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# Implementation of green supplier development process model in Indian automobile industry

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938

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## Abstract

**Purpose** – The purpose of this paper is to develop a green supplier development (GSD) process model and validate the model with a case study in Indian automobile industry.

**Design/methodology/approach** – A literature survey of peer-reviewed journal articles, survey reports and paradigmatic books with managerial impact is done for the research. The process of GSD is modeled using stage-gate approach and KPIV and KPOV of the process are determined. The process model is implemented in an Indian automobile components manufacturing industry for validation.

**Findings** – The industry implemented the model with ten suppliers and was able to successfully convert seven of them into Green suppliers. Remaining three suppliers were asked to repeat the process again or terminate the contracts. Model implementation took around three years starting from planning of resources and finances to actual development of suppliers.

**Research limitations/implications** – The model implementation was done with a small automobile industry and hence the validation and implications may be generalized by taking the case study further in different industries. It would be beneficial to test the model with case studies of large-scale industries.

**Practical implications** – The process model for implementing GSD activities will help managers in taking complex investment decisions. The stages and process inputs and outputs are clearly defined which helps the managers to successfully develop the suppliers.

**Originality/value** – This paper puts forward the process model that should be implemented for the successful development of green suppliers. It might represent new opportunities for rigorous and relevant research in the area of green supply chain.

**Keywords** Procurement, Green supply chain, Automobile industry, Green suppliers

**Paper type** Research paper

## 1. Introduction

Green procurement deals with procurement of products and services that have least impact on environment (Green *et al.*, 1998; Blome *et al.*, 2014; ECO-Buy Limited, 2013; Goshen Stephen, 2015; Muralidhar, 2012; Silveiro and Edison, 2002; Salam, 2008). In the broader supplier development literature, supplier development programs include practice groupings such as trust building, finance and technology investment, relational norms development, knowledge transfer (Ahmad and Daghfous, 2010), collaborative communication (Carr and Kaynak, 2007; Prahinski and Benton, 2004), management and supplier involvement (Song and Di Benedetto, 2008), internal and external supplier integration (Dowlatshahi, 1998) and socialization mechanisms (Krause and Ellram, 1997; Das *et al.*, 2006; Giannakis, 2008; Modi and Mabert, 2007; Narasimhan *et al.*, 2008).

Supplier development is activity done by buying firm so as to improve performance of the suppliers (Hahn *et al.*, 1990; Sucky and Durst, 2013) and also to meet the buying firm's supply needs (Watts and Hahn, 1993; Krause, 1999; Krause *et al.*, 2007). Initially the focus of supplier

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development was only on economic performance of suppliers, quality of products, cost and delivery time (Birou and Fawcett, 1994; Govindan *et al.*, 2010; Humphreys *et al.*, 2004; Hartley and Jones, 1997; Lemke *et al.*, 2003). Researchers have done studies on green practices for minimizing the supplier s environment impact (Blome *et al.*, 2014; Jabbour and Jabbour, 2009; Simpson and Power, 2005; Busse *et al.*, 2016). Supplier development programs improve the supplier performance by developing manufacturing and production processes (De Toni and Nassimbeni, 2000; Modi and Mabert, 2007). Supplier development programs include seminars and workshops for suppliers, visits to supplier location, guiding the suppliers for technical difficulties, etc. (Krause *et al.*, 2007; Ellegaard *et al.*, 2003; Galt and Dale, 1991).

This research offers model and strategy for green supply chain managers to take action for the successful development of suppliers. The subsequent sections describe the research methodology, green supplier development (GSD) process model, case study which is followed by discussion, managerial implications, conclusions, limitations and future work.

## 2. Literature survey

The development of suppliers with environmental goals has recently entered the supply chain literature. Bai and Sarkis (2010) noted that “investigation into [environmental] supplier development programs is virtually non-existent” (p. 1200). One of the few established terms in the field was coined by Vachon and Klassen (2008). They refer to joint ecological efforts between buying firms and suppliers as “environmental collaboration,” which typically includes environmental supplier training (to spur initiatives such as emissions reduction, advanced waste treatment, and resource efficiency), on-site intervention with suppliers’ production processes and operations to improve their environmental footprint, and joint projects to develop green innovations (Azadegan 2011; Wynstra *et al.*, 2001). To identify the research gap, we conducted a systematic search for articles and papers in journals, seeking for GSD publications. The bibliographic databases searched are Science Direct, Google Scholar, Emerald, Taylor & Francis, Springer, Wiley, ISI Web of Science and Scopus. This search confirmed that no study was published so far with a focus on Model development in the GSD context, helping us to better draw the research gap.

For data collection, two main decisions to be taken are the definition of the material and the definition of the unit of analysis. The search engines and databases used to search the articles were same as the ones used in Step 1. Table I shows the literature survey results. The keywords used for retrieving the papers are: “GSD,” “Green Procurement” and “GSD programs.”

### 2.1 Literature survey on GSD

GSD is perceived as a high commitment activity and it helps building a positive reputation for industries (Bai and Sarkis, 2010; Bai and Sarkis, 2014; Chen, 2005) as it demonstrates the firms capabilities in handling complex environment challenges (Hall, 2000; Paulraj, 2011; Zhao *et al.*, 2017). Supplier development activities improves suppliers’ sustainable and

Sr. no.	Resource	Primary keywords	Secondary keywords	Time period
1	Google Scholar	Green supplier development Green procurement	Supplier development programs Green supply chain Automobile industry supply chain	2000-2017
2	Science Direct			
3	Emerald Insight			
4	ACM Digital Library			
5	Springer			

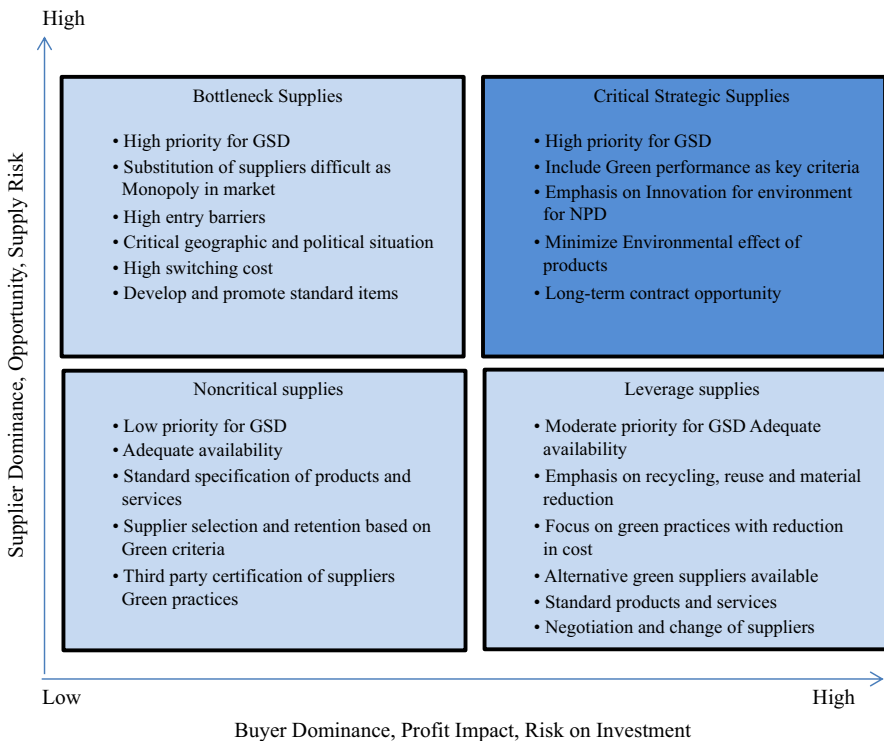
**Table I.**  
Literature search  
with keywords

economic performance and also helps in gaining competitive advantage (Foerstl *et al.* 2015; Menguc *et al.*, 2010). Another advantage of supplier development activities is better relation and coordination between buyer and suppliers (Busse *et al.*, 2016). A strong collaborative relationship between the buyers and suppliers increases speed of product development (Carr and Pearson, 1999; Cox, 2001; Ellram, 1991; Graham *et al.*, 1994; Gunasekaran *et al.*, 2001; Landeros *et al.*, 1995; Zaheer *et al.*, 1998).

Research has been done on antecedents (Routroy and Pradhan, 2012; Wagner, 2011), processes (Bai *et al.*, 2012; Wagner, 2011), and outcomes (Ehrgott *et al.*, 2013) of supplier development in general and of sustainable supplier development in particular (Ruparathna and Hewage, 2015; Sancha *et al.*, 2015). Assessment and ranking of suppliers with different environment and sustainability criteria is a well established field (Sarkis and Talluri, 2002; Igarashi *et al.*, 2013). Green performance is one of the criteria for supplier assessment (Kenneth *et al.*, 2012), but usually very down on the priority list.

2.2 Literature survey on portfolio model for supplier selection

For selecting the suppliers to undergo GSD programs, the buyer company sorts out all its purchased items into the categories based on Portfolio Model (Olsen and Ellram, 1997; Mello *et al.*, 2017) as shown in Figure 1. Strategic (high-profit impact, high supply risk), bottleneck (low-profit impact, high supply risk), leverage (high-profit impact, low supply risk), and noncritical (low-profit impact, low supply risk) (Kraljic, 1983). Pagell *et al.* (2010) proposed



**Figure 1.** Selection of suppliers for green supplier development based on portfolio purchasing model

Source: Modified from Kraljic (1983)

modifications in the Kraljic procurement model by considering social and environmental aspects in the dimensions of the matrix, given the concept of the triple bottom line. Each category in the matrix requires distinct approach for purchasing company (Mortensen and Arlbjørn, 2012; Caniels and Gelderman, 2005; Akman, 2015):

- Strategic Supplies: strategic supplies involve economic as well as sustainable issues related to products procurement (Caniels and Gelderman, 2005). Critical and strategic items purchasing includes market analysis, risk assessment, optimization models, simulations, forecasting and much other analysis.
- Bottleneck supplies: the bottleneck items involve low impact on any of the triple bottom line elements, but high risks of supply. For the bottleneck items, the adoption of sustainable practices is more difficult because the purchase organization is in a situation of dependence. Buyer organization can encourage the adoption of standardization and certification in supplier organizations (Gelderman and Weele, 2002). Bottleneck supplies require specific market analysis and decision models.
- Leverage supplies: for leverage suppliers, investments are carried out with environmental elements (Krause *et al.*, 2009; Ramayah and Rahbar, 2013; Anderson and Brodin, 2005). This initiative minimizes threats to the triple bottom line and creates new opportunities for a lasting relationship, but increases the risk of investment loss if the supplier is replaced. Leverage items may require vendor and value analysis, price forecasting models and decision models.
- Noncritical supplies: the goal in the management of this category is to get the lowest cost of supply. As far as noncritical items are concerned, simple market analyses, decision policies and inventory optimization models will normally suffice (Kraljic, 1983).

### 2.3 Research gaps

Bai and Sarkis (2010) and Dou *et al.* (2014) reported GSD as a recent area of investigation with several opportunities for development of formal models and tools. Supplier development from a green perspective is very less explored activity and there is a need to find out how it impacts suppliers' green performance (Dobos and Vörösmarty, 2014). GSD is gaining importance globally due to some factors such as the implementation of environment management systems (Wong *et al.*, 2015), economic issues, green marketing and social issues. It is required to formulate and model GSD process to understand various activities and stakeholders involvement. Validation of the model with industry application as GSD is considered a low priority part in supply chain and the most difficult initiative to implement in the GSCM area.

### 2.4 Problem definition

Automobile manufacturers demand the best quality at optimum price from their suppliers (Park and Hartley, 2002; Ilo, 2004; Gules *et al.*, 1997; Koplin *et al.*, 2007). Future aspects of the automobile supply chain are cleaner production with low energy consumption (Caniels *et al.*, 2013; Awayshah and Klassen, 2010; Geffen and Rothenberg, 2000; Yu and Hou, 2016). Sustainable and green business model is the key for all automobile manufactures of developing countries so as to respond to the market dynamics (Oh and Rhee, 2010). This could be achieved through GSD and strengthening the relations with suppliers (Zirpoli and Caputo, 2002; Corswant and Tunalv, 2002). The automobile industry under study has developed processes and products for turning their supply chain as green supply chain. Use of plastic crate for parts supply to nearby industries and use of reusable PP boxes instead of corrugated boxes for the supply of parts to outside industries are some of the initiatives taken by industry. They had also conducted seminars and Green technology development workshops for the suppliers but there

is no matrix or process existing in the firm for developing Green suppliers. It is required for the industry to have a standard model and process for developing green suppliers as the current process is not giving the expected outcomes. Many suppliers are hesitant in sharing information and being a part of supplier development programs (Figure 2).

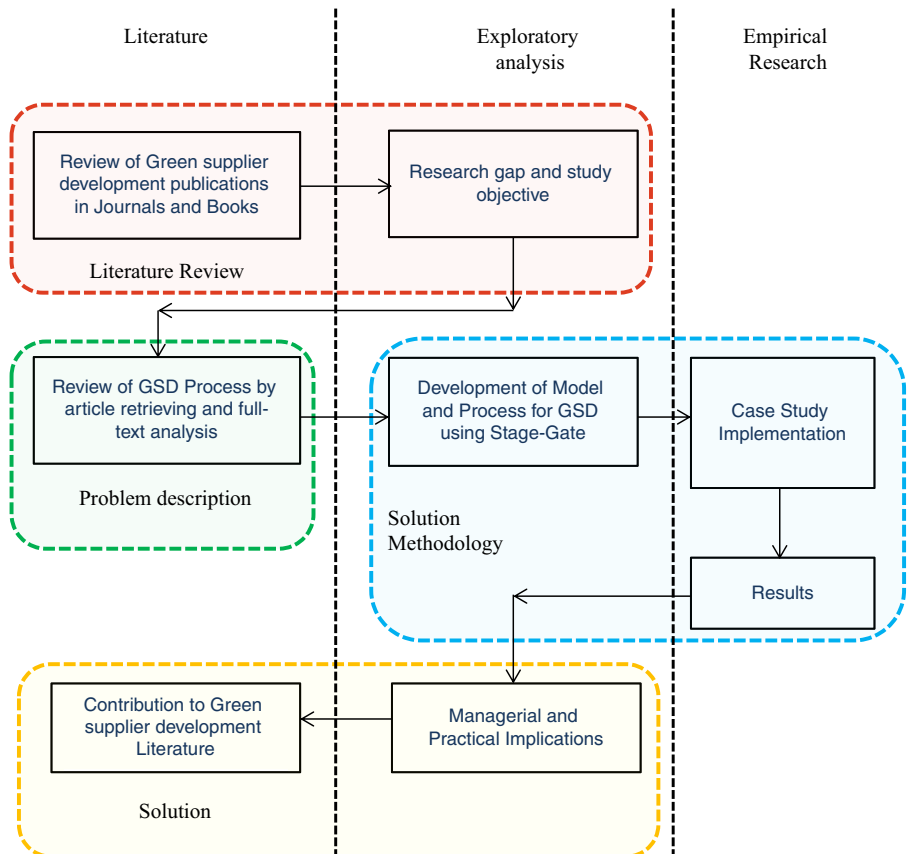
**3. Research methodology**

The research work is in three stages as: literature search, exploratory analysis and empirical research. The literature survey contains the review of publications on GSD. We have excluded green supplier ranking papers as it is highly developed area and the research objective is to develop the model and process for GSD. The exploratory analysis includes deriving the research gaps from literature survey, development of GSD model and process and finally developing the strategies for the managers and practitioners for successful implementation of GSD model. The empirical research is done for implementing case study in an automobile industry for validation of the model developed.

**4. Solution methodology**

*4.1 Stage-gate process for GSD*

Stage gate can be defined as “a conceptual and operational map for moving new product/projects from idea to launch and beyond” (Cooper, 1990). The working of stage-gate process



**Figure 2.** Research methodology flowchart

is divided into a number of stages with the conceptualization of an idea being the first stage and the launch or success of the new project being the final stage (Sokovic *et al.*, 2005; Wang *et al.*, 2004). All the stages in between comprise of the whole process. After the end of one stage and before the beginning of next stage, a gate is incorporated that decides how effectively work has been done in the previous stage. Stage-gate process helps in identifying the problems and assessing the progress of the project before the project is over. It also gives conceptual and operational road map for the new project implementation. The stage-gate process for GSD has seven crucial stages which when executed correctly ensures a successful project for the organizations:

- (1) Conceptualizing an idea – this stage deals with finding out what opportunities can be tapped into and what ideas would work best for developing suppliers. Once the project team decides on an idea, it is presented to the decision makers for their approval. This is the first stage gate that is encountered in the process and a crucial one to decide the success of the project (Ebrahim *et al.*, 2009).
- (2) Understanding the scope – in this stage, the team decides the technical and environmental benefits of the project. It is important to gauge the competition in the market (Johnson *et al.*, 2000). Once the team is satisfied with the scope of the project, the findings have to be put to the management for approval (Froehle *et al.*, 2001).
- (3) Developing business plan – the success of the whole project depends on this crucial stage. In this stage, all the feasibility aspects of finance, technical, and business are analyzed and a plan is made which has three major parts namely details of the project, why this project would be successful and the plan for the project implementation (Stevens and Dimitriadis, 2005).
- (4) Project development – in this stage, the plan is executed and the concept is made into reality (Grönlund *et al.*, 2010). This involves discussions and meeting with suppliers, finding feasible solutions for environmental issues, implementing supplier development initiatives.
- (5) Assessment and validation – this phase involves validating the project by evaluating the suppliers, the process involved in supplier development, performance and ranking of suppliers.
- (6) Awards and end of the project – this final stage involves finalizing long-term contracts with green suppliers, finalizing the activities for GSD, awards, and recognition to suppliers and continuation of the process with same or new suppliers (Figure 3).

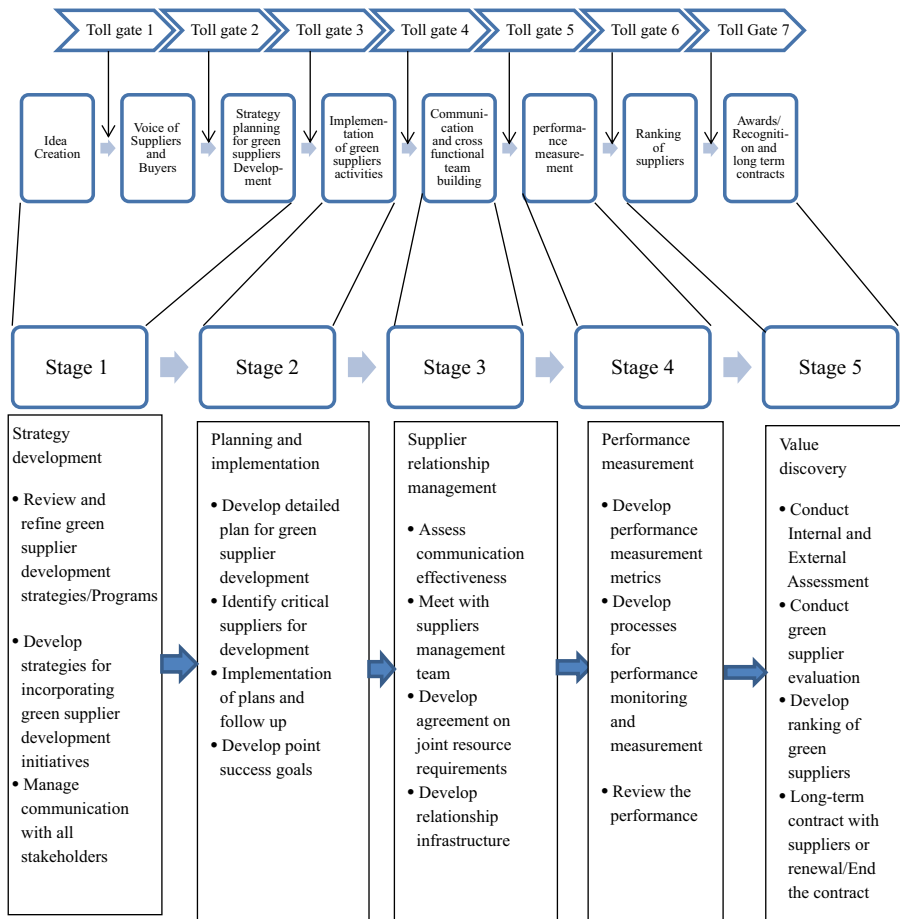
A key process output variable (KPOV) is an outcome obtained by a process which is defined by its key process input variables (KPIV). Depending on their positions, KPOVs may also become KPIVs for the next stage of a process. KPOVs need to measure and tracked to ensure that the corresponding KPIVs are generating the right result (i.e. a more positive KPOV) (Cai *et al.*, 2009).

KPOVs are usually measured before any process improvements are made as this gives a standard with which a comparison can be made. In Figure 4, the KPIV are listed on the left-hand side and the KPOV are listed on the right-hand side of the diagram. In some cases, the KPIVs may be same, for example, suppliers, finance, and resources.

## 5. A case study of automobile industry in India

### 5.1 Background of industry

The case study is based on automobile spare parts manufacturing firm XYZ automobiles, located in Nashik, Mumbai that designs and manufactures components for automobiles. The automobile industry under study was established in 1982 and has three major units



**Figure 3.**  
Green supplier  
development  
process model

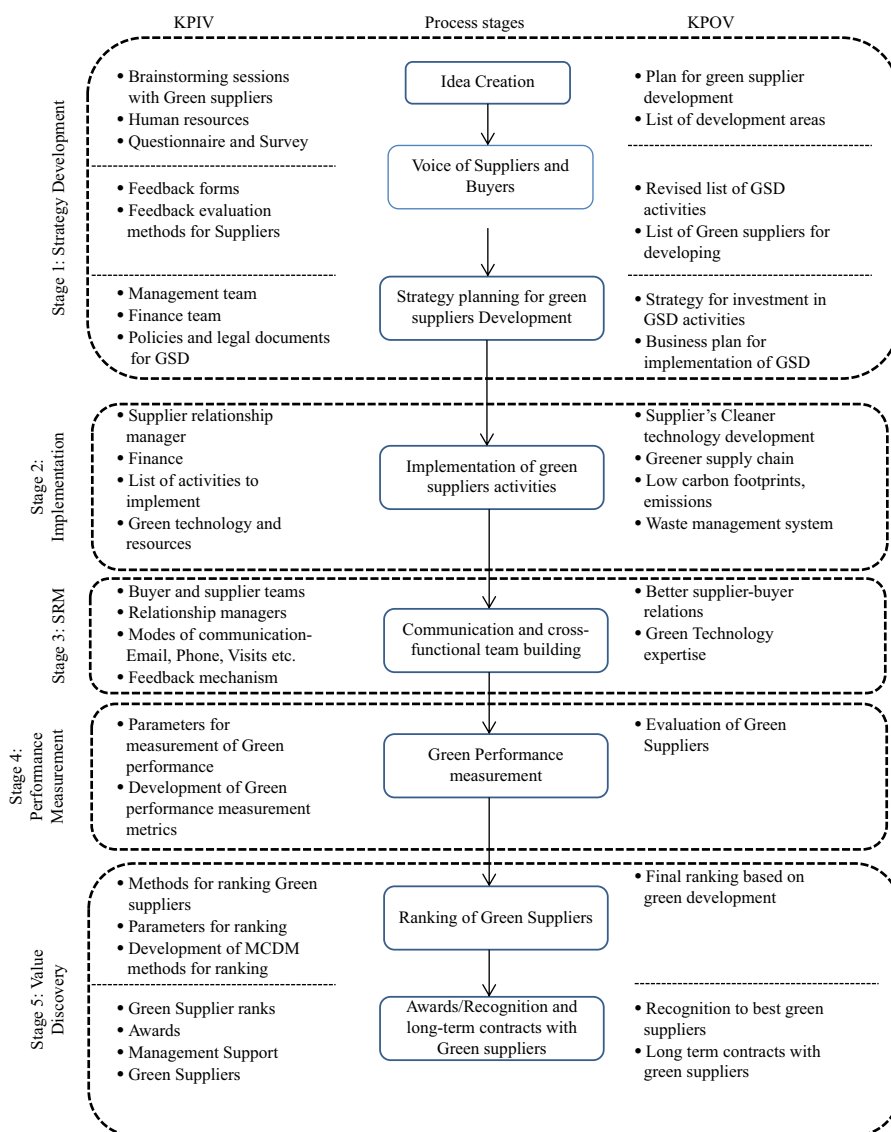
along with testing workshops. They have TS 16949 certification which is required for automobile industry. The annual turnover of the company is 40 Crore and employee strength is 100.

It has around 15 suppliers for the supply of various components and raw materials. The automotive supply chain includes a multitude of tiers 1-3 suppliers or manufacturers with many assembly operations and a number of dealerships (Scannell *et al.*, 2000; van Hoek, 2001).

### 5.2 Data collection

Industry case study is done by authors as it gives the opportunity to work closely with the industry and conduct the pilot level studies (Seawright and Gerring, 2008). The buyer industry maintained the record of progress and took feedback from suppliers time to time. Team members from Buyer firm were given questionnaire at the start of the program and then annually till they successfully completed the project. The questionnaire has two sections, one for basic information and the second one for details in green initiatives taken by Buyer and suppliers and help given by buyer firm. The sample questionnaire is given in





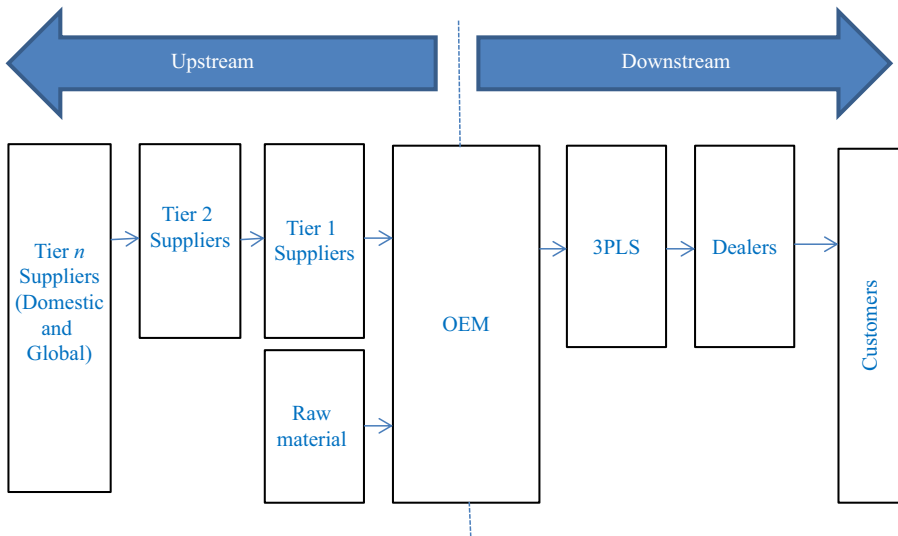
**Figure 4.** KPIV and KPOV for each stage of green supplier development process

Appendix. The questionnaire was mailed to the team and responses were obtained after two rounds of follow-up through mail and calls Figure 5.

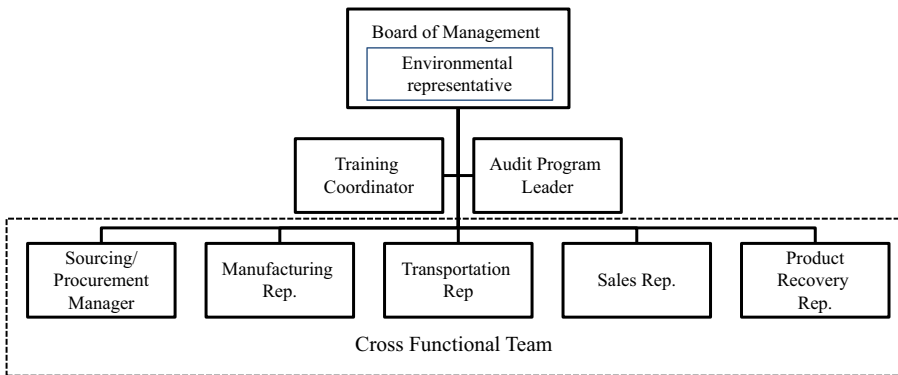
### 5.3 Team and resources

The buyer industry has an environment management system in place. The structure of EMS in the industry is given in Figure 6. The environmental policy developed by EMS of the industry is:

- to minimize the adverse environmental effects of all activities of its value chain in the production of automobiles;



**Figure 5.**  
Automobile industry  
supply chain



**Figure 6.**  
Green supplier  
development team

- to continuously improve and minimize pollution;
- to comply with all environmental laws and regulations in the country;
- to review the environmental objectives and targets for its supply chain for continuous improvement; and
- to document, implement, maintain and communicate to all employees and business partners about the environmental management system and its functions.

The cross-functional team comprising members from each of the supply chain functions of sourcing/procurement, manufacturing, distribution/transport, product recovery, as well as maintenance and sales to steer the implementation and continued development of its environmental policy. We contacted suppliers through procurement manager of the industry under study. The suppliers were informed about the GSD process and had given the contract to sign for three years to be a part of GSD program.

### 5.4 Delphi method

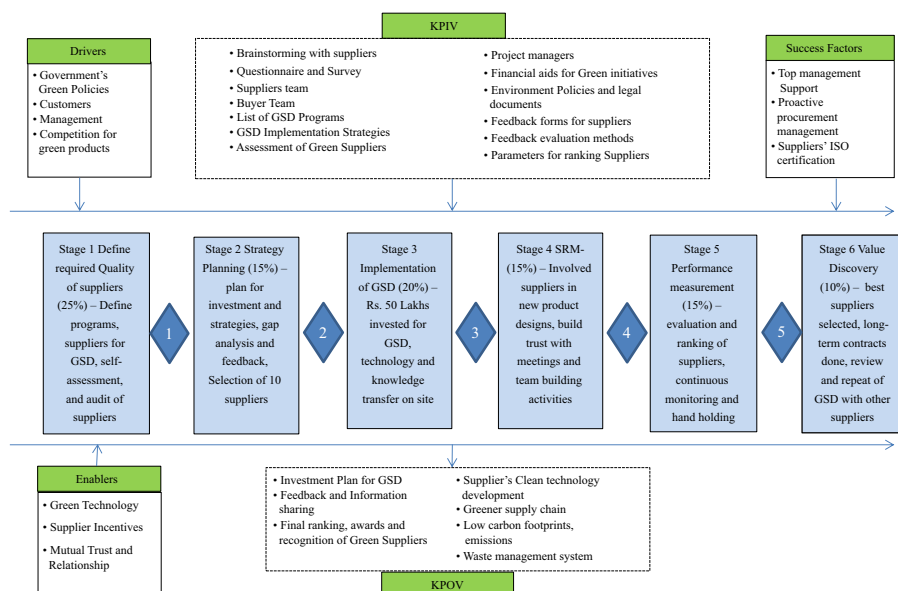
The model developed by authors was validated through two rounds of Delphi method as it brings a consensus of opinions among experts by maintaining the unanimity among them (Seuring and MüEler, 2008; Prusty *et al.*, 2010; Narges *et al.*, 2015). The experts from automobile industry in and around Mumbai were consulted for the model validity in the automobile sector. After getting first rounds of feedback and suggestions, the model was revised to incorporate KPIV, KPOV and other factors related to the process (Table II).

### 5.5 Model implementation

The automobile industry has applied the stage-gate process model prepared by authors for GSD. KPIV and KPOV for their supply chain along with stage gates at every step are given in Figure 7. Key areas like drivers, success factors, enablers are defined for the successful implementation of the process model. Top management commitment to green supplier relationship development (Lee, 2008), and internal purchasing evaluation on strategic metrics find regular mention in the sourcing literature as important enablers (Sanchez-Rodriguez *et al.*, 2005) and facilitators of strategic sourcing programs (Das *et al.*, 2006). Drivers like government's green policies and support for green initiatives, customers awareness for buying environment-friendly products, management policies and global competition for green and innovative products are required for successful implementation of the process. Critical success factors are the one deciding the successful implementation of the proposed

Position of experts	Industrial experience (years)	Total no. of experts
Director, CEO	> 20	2
Purchase managers of automobile industry	10-20	3
Buyers/suppliers to automobile industries	5-15	3
Environmental managers	5-10	2

**Table II.** Expert profiles considered for Delphi method



**Figure 7.** Green supplier development process: stage gate, drivers, enablers, success factors, KPIV and KPOV

model (Raafat *et al.*, 2012). Top management's commitment and support are considered as a critical success factor for any initiative in the green supply chain (Ragatz *et al.*, 1997). Other success factors include proactive procurement management, supplier's commitment (Ghijssen *et al.*, 2010; Routroy and Pradhan, 2013) and awareness for environment-friendly and clean processes.

### 5.6 Validation of questionnaire

The questionnaire is validated by finding whether it measures what it is meant to measure. Internal consistency is the extent to which the questionnaire items are consistent in measurement of the same construct. The questionnaire was validated for its reliability by conducting reliability test. After obtaining the responses of questionnaire from the buyer firm, Cronbach's  $\alpha$  value for the questionnaire was calculated as 0.7778 which exceeded the recommended cutoff of 0.70.

### 5.7 Model validation

Strengthen relationships with suppliers result in lower inventory levels, costs and higher accuracy (Dunn and Young, 2004; Wen-Li, *et al.*, 2003; Sillanpää *et al.*, 2015). The process of GSD involves many stakeholders and is considered as one of the crucial processes for making greener supply chains. We have tried to develop a conceptual model for GSD process by considering a stage-gate approach as it helps in identification of input and outputs at each stage. Stage gate provided a framework for arranging GSD implementation into distinct stages. KPIV and KPOV of each stage in the process are listed for a better understanding of the resources required to complete the process and output obtained after each stage gate. The model was implemented successfully by the industry and they were also able to strengthen their relationship with suppliers. They have signed long-term contracts and have continued with supplier development programs.

## 6. Results and discussion

Based on ranking, evaluation, screening process for all suppliers under the four categories described in portfolio purchasing model, the final selection is done for suppliers to undergo GSD program. The process model developed by us has been incorporated by the automobile industry for developing their suppliers and moving towards green supply chain. The suppliers were involved with Supply chain integration and collaborations for making green supply chain. Six months of vigorous implementation and follow-up the process we were able to identify the benefits of the framework provided to industry. Based on discussions with supply chain manager, procurement manager and other technical experts of the organization, following comments were given to authors after model implementation by the industry:

- (1) Overcoming barriers to GSD implementation: we were facing many barriers to the implementation of GSD programs as suppliers did not want to invest in green technologies. Hence we decided to make a list of suppliers who were to be considered for the said program and have meetings with them. After finalizing list and strategies of supplier development initiatives we have implemented around four programs for supplier development which are: Acquiring ISO14000 Certification for suppliers, Green knowledge transfer by conducting training and seminars for suppliers, rewards for green suppliers and long-term contracts with suppliers and financial assistance to suppliers. This was discussed and verified with Procurement manager and CEO of the company.
- (2) Use of stage-gate process model: the industry worked on basic rules of Process development but the stage-gate approach was never utilized by them. The key person from EMS team stated, "KPIVs and KPOVs of each stage along the GSD

implementation process were listed and we had ensured to get all outputs recommended to us. The stage-gate process has helped us immensely in identifying the possible inputs and outputs required at every stage and we could achieve the targets without any hassles.”

- (3) Involvement of suppliers in strategy planning: we had involved the suppliers in strategy planning and got some very important feedback from them regarding troubles faced by them while incorporating environmental-friendly technologies and processes. For instance, one of the suppliers could not deal with the wastage produced after raw material processing. So the technical experts from buyer industry held training for them and informed about environment-friendly ways of dealing with wastage. The problem was solved at very early stages due to efficient planning and strategy implementation.
- (4) Ranking of suppliers: the process road map helped us in identifying and dealing with barriers and finding distinct outputs after completion of each stage. We had involved five suppliers in the program and after successful completion of supplier development process we could rank our suppliers and decide on further long-term contracts with them.

## 7. Strategies for managers and practitioners

After successful implementation of the GSD process, the need for more research regarding environmental performance across different actors in the supply chain is recognized by authors. The process of GSD was discussed in detail with all team members of the automobile industry and some guidelines and strategies for successful implementation of GSD were developed as given below:

- (1) Green product certifications confirm that a product meets a particular standard and offers an environmental benefit. It is required to ensure suppliers training, education and skill development to match the green standards required.
- (2) Top management awareness and support are essential for successful implementation of any green initiative. It has been proved by many researchers in different studies that management involvement and support plays vital role in new initiatives.
- (3) Process of GSD is rather a complex one that involves many parties and high investment. Enable Simplified and standardized processes for GSD implementation.
- (4) Approval of budget and other monetary requirements is a mandatory stage for GSD. Prepare detailed insight of cost and financial requirements.
- (5) One of the main factors for successful implementation of GSD model in the automobile industry was strong relation between the firm and its suppliers. Ensure Cross-functional and strategic collaboration with suppliers.
- (6) Sustainable programs are developed considering long-term possibilities, opportunities and challenges. Make GSD as part of a sustainability program.
- (7) Keeping environment clean and green is a big challenge for manufacturing industries. Create awareness on environmental issues and conservation in staff and employees.
- (8) Government rules on carbon emissions and environment policies are present from long time but small scale industries are not adhering to the norms. The industry need to enforce that the suppliers also follow the environmental legislation, regulations, and directives.

- (9) Suppliers require the support from buyer firm for developing their manufacturing process and redesign of products to convert as a green supplier. Develop Infrastructure support and facility for GSD.
- (10) Green technologies are developing at fast rate. Innovation and new product development are prime areas to focus for manufacturing units. Create, develop and invest in GSD technology.
- (11) Considering the geographical positions of buyer and supplier, it may not be possible for both parties to meet Make e-collaboration for fast and effective coordination with suppliers.
- (12) Performance measurement metrics are used to measure the performance of suppliers with careful consideration of KPIs related to the supply chain. Make and use performance metrics for green suppliers.
- (13) Motivation and encouragement to suppliers always results in better performance by the suppliers. Recognize and award green and environmental suppliers.
- (14) The suppliers may not be capable for innovating new products or processes as required for going green considering low scale production and less skilled workers available with the suppliers. Establish process and products for suppliers ensuring environmental benefits.
- (15) Design of new product requires inputs from all involved in the production. Usually the suppliers are informed at later stage about the new product development which may not be feasible to manufacture by them. Involve suppliers in eco-design and various stages of products development.

Practitioners, from industries or policymakers, are required to take part in GSD implementation else the research will be only conceptual and theoretical. The investigations done in this research are useful in practice and in policymaking. Integrating real industry data and practitioner groups into this investigation will benefit both practical and theoretical advancement.

## 8. Conclusion

Given the gaps in the extant literature, this paper tries to investigate the challenges in the GSD. Buyer firm can gain competitive advantage with a strong Supplier Buyer relationship (Tangpong *et al.*, 2008; Ross *et al.*, 2009). GSD is crucial and requires coordination from all level of the workforce, from bottom line employee to top management. The GSD is concerned with upstream supply chain connecting Suppliers with other suppliers or OEMs. It is essential to make upstream supply chain green as most of the products are manufactured or obtained by suppliers in the automobile industry. This paper presents a framework to model the GSD process and to make managers' efforts towards environmental improvement a little easier. Industries may be benefitted with this model while converting their traditional suppliers into Green suppliers. Active participation in green initiatives of OEMs is yet another factor on which they can win or lose orders. The greening of the supply chain provides a challenge and a chance to also compete on sustainable production methods and extensive knowledge about green manufacturing and green products (Srivastava, 2007; Ahi and Searcy, 2013; AlKhidir and Zailani, 2009; Gardas and Narkhede, 2013).

## 9. Future scope

This work has few limitations and can be considered for future study in area of GSD. Various sectors of the industry could be considered for the exhaustive investigation leading

to further improved ways for GSD implementation. Studies can also be conducted on finding the effectiveness of the model from buyers and suppliers perspective. The automobile industry considered is a medium scale industry and hence it would be beneficial to consider a large-scale industry with global suppliers. This work gives the road map for successful implementation of GSD provided all the related variables and matrix are considered hence developing the strategic models for GSD could be beneficial to industries planning to introduce green supply chain.

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### Appendix. Excerpts from questionnaire for green supplier development initiatives

Section A: respondent's details:

Name of Respondent

Post/Role of respondent

Experience

Education/Qualification

Name of Industry/Institute

Company's main activity: Service/Manufacturing/Consultation/Other. Please specify

How many employees does the company have? Number: \_\_\_\_\_

What is Company's Annual Turn Over: Value: \_\_\_\_\_

Section B: Green supplier development initiatives:

- (1) Does your company belong to a multinational national corporation (MNC) category?
- (2) Does your company have ISO 9000 Certification?
- (3) Does your company have ISO14000 Certification?
- (4) Does your company have Environment management system/Department
- (5) In the last two years, the company has taken environmental actions in the following areas (on a four-point scale of strongly disagree, disagree, agree, strongly agree):
  - Environment-friendly raw materials
  - Substitution of environmental questionable materials
  - Choice of suppliers by environmental criteria
  - Urging/pressuring supplier(s) to take environmental actions
  - Taking environmental criteria into consideration
  - Design considerations
  - Optimization of processes to reduce solid wastes
  - Optimization of processes to reduce water use
  - Optimization of processes to reduce air emissions
  - Optimization of processes to reduce noise
  - Use of cleaner technology processes to make savings (energy, water, wastes) Recycling of materials internal to the company
  - Use of waste of other companies
  - Use of alternative sources of energy
  - Helping suppliers to establish their own EMS
  - Recovery of the company's end-of-life products
  - Eco-labeling
  - Environmental improvement of packaging
  - Taking back packaging
  - Providing consumers with information on environment-friendly products and/or production methods
  - Change for more environmental-friendly transportation
- (6) In the process of Greening the Suppliers/Buyers, the company has taken actions in the following areas with regard to the Suppliers/Buyers (on a four-point scale of strongly disagree, disagree, agree, strongly agree):
  - Holding awareness seminars for suppliers/contractors
  - Guiding suppliers to establish their own environmental programs
  - Bringing together suppliers in the same industry to share their know-how and problems
  - Informing suppliers about the benefits of cleaner production and technologies
  - Urging/pressuring suppliers to take environmental actions
  - Choice of suppliers by environment criteria
  - Arranging for funds to help suppliers to purchase equipment for pollution prevention, wastewater recycling, etc.

- Sending in-house company auditors to appraise the environmental performance of suppliers
- (7) Due to Green Supplier/Buyer development activities in the firm, there has been valued addition in following areas (on a four-point scale of strongly disagree, disagree, agree, strongly agree):
  - Increase in productivity, the reliability of components
  - Increase in customer satisfaction
  - Offer more innovative and environment-friendly products
  - Reduce carbon footprints along the supply chain
  - Not applicable
  - Other- Describe the benefits of developing green suppliers to your firm.

#### About the authors



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