-41.

Giannakis, M. (2012), "The role of procurement in the management of supplier relationships", *International Journal of Procurement Management*, Vol. 5 No. 3, pp. 368-408.

Giovanni, P.D. (2012), "Do internal and external environmental management contribute to the triple bottom line?", *International Journal of Operations and Production Management*, Vol. 32 No. 3, pp. 265-290.

Gonzalez, M.E., Quesada, G. and Bahill, A.T. (2003), "Improving product design using quality function deployment: the school furniture case in developing countries", *Quality Engineering*, Vol. 16 No. 1, pp. 47-58.

Gupta, M. and Boyd, L. (2011), "An excel-based dice game: an integrative learning activity in operations management", *International Journal of Operations and Production Management*, Vol. 31 No. 6, pp. 608-630.

Hair, J.F. (1995), *Multivariate Data Analysis*, Prentice-Hall International Inc., New Jersey, NJ.

Hayes, R.H. and Pisano, G.P. (1994), "Beyond world-class: the new manufacturing strategy", *Harvard Business Review*, Vol. 72 No. 1 pp. 77-84.

Hervani, A.A., Helms, M.M. and Sarkis, J. (2005), "Performance measurement for green supply chain management", *Benchmarking: An International Journal*, Vol. 12 No. 4, pp. 330-353.

Hill, C.W.L. and Jones, G.R. (2001), *Strategic Management: An Integrated Approach*, 5th ed., Houghton Mifflin Company, Boston, MA.

Hiltrop, J.M. (1992), "Just-in-time manufacturing: implications for the management of human resources", *European Management Journal*, Vol. 10 No. 1, pp. 49-55.

Hitt, M.A. and Irelend, R.D. (1985), "Corporate distintive competence, strategy, industry and performance", *Strategic Management Journal*, Vol. 6 No. 3, pp. 273-293.

Hitt, M.A., Irelend, R.D. and Stadter, G. (1982), "Functional importance and company performance: moderating effects of grand strategy and industry type", *Strategic Management Journal*, Vol. 3 No. 4, pp. 315-330.

Hoof, B.V. and Lyon, T.P. (2013), "Cleaner production in small firms taking part in Mexico's sustainable supplier program", *Journal of Cleaner Production*, Vol. 41, pp. 270-282.

Hsu, C.W. and Hu, A.H. (2009), "Applying hazardous substance management to supplier selection using analytic network process", *Journal of Cleaner Production*, Vol. 17 No. 2, pp. 255-264.

Huson, M. and Nanda, D. (1995), "The impact of just-in-time manufacturing on firm performance in the U.S.", *Journal of Operations Management*, Vol. 9 No. 1, pp. 5-14.

Johansson, G. and Winroth, M. (2009), "Lean vs green manufacturing: similarities and differences", *Proceedings of the 16th International Annual EurOMA Conference, Implementation Realizing Operations Management Knowledge*, *Göteborg*, *June 14-17*.

Kaynak, H. (2003), "The relationship between total quality management practices and their effects on firm performance", *Journal of Operations Management*, Vol. 21 No. 4, pp. 405-435.

Koning, H. and Mast, J. (2006), "A rational reconstruction of Six-Sigma's breakthrough cookbook", *International Journal of Quality & Reliability Management*, Vol. 23 No. 7, pp. 766-787.

Large, R.O. and Konig, T. (2009), "A gap model of purchasing's internal service quality: concept, case study and internal survey", *Journal of Purchasing and Supply Management*, Vol. 15 No. 1, pp. 24-32.

Liker, J. (2004), *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*, McGraw-Hill, New York, NY.

Markley, M.J. and Davis, L. (2007), "Exploring future competitive advantage through sustainable supply chains", *International Journal of Physical Distribution & Logistics Management*, Vol. 37 No. 9, pp. 763-774.

Mehra, S. (2005), "Current issues and emerging trends in supply chain management: an editorial perspective", *International Journal of Production Research*, Vol. 43 No. 16, pp. 3299-3302.

Micheli, G., Cagno, E. and Giulio, A.D. (2009), "Reducing the total cost of supply through risk-efficiency-based supplier selection in EPC industry", *Journal of Purchasing and Supply Management*, Vol. 15 No. 3, pp. 166-177.

Nollet, J., Calvi, R., Audet, E. and Côté, M. (2008), "When excessive cost savings measurement drowns the objectives", *Journal of Purchasing and Supply Management*, Vol. 14 No. 2, pp. 125-135.

Parast, M.M. (2011), "The effect of six-sigma projects on innovation and firm performance", *International Journal of Project Management*, Vol. 29 No. 1, pp. 45-55.

Pereira-Moliner, J., Claver-Cortes, E., Molina-Azorin, J. and Tari, J. (2012), "Quality management, environmental management and firm performance: direct and mediating effects in the hotel industry", *Journal of Cleaner Production*, Vol. 37, pp. 82-92.

Pisano, G.P. and Shih, W.C. (2009), "Restoring american competitiveness", *Harvard Business Review*, Vol. 87 Nos 7/8, pp. 114-125.

Porter, M.E. (1985), *Competitive Advantage: Creating and Sustaining Superior Performance*, The Free Press, New York, NY.

Porter, M.E. and van der Linde, C. (1995), "Towards a new conception of the environment competitiveness relationship", *Journal of Economic Perspectives*, Vol. 9 No. 4, pp. 97-118.

Prajogo, D., Chowdhury, M., Yeung, A.C.L. and Cheng, T.C.E. (2012), "The relationship between supplier management and firm's operational performance: a multi-dimensional perspective", *International Journal Production Economics*, Vol. 136 No. 1, pp. 123-130.

Ramsay, J. and Wagner, B.A. (2009), "Organisational supplying behaviour: understanding supplier needs wants and preferences", *Journal of Purchasing and Supply Management*, Vol. 15 No. 2, pp. 127-138.

Schonberger, R.J. (1986), *The World Class Manufacturing: The Lessons of Simplicity Applied*, Free Press, New York, NY.

Schroeder, R.G., Linderman, K., Liedtke, C. and Choo, A.s. (2008), "Six Sigma: definition and underlying theory", *Journal of Operations Management*, Vol. 26 No. 4, pp. 536-554.

Sharma, M., Ammons, J. and Hartman, J. (2007), "Asset management with reverse product flows and environmental considerations", *Computers & Operations Research*, Vol. 34 No. 2, pp. 464-480.

Sikdar, S.K. and Howell, S.G. (1998), "On developing cleaner organic unit processes", *Journal of Cleaner Production*, Vol. 6 No. 3, pp. 253-259.

Stefanovic, N. and Stefanovic, D. (2011), "Supply chain performance measurement system based on scorecards and web portals", *ComSIS*, Vol. 8 No. 1, pp. 167-192.

Thakkar, J., Kanda, A. and Deshmukh, S.G. (2008), "Interpretive structural modeling (ISM) of IT-enablers for Indian manufacturing SMEs", *Information Management & Computer Security*, Vol. 16 No. 2, pp. 113-136.

Tranfield, D., Denyer, D. and Smart, P. (2003), "Towards a methodology for developing evidence-informed management knowledge by means of systematic review", *British Journal of Management*, Vol. 14 No. 3, pp. 207-222.

UNEP Year Book (2011), *UNEP Year Book*, UNEP, Nairobi, available at: www.unep.org/yearbook/2011/

United Nation Statistics (2012), "Statistical year book 2010 fifty-fifth issue", United Nations, New York.

Vachon, S. and Klassen, R.D. (2006), "Green project partnership in the supply chain: the case of the package printing industry", *Journal of Cleaner Production*, Vol. 14 Nos 6-7, pp. 661-671.

Vachon, S. and Klassen, R.D. (2008), "Environmental management and manufacturing performance: the role of collaboration in the supply chain", *International Journal of Production Economics*, Vol. 111 No. 2, pp. 299-315.

Wagner, S.M., Grosse-Ruyken, P.T. and Erhum, F.(2012), "The link between supply chain fit and financial performance of the firm", *Journal of Operations Management*, Vol. 29 Nos 1-2, pp. 340-353.

Wayhan, V.B., McCallum, M.F. and Golyer, N.M. (2013),"TQM and financial performance: are findings of direct effects methodical artefacts?", *Total Quality Management & Business Excellence*, Vol. 24 Nos 1-2, pp. 171-187.

World Commission on Environment and Development (1987), *Our Common Future*, Oxford University Press, Oxford.

Xu, L. and Beamon, B.M. (2006), "Supply chain coordination and cooperation mechanisms: an attribute-based approach", *Journal of Supply Chain Management*, Vol. 42 No. 1, pp. 4-12.

Yusuf, Y., Gunasekaran, A. and Dan, D. (2007), "Implementation of TQM in China and organisation performance: an empirical investigation", *Total Quality Management & Business Excellence*, Vol. 18 No. 5, pp. 509-530.

Zhang, G.P., Hoekstra, A.Y. and Mathews, R.E. (2013), "Water Footprint Assessment (WFA) for better water governance and sustainable development", *Water Resources and Industry*, Vol. 1 No. 2, pp. 1-6.

Zhu, Q., Sarkis, J. and Lai, K.-H. (2008), "Confirmation of a measurement model for green supply chain management practices implementation", *International Journal of Production Economics*, Vol. 111 No. 2, pp. 261-273.

Zhu, Q., Sarkis, J. and Lai, K.-H. (2012), "Examining the effects of green supply chain management practices and their mediation on performance improvements", *International Journal of Production Research*, Vol. 50 No. 5, pp. 1377-1394.

Further reading

Bernardes, E.S. and Zsidisin, G.A. (2008), "An examination of strategic supply management benefits and performance implications", *Journal of Purchasing and Supply Management*, Vol. 14 No. 4, pp. 209-219.

Chen, Z. and Tan, K.H. (2011), "The perceived impact of JIT implementation on operations performance: evidence from Chinese firms", *Journal of Advances in Management Research*, Vol. 8 No. 2, pp. 213-235.

Kim, S.K., Lee, B.G., Park, B.S. and Oh, K.S. (2011), "The effect of R&D, technology, commercialization capabilities and innovation performance", Vol. 17 No. 4, pp. 563-578.

Zhu, Q., Sarkis, J. and Geng, Y. (2005), "Green supply chain management in China: pressure, practices and performance", *International Journal of Operations and Production Management*, Vol. 25 No. 5, pp. 449-468.

(The Appendix follows overleaf.)

Appendix

This Questionnaire is a part of research work being undertaken on the topic "Exploring antecedents of extended supply chain performance measures: An insight from Indian Green Manufacturing Practices." The data collected from this survey will be used for academic purpose only. This questionnaire will take ten to 12 minute's time to answer the responses. We would be thankful to you for sparing your valuable time and sharing your experience for the research cause. For any queries related to the study feel free to contact.

1	Please answer all of the following questions						
a	Basic products and fabricated metal products						
b	Machinery and optical equipments						
c	Automotive industry						
d	Other						
e	How many employees does company have						
f	Does your company have Corporate Social Responsibility or Sustainability Dept?						
g	Do you have green supply chain department	Y/N					
2	Using the scale provided, please indicate your preference by circling relevant number *(1) Strongly Disagree* *(2) Disagree* *(3) Neutral* *(4) Agree* *(5) Strongly Agree*						
	Green Supply Chain Practices adopted by your company						
a	Pull system		1	2	3	4	5
b	JIT		1	2	3	4	5
c	TPM		1	2	3	4	5
d	Simplicity practice impact on company performance		1	2	3	4	5
e	Statistical Quality Control		1	2	3	4	5
f	Six-Sigma practice impact on company performance		1	2	3	4	5
g	Quality benchmarking practice impact on company performance		1	2	3	4	5
h	Innovation		1	2	3	4	5
i	Green technology		1	2	3	4	5
j	Research budget		1	2	3	4	5
k	Research culture		1	2	3	4	5
l	Patent of ideas and Technology		1	2	3	4	5
m	Sourcing		1	2	3	4	5
n	E-procurement		1	2	3	4	5
o	Supplier evaluation		1	2	3	4	5
p	Days of payable outstanding		1	2	3	4	5
q	Green purchasing performance		1	2	3	4	5
r	ROA		1	2	3	4	5
s	Profitability		1	2	3	4	5
t	Customer satisfaction		1	2	3	4	5

Table AI.

Corresponding author
Dr Rameshwar Dubey can be contacted at: rameshwardubey@gmail.com