Synopsis of Research Work Undertaken for the Award of Ph.D.

On

SUSTAINABILITY ADOPTION THROUGH RELATIONSHIP MARKETING ACROSS SUPPLY CHAIN IN INDIAN FIRMS

Submitted by

DIVESH KUMAR

(Enrollment No: 10921003)

Under the Supervision of

Dr. Zillur Rahman
(Supervisor)

Department of Management Studies
Indian Institute of Technology Roorkee
Roorkee-247667, (Uttarakhand)
India

April-2015

1. INTRODUCTION

Supply chain is a process that involves various stages of production and each stage affects sustainability of the final product (Darnall, 2008). Sustainability practices adoption across supply chains has become a matter of increasing concern over time, and come under the scanner of the media and many NGOs (Rao & Holt, 2005). Recently, Apple was under question due to some unsustainable practices followed by one of its suppliers in China (Garside, 2013). In this case, Apple is a 'focal firm' facing pressure from external agencies on sustainability issues. A focal firm is a firm that generally owns a brand, is involved in the designing of products and services, and rules the supply chain (Seuring & Muller, 2008). Focal companies across the globe are trying to promote the concept of sustainability into their supply chain. This stems from realizing the importance of sustainability and its possible benefits (Hsu et al., 2013). Companies are developing stronger partnerships with supply chain partners for implementing this concept (Cote et al., 2008).

Companies are ready to adopt sustainability to achieve long-term benefits like a marketing advantage, competitive advantage and cost reduction. Besides, there are other benefits like reduced pressure from external agencies, legal fulfillment and lower environmental accidents (Ageron et al., 2011). However, the commitment of top management of all the supply chain partners has been a big issue. An increasing wave of incorporating sustainability in supply chain has resulted in a supplier selection based on sustainability standards and regular performance reviews (Hutchins & Sutherland, 2008). In addition, the pressure of incorporating sustainable activities in supply chain has motivated companies to come together and develop problem specific relationships to improve the overall performance of the supply chain (Bommel, 2010).

2. GAPS IDENTIFIED FROM THE LITERATURE

Following gaps were identified from the literature. Sustainable supply chain research is very new to Indian firms. Only one study by Kushwaha (2010) on sustainable development through green supply chain management is available. However, that research neglected the social sustainability of the supply chain in India. In the literature review, a clearer understanding of the interrelationships among and classification of the various enablers of the sustainable supply chain is needed. In the literature, no studies strictly focused on the supplier selection and order allocation in a sustainable supply chain. One study by Shaw et al. (2012) tried to develop the supplier selection and order allocation model for the low carbon emission supply chain. However, this paper has neglected social sustainability as well as some dimensions of environmental sustainability including waste minimization and minimizing energy use. Additional studies need to be done to address sustainability more comprehensively in the supplier selection and order allocation. There is only one study on the buyer-supplier relationship selection in the literature that considers benefits, opportunity, cost, and the risk of developing a relationship. This study by Lee (2009) lacks the incorporation of sustainability criteria in the relationship selection. One of the most important gaps identified from the literature is none of the studies have empirically tested the model of the sustainable supply chain development mechanism.

3. OBJECTIVES AND METHODOLOGIES

This research is based on five main objectives as follows:

Objective 1: To analyze the issues related to sustainability adoption in a supply chain.

Objective 2: To develop a model stating the interrelationships and classifications among the enablers of a sustainable supply chain in the Indian automobile sector.

Objective 3: To develop a model for supplier selection and order allocation for developing a sustainable supply chain in the Indian automobile sector.

Objective 4: To develop the best form of a relationship selection model for developing a sustainable supply chain in the Indian automobile sector.
Objective 5: To develop a model to investigate the mechanism for developing a sustainable supply chain.

Both qualitative and quantitative methods are used to achieve the objectives under consideration. Interpretive structural modeling (ISM) is used for identifying and summarizing relationships among specific variables. Fuzzy MICMAC is used for the classification of a variable under study based on driving and dependence. Fuzzy AHP has been used to prioritize the criteria of supplier selection and order allocation and is also used for prioritizing the best form of a buyer-supplier relationship. Fuzzy multi-objective programming has been used for developing a model for order allocation among the suppliers. A structured questionnaire survey has been conducted to collect the information regarding the buyer-supplier relationship, sustainability performance of the supply chain and various enablers affecting the top management's commitment to adopt sustainability. Partial least square (PLS) and structural equation modeling (SEM) techniques are used to test the proposed hypotheses.

4. RESULTS AND ANALYSIS

A conceptual model has been developed based on the literature for developing sustainable supply chain using buyer supplier relationship. After the identification of enablers of sustainable supply chain in the context of Indian automobile industry a qualitative model has been developed to depict the interrelationship among the enabler and their classification. Fuzzy scale is used to know the indirect relationship among the enablers. Fuzzy matrix is established and values are plotted on the MICMAC graph. A supplier selection and order allocation model has been developed using Fuzzy AHP and Fuzzy Multi-objective linear programming. In this study two approaches have been compared, these two approaches are: symmetric and asymmetric. A sensitivity analysis has been done to show the changes in the objective function with respect to the main objective function.

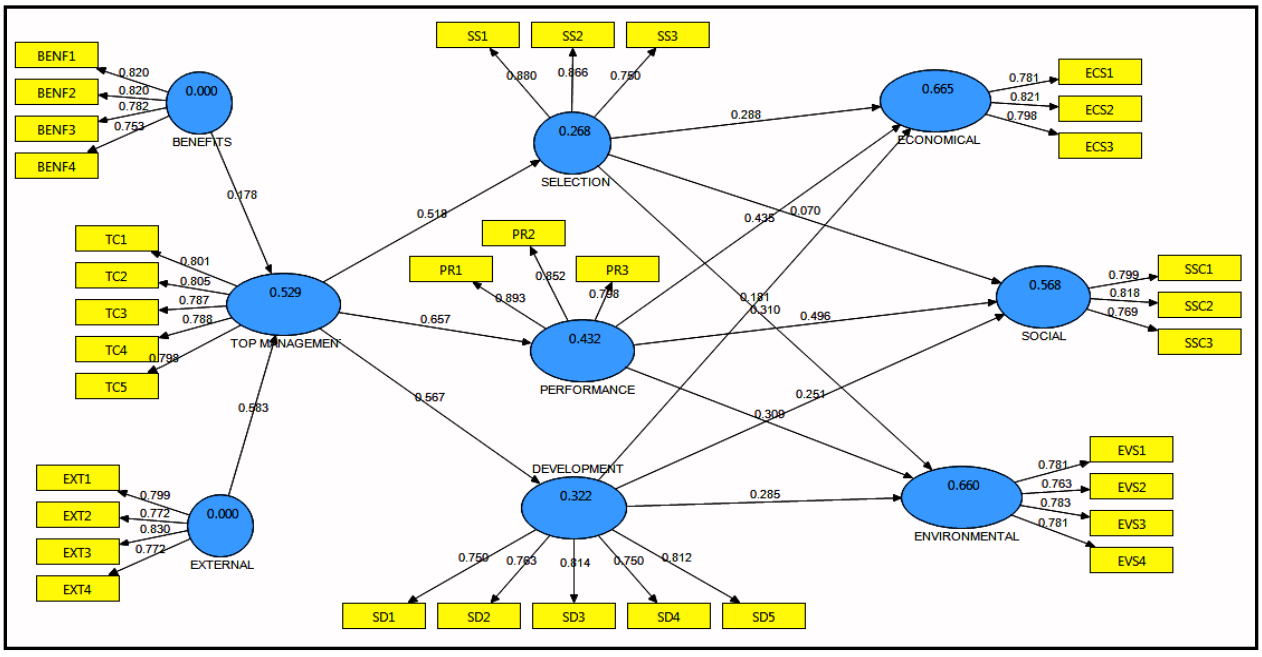

Figure 1: Results of structural model

After developing model for supplier selection for sustainable supply chain, a qualitative model has been developed for the relationship selection in sustainable supply chain. Fuzzy AHP has been used for this purpose. The final selection of the alternatives has been done by using five different methods of association of BOCR. A sensitivity analysis has been performed to understand the change in relationship alternative selection with respect to the change in the weight of benefits, opportunity, cost and risk. Hypotheses based on the literature review were formulated. Most of the hypotheses were accepted except two hypotheses (Figure 1). Positive impact of supplier selection activities on economical sustainability and positive impact of supplier section activities on social sustainability were rejected in our empirical validation of conceptual model.

5. SIGNIFICANT RESEARCH

The main purpose of this study was to provide a better understanding of developing sustainable supply chain. In the present study both qualitative and quantitative models were developed for the help of practitioners and decision makers of the Indian automotive industries. These developed models will help researchers working in this field of study. These models will fulfill the gaps in the available literature to some extent and to achieve the objectives of the present study.

6. CONCLUSION AND MANAGERIAL IMPLICATIONS

The outcomes of the present research add to the existing body of literature on sustainable supply chain. The results of the study provide a path for the both academicians and practitioners for the developing sustainable supply chain in the long run as well its impact on developing buyer supplier relationship. The outcome of the present study presents the practical implications of the identified corporate sustainability measurement factors. Their application in the Indian automobile sector provides a guideline for the managers and decision makers of these companies to improve their corporate sustainability performance. The important managerial implications of the present study are summarized as below:

- A bibliographic record provided in the literature review of the present research may work as a guideline for future research in this field of study. Many items identified under the categories of enablers of sustainable supply chain, BOCR of buyer supplier relationships, relationship management strategies, sources of external influence, barriers of sustainable supply chain, and indicators of sustainability in supply chain can be used by researchers/academicians for their research work.
- Managers can have a better understanding of enablers at each stage of adoption with the ISM model and MICMAC categorization. The focal firm's ability to induce changes in the supply chain depends upon the willingness of supply chain partners to support and accept the change.
- From a managerial perspective, supplier selection is important for managing the sustainability of the final product. Rather than ranking suppliers on sustainability standards, companies can now allocate the ordering units among them.
- The proposed supplier selection and order allocation method can be used in a way that particularly suits the need of the supply chain, by weighing and comparing the different selection criteria.
- The model presented in Figure 1 provides clearer picture in term of explaining the various activities involved in developing sustainable supply chain. Managers can use this study to evaluate the role of specific latent variable in developing a sustainable supply chain.

7. ORGANIZATION OF THE THESIS

The thesis is structured in 8 chapters. *Chapter 1* provides an introduction of the thesis and discussed a brief introduction on background of the present study, problems statement, research issues, and research objectives. *Chapter 2* provides a comprehensive review of literature in the field of sustainable supply chain. *Chapter 3* presents the enablers of SSCM and explores the relationships among identified key factors with the help of ISM and fuzzy MICMAC approach. *Chapter 4* deals with the problem of order allocation among suppliers by using fuzzy AHP and fuzzy Multi objective linear programming. In *Chapter 5*, a fuzzy AHP based hierarchical model is developed for relationship selection. *Chapter 6* presents the research methodology adopted in the present study which includes research design, scaling techniques, questionnaire design, sample design, data collection method and analysis process. In *Chapter 7*, partial least square (PLS) approach is used to validate the model and investigate the relationships of various constructs under consideration. *Chapter 8* provides the research summary, conclusions, managerial implications and the scope for future work.

References

1. Ageron, B., Gunasekaran, A., & Spalanzani, A. (2012). Sustainable supply management: An empirical study. *International Journal of Production Economics*, 140(1), 168-182.
2. Bommel, W. V. (2010). A conceptual framework for analyzing sustainability strategies in industrial supply networks from an innovation perspective. *Journal of Cleaner Production*, 19(8), 895-904.
3. Cote, R. P., Lopez, J., Sunny M., Genevieve M. P., & Ramsey W. (2008). Influences, practices, and opportunities for environmental supply chain management in Nova Scotia SMEs. *Journal of Cleaner Production*, 16(15), 1561-1570.
4. Darnall, N., Jolley, G. J., & Horvath, A. (2008). Environmental management system and green supply chain management: complements for sustainability. *Business Strategy and the Environment*, 17(1), 30-45.
5. Garside, J. (2013). Child labour uncovered in Apple's supply chain. *The Guardian. http://www.theguardian.com/technology/2013/jan/25/apple-child-labour-supply*, accessed on 7th march 2013.
6. Hsu, C. W., Kuo, T. C., Chen, S. H., & Hu, A. H. (2013). Using DEMATEL to develop a carbon management model of supplier selection in green supply chain management. *Journal of Cleaner Production*, 56, 164-172.
7. Hutchins, M. J. & Sutherland, J. W. (2008). An exploration of measures of social sustainability and their application to supply chain decisions. *Journal of Cleaner Production*, 16(15), 1688-1698.
8. Kushwaha, G. S. (2011). Sustainable development through strategic green supply chain management. *International Journal of Engineering and Management*, 1(1), 7-11.
9. Lee, A. H. I. (2009). A fuzzy supplier selection model with the consideration of benefits, opportunities, costs and risks, *Expert Systems with Applications*, 36(2), pp. 2879-2893.
10. Rao, P. & Holt, D. (2005). Do green supply chain lead to competitiveness and economic performance?. *International Journal of Operation & Production Management*, 25(9), 898-916.
11. Seuring, S. & Muller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production.* 16(15), 1699-1710.
12. Shaw, K., Shankar, R., Yadav, S. S., & Thakur, L. S. (2012). Supplier selection using fuzzy AHP and fuzzy multi-objective linear programming for developing low carbon supply chain. *Expert Systems with Applications.* 39, 8182-8192.

PUBLICATION FROM THE PRESENT RESEARCH

Publication Accepted in Refereed International Journals

- **Kumar, D.** and Rahman, Z. (forthcoming) Sustainability adoption through buyer supplier relationship across supply chain: A literature review and conceptual framework, *International Jouranl of Strategic Management Review*, (**Accepted - Elsevier**)
- **Kumar, D.** and Rahman, Z. (2013) Modelling relationship marketing relationship strategies, *International Journal of intercultural information management* Vol 3. No. 4 pp. 267-281.
- **Kumar, D**., Rahman, Z., and Goyal, P. (2012) Sustainability adoption through e-learning, *International Journal of the Computer, the Internet and Management*. Vol. 19 No. SP2 pp. 1-4.
- **Kumar, D.,** Rahman, Z., and Kumar, I. (2011) Sustainable Consumption in India: Opportunities and Challenges. *International Journal of Management and Business Studies*, Vol. 2 Issue: 1.

Research papers: Submitted/under Review in International Journals

- **Kumar, D.,** Rahman, Z., and Qureshi, M.N. Analyzing enablers of sustainable supply chain (Under review) *Benchmarking: an International Journal* (Emerald)
- **Kumar, D.,** Rahman, Z., and Chan, F.T.S. Fuzzy AHP and Fuzzy Multi-objective linear programming model for order allocation in sustainable supply chain (Under review) *International Journal of Computer Integrated Manufacturing*. (Taylor & Francis)
- **Kumar, D.** and Rahman, Z. Relationship selection in sustainable supply chain (Under review) *Production, Planning & Control* (Taylor and Francis)
- **Kumar, D.** and Rahman, Z. Sustainability adoption in supply chain (Under review) *International Journal of Productivity, Performance and Managment* (Emerald)

Award

- **Emerald IMA South Asian Management Research Fund Award** – 2013 for the project "Problems and prospects of compost marketing in Uttarakhand".

Conferences

- **Kumar, D**. and Rahman, Z. "Modelling the barriers of sustainable supply chain", 7th ICCB and GLOGIFT 14, Organized by Curtin University and Global Flexible System Management at Curtin University, Singapore on October 15-17, 2014.
- **Kumar, D**. and Rahman, Z., "Modelling relationship marketing strategies for sustainable supply chain, ICOMB organized by Malviya National Institute of Technology, Jaipur on 18-19 May 2013.
- **Kumar, D**., Rahman, Z. and Katiyar, R., "Sustainability adoption through relationship marketing across supply chain", Organized by Department of Management Studies, Indian Institute of Technology, Roorkee on 1-2 June, 2012.
- **Kumar, D**., Rahman, Z. and Goyal, P., "Sustainability adoption through E learning", The Eight International Conference on E-learning, M learning and U learning, organized by Assumption University at Information Centre Bangkok Thailand on 23-24 February, 2012.
- **Kumar, D.**, Rahman, Z., and Goyal, P. "Green Marketing Mix: Rethinking Competitive Advantage During Climate Change", "The First International Congress of Interdisciplinary Research and Development" Organized by Assumption University at Impact Convention Centre Bangkok Thailand on June 1, 2011.
- **Kumar, D**. & Rahman, Z., "Marketing Responsibility to promote Sustainability in Supply Chain", "Conference on Excellence in Research and Education" Organized by IIM Indore on May 13-16, 2011.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE

CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in this thesis entitled "**SUSTAINABILITY ADOPTION THROUGH RELATIONSHIP MARKETING ACROSS SUPPLY CHAIN IN INDIAN FIRMS**" in partial fulfilment of the requirements for the award of the Degree of Doctor of Philosophy and submitted in the Department of Management Studies of the Indian Institute of Technology Roorkee, Roorkee is an authentic record of my own work carried out during a period from July, 2010 to April, 2015 under the supervision of Dr. Zillur Rahman, Associate Professor, Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee.

The matter presented in this thesis has not been submitted by me for the award of any other degree of this or any other Institute.

(DIVESH KUMAR)

This is to certify that the above statement made by the candidate is correct to the best of my (our) knowledge.

(Zillur Rahman**)**
Supervisor

Date:

The Ph. D. Viva-Voce Examination of **Divesh Kumar**, Research Scholar, has been held on ……

Chairman, SRC **Signature of External Examiner**

This is to certify that the student has made all the corrections in the thesis.

Signature of Supervisor (s) **Head of the Department**

Abstract

The concept of sustainability is frequently used in management and engineering research. Many international efforts including the Stockholm Conference (1972), World Conference on Economic Development (1987) and International Union for Conservation in Nature (IUCN) worked as a catalyst for the adoption and implementation of sustainability practices in business. A major breakthrough came in 1994 when Elkington introduced the three dimensions of sustainability: social, economical, and environmental. These dimensions are the most accepted across academia and industry. Business firms are crucial for the sustainable development of society since they consume a great quantity of natural and human resources and degrade the environment and human habitat directly or indirectly. Focal companies in the supply chain are putting efforts to extend sustainability practices towards supply chain partners. Yet there is the implementation issue of sustainability across supply chain. This raises many questions. First, how can supply chain partners and their top management be motivated to adopt sustainability practices? Second, how sustainability practices can be adopted across supply chain? Third, how buyer-supplier relationships can be used to develop sustainable supply chain? Fourth, what are the indicators of sustainability in a supply chain?

For this purpose, many authors have published several conceptual studies. There are also few empirical studies mostly focusing on one dimension of the sustainability, either environmental or social. Most of these studies have been carried out in the developed countries and some of the work belongs to China also. Therefore, it is necessary to develop a proper model for a sustainable supply chain considering the buyer-supplier relationship in Indian context. Many studies have acclaimed that a relationship based supply chain is more sustainable. There are various enablers including the buyer-supplier relationship, expected benefits of sustainability adoption, and external influence that can help propagate sustainability across supply chain. Literature has indicated many buyer-supplier relationship strategies such as supplier selection on sustainability standards, performance review of suppliers, and supplier development activities. The main question that arises is how to select a relationship with every supply chain partner? Relationship marketing literature suggests that joint development and long term relationships are always not profitable. Relationship marketing literature also focuses on the benefits, opportunities, cost, and risk of a relationship. Hence, there is need to develop a relationship selection model for developing sustainable

supply chain.

The Indian automobile industry is becoming a global hub for the production and export of automobile products. India will become one of the biggest exporters of automotive components and finished automotive products very soon. The role of sustainable business practices cannot be ignored in the global supply chain.

The present study evaluated the enablers of a sustainable supply chain, supplier selection model, relationship selection model, and role of the buyer-supplier relationship for developing a sustainable supply chain in the context of the Indian automobile industry. This study used both qualitative and quantitative studies.

The main input and key findings of the present study are given below:

- In this study a review and taxonomical and conceptual analysis of the available literature was presented. Different factors related to sustainability adoption across supply chain were derived from a further perusal of the present study.
- After the identification of the enablers of a sustainable supply chain in the context of the Indian automobile industry, a qualitative model was developed to depict the interrelationships among enabler.
- A supplier selection and order allocation model was developed using Fuzzy AHP and Fuzzy Multi-objective linear programming.
- After developing a model for supplier selection for a sustainable supply chain, a qualitative model was developed for the relationship selection on the basis of benefits opportunities, cost and risk of relationship type. Final model has been developed and tested for the hypothesis using PLS 2.0M3.

Keywords: Sustainability, Sustainable Supply Chain, Relationship Marketing, Analytic Hierarchy Process (AHP), Interpretive Structural Modelling, Fuzzy, Multiobjective Linear Programming, Partial Least Square, Automobile Industry, India.

Acknowledgement

The dream begins with teachers, family, and friends who believe in you, who tug and push and lead you to the next plateau, sometimes poking you with a sharp stick called *"truth".*

The wok in this thesis is far more than the result of years of study. This work also reveals the relationships with many generous and inspiring people I have met since the beginning of my research. The list is long, and I cherish each contribution towards my development as a scholar. A number of people have made important contributions during this process.

For those who know me, doing a doctoral degree is totally out of their expectation, not to mention mine. To do the impossible, one needs a great mentor. My sincere gratitude goes to my supervisor, Dr. Zillur Rahman, Associate Professor, Department of Management Studies, IIT Roorkee, for devoting his time and efforts to nurture his students to achieve perfection. Without their dedication and enthusiasm toward education, many of us would not have had the invaluable opportunity to acquire the knowledge and pursue a sound academic career. I sincerely thank Mrs. Rahman for her kind concern and cooperation throughout my research work.

I extend my gratitude to Dr. M. N. Qureshi, Associate Professor, Department of Mechanical Engineering, The M. S. University of Baroda, Vadodra, Dr. P. L. Meena, Assistant Professor, New York Institute of Technology, USA and Prof. Felix T. S. Chan, Department of Mechanical Engineering, Hongkong Polytechnic University, Hongkong for providing me inputs for the betterment of my research work.

The joy of studying at an institute of national importance did not end with superb supervisor. The treasure here is the great team of learned, and yet humble professors. I sincerely thank Dr. Santosh Rangnekar, Chairman SRC and Head, Department of Management Studies, IIT Roorkee, for providing constructive advice to my thesis as well as my study at the institute. I am also grateful to Dr. Rajat Agrawal (Internal Member, Student Research Committee), Department of Management Studies, Indian Institute of Technology Roorkee, and Prof. Ravi Kumar (External Member, SRC), Department of Mechanical and Industrial Engineering, Indian Institute of Technology Roorkee, Rookee for giving valuable suggestions in enhancing the quality of the present research work and giving their valuable time in offering new perspectives to students. I would also like to thank Prof. V. K. Nangia,

who always offered vigorous comments to ensure the standard and quality. I am also grateful for the opportunity to learn from Dr. Vinay Sharma and Dr. M. K. Barua.

I thank to the Industry persons who have helped and contribute in my work. I thanks to Mr. Madhav Sharan, Asst. Production Manager, DENSO INDIA Limited, Mr. Raghav Kumar, Quality Engineer, LG Electronics, Noida, Mr. Govind Sharma, Asst. Quality Engineer, TATA Motors, Pantnagar, Mr. Yogesh Kumar, Quality Engineer, Padmini VNA Mechatronics, Gurgaon, and Mr. Nitesh Kumar, Associate Plastics, Timex Group Precision Engineering Limited, Noida.

Availing a financial support is very crucial in the long journey of the doctoral degree. My thanks go to the University Grant Commission for providing the financial assistance to carry out my research in a smooth manner. I wish to express my sincere thanks to all staff members of the Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee for their continuous encouragement and various helps during the course of my research.

My research would not have been materialized without the kindest assistance of many. Friends and experts from diverse fields have offered their time and professional perspective, making my thesis possible, and hopefully, a piece worth reading. My sincere thanks go to those who helped me in this journey. The same goes to Dr. Faisal Talib, Dr. Ruchi Garg, Dr. Ishwar Kumar, Dr. Praveen Goyal, Dr. Vinod Kumar, Ms. Mobin Fatima, Mr. Amit Agrawal, and Mr. Arun Kaushik. I would also like to thank to my other colleague Mr. Devendra Singh, Dr. Gaurav Chaudhary, Dr. Sanjeev Arora, Dr. K. S. Reddy, Mr. Virendra Balon, Ms. Kumkum Bharti, and Mr. Rajesh Katiyar, and I value their friendship. I also thank Mr. Stephen Winchell and Mr. Dhruva for their cooperation during the proofreading of this thesis.

Those who have gone through the long and winding path of doctoral study would share my feelings. Our family and friends are the foundation of strength and energy. My parents Mr. Shiv Prasad and Mrs. Savitri Devi, my elder brothers Mr. Yogesh Dhiman and Mr. Nitesh Dhiman, my sister in laws Mrs. Anju Dhiman and Mrs. Ritu Dhiman, and my uncle Mr. Keshav Sharan have been my pillar of support with their unconditional love and understanding. I would also like to thanks some of the gems of my life Mr. Ajay Kumar, Mr. Rajkumar Srivas, Mr. Arun Goswami, Mr. Vivek Rajput, Mr. Sandeep Kumar, Mr. Shiv Kumar, and Mr. Amit Sharma for their continuous concern about my work and progress. I would like especially thank to Ms. Raushan, Faculty, Madan Mohan Malviya Engineering College, Gorakhpur for her unconditional support towards me. They all have kindly absorbed

all my stress from failure or discontentment. Without their presence and care, my life would not be the same and I would not be as happy and grateful as I am.

Finally, I bow down to God for guiding me to come through the most challenging work that I experienced in my life.

(DIVESH KUMAR)

Table of contents

List of figures

List of table

List of abbreviations

Abbreviations	Full Name
ACMA	Automotive component manufacturer association
AHP	Analytical hierarchy process
AMOS	Analysis of moment of structures
ANOVA	Analysis of variance
ANP	Analytical network process
AVE	Average variance extracted
B2B	Business-to-business
BSR	Buyer-supplier relationship
CFA	Confirmatory factor analysis
CR	Composite reliability
EFA	Exploratory factor analysis
FAHP	Fuzzy analytical hierarchy process
FMOLP	Fuzzy multi objective linear programming
GRI	Global reporting initiatives
HM	Hospitality management
IRM	Initial reachability metrix
ISM	Interpretive structural modelling
LP	Linear programming
IUCN	International union for conservation of nature
LCA	Life cycle analysis
MCDM	Multi criteria decision making
PLS	Partial least square
PR	Performance review
RM	Relationship marketing
RQ	Research question
R&D	Research and development
SD	Supplier development
SIAM	Society of Indian automobile manufacturers
SCM	Supply chain management
SSC	Sustainable supply chain
SS	Supplier selection
SSIM	Structural self-interaction matrix
SEM	Structural equation modeling
WCED	World commission on environment and development

Chapter 1
Introduction

Preview

This chapter gives a background of the present study. It starts with details of the problem statement, motivation for the research, research objectives, and research questions, followed by the extant methodology and overview of the present study. In the last, a brief outline of the ensuing chapter of the thesis is given.

1 Background of the present study

Sustainability has been discussed for hundreds of years. The development of sustainability came from various areas like economics, philosophy, science and writers from the eighteenth, nineteenth, and early twenty centuries (Lumley & Armstrong, 2004; Holland, 2003). The concept has roots in the ecology, conservation, biology and in many other fields like forestry (Fliho, 2000; Dixon & Fallon, 1989). In recent times, the most evident global efforts can be traced from the 1972 UN Conference on Human Environment, which assessed the importance of the environment management and emphasized it as a management tool. The World Conservation Strategy (1980) was another milestone in the path of sustainability, launched by the 'World Wildlife Fund for Nature and The United Nations Environment Program' (Trzyna, 1995). The World Commission on Environment and Development (WCED) defined sustainability as "*development meets the needs of present without compromising the ability of future generations to meet their own needs*" (1987, p.43). This definition remains the most influential for developing a global view towards sustainability (Mebratu, 1998, Seuring & Muller, 2008).

In the business context, The International Institute for Sustainable Development, Deloitte & Touche (IISD) and the World Business Council for Sustainable Development (WBCSD) define sustainability as "*adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future*" (as cited in Málovics et al., 2008, p. 908). The introduction of the concept of the triple bottom line has helped business firms to include sustainability in their corporate strategy. The triple bottom line has three

dimensions: environmental, social and economic. A proper balance is needed among these three dimensions.

A review of literature clearly shows the concept of sustainability in business is not only related to the company itself but covers the entire supply chain (Mahler, 2007). The role of the focal firm in spreading sustainability across its supply chain has been authenticated by many authors (Carters & Rogers, 2008, Seuring & Muller, 2008). Some definitions of Sustainable Supply Chain are as follows:

Carter and Roger, (2008) defined sustainable supply chain management as: "*The strategic achievement and integration of an organization's social, environmental, and economic goals through the systemic coordination of key inter-organizational business processes to improve the long-term economic performance of the individual company and its value network*".

Seuring and Muller (2008) defined a sustainable supply chain management as "*the management of material, information and capital flow as well as cooperation among companies along the supply chain while taking goals from three dimensions of sustainable development, i.e. economic, environmental and social, into account which is derived from customer and stakeholder requirements*".

Studies on sustainability increase by the year, yet they remain inconclusive when it comes to the implementation of sustainability practices (Touboulic & Walker, 2015; Pagell & Shevchenko, 2014; Seuring & Muller, 2008). Supply chain is a process that involves various stages of production and each stage affects sustainability of the final product (Bommel, 2010; Vachon & Klassen, 2006) due to the social and environmental burdens imposed in the initial stages of the supply chain (Darnall, 2008; Micheleson, 2007). Sustainability practices adoption across supply chains has become a matter of increasing concern over time, and come under the scanner of the media and many NGOs (Rao & Holt, 2005). Recently, Apple was under question due to some unsustainable practices followed by one of its suppliers in China (Garside, 2013). In this case, Apple is a 'focal firm' facing pressure from external agencies on sustainability issues. A focal firm is a firm that generally owns a brand, is involved in the designing of products and services, and rules the supply chain (Seuring & Muller, 2008). Focal companies across the globe are trying to promote the concept of sustainability into their supply chain. This stems from realizing the importance of sustainability and its possible benefits (Hsu et al., 2013). Companies are developing stronger partnerships with supply chain partners for implementing this concept (Walker et al., 2008; Cote et al., 2008).

1.1 Sustainable supply chain

Companies are adopting sustainability practices such as minimizing energy use, low emission, waste reduction, working condition of employees, improved operational performance and so on. A tradeoff among the triple bottom line dimensions across supply chain is becoming very important for the focal companies. There generally are two motivating factors behind adoption of sustainability practices by firms in the industrial environment (Hsu et al., 2013): first, the majority of firms adopt sustainability practices due to external pressure from multiple agencies such as NGOs, governments, customers and other stakeholders (Clemens & Douglus, 2006). Second, companies seek opportunities from sustainability practices adoption in order to gain marketing and competitive advantages, increase employee retention, and improved reputation (Walker et al., 2008; Cote et al., 2008). In both situations, the supplier firm faces certain economic, technological, and operation-specific barriers (Kudla & Klaas-Wissing, 2012). The role of the focal firm comes in picture for developing the capacity and capability of its supply chain partners. Thus, firms require effective strategies to overcome these barriers in order to make the supply chain more sustainable.

1.2 Buyer supplier relationship

Literature on sustainable supply chain and relationship marketing clearly shows that during the adoption of any new process/technology, buyer-supplier relationships play an important role (Tangpong et al., 2015). In marketing literature, it has been stated that the relationship among the buyer-supplier should be objective and specific based on the partners' investments and expected outcomes (Hadjikhani & LaPlaca, 2013; Kumar and Rahman, 2013). According to Simpson & Power, 2005: *"Supply relationships may provide a key way for businesses to influence the sustainability of* their products and services through better manufacturing".

Many studies argue that relationship marketing is not a good option every time (Dowling & Uncles, 1997). Choosing a relationship is important to remain profitable and competitive (Kumar et al., 2003). There is a need of being familiar with supply chain partners before moving ahead with a relationship (Ganesan, 1994). Reinartz & Kumar (2002) stated that relationship selection starts with identification of partner and their intention to pursue a relationship in terms of investment and performance. Researchers have made efforts to classify the different types of relationships in the supply chain. Channel literature first revealed that

relationships in a supply chain varied from arm's length to vertical integration (Golicic et al., 2003; Contractor & Lorange 1988; Webster 1992). A relationship can be classified on the basis of duration of the relationship and the investment required in developing and maintaining the relationship. The type of relationship depends upon the capability, capacity, and intention of the supplier to adopt sustainability (Gao et al., 2005; Murray et al., 2005).

1.3 Problem statement

There are many publications in the area of supply chain sustainability. As discussed in section 1.1, companies are ready to adopt sustainability to achieve long-term benefits like marketing advantage, competitive advantage and cost reduction. Besides, there are other benefits like reduced pressure from external agencies, legal fulfillment and lower environmental accidents (Hsu et al., 2013; Ageron et al., 2011; Young & Kielkiewicz-Young, 2001). However, the commitment of top management of all the supply chain partners has been a big issue. An increasing wave of incorporating sustainability in supply chain has resulted in a supplier selection based on sustainability standards and regular performance reviews (Brito et al., 2008; Ciliberti, 2008; Hutchins & Sutherland, 2008). In addition, the pressure of incorporating sustainable activities in supply chain has motivated companies to come together and develop problem specific relationships to improve the overall performance of the supply chain (Bommel, 2010; Vachon & Klassen, 2006).

According to Simpson & Power (2005) *"Supply relationships may provide a key way for business to influence the sustainability of their products and services through better manufacturing".* The buyer-supplier relationships for developing a sustainable supply chain have been discussed by many authors (Hsu et al., 2013; Seuring & Muller, 2008; Carters & Rogers, 2008). In a sustainable supply chain, the buyer-supplier relationship is vital for mutual sustainable development (Cheung & Rowlinson, 2011). Upstream and downstream collaborations with supply chain partners are directly related to the adoption of environmental sustainability practices (Vachon & Mao, 2008; Klassen & Vachon, 2003). In last decade, many authors have tried to relate supply chain relationships with the adoption of new technology and processes. The same has been tried in the case of sustainability adoption. Researchers have used social sustainability (Peters et al., 2011; Bommel, 2010; Olorunniwo & Li, 2010), environmental sustainability (Wu & Pagell, 2011; Nakano & Hirao, 2011; Buyukozkan &

Cifci, 2010; Zhu et al., 2008b; Smith, 2007) and economical sustainability (Carbone & Moatti, 2011) in their researches.

The focal firm should select partners based on sustainability standards and then decide the type of relationship (Kumar & Rahman, 2013; Lee, 2008). Although sustainability adoption is achievable by developing relationships with supply chain partners (Cali, 2008; Walton et al., 1998), literature on the buyer-supplier relationship focuses on determining the relationship magnitude with respect to specific suppliers and the tradeoff between the cost of the relationship and relationship performance. The magnitude of relationship depends on the capacity, capability and intention of the supplier to adopt and accept sustainability standards (Ageron et al., 2011; Vachon & Klassen, 2008; Hall, 2000).

There are very few studies addressing the sustainable supply chain in developing countries. Although sustainability is one of the most discussed concepts in business research, there is still inconclusiveness about its implementation across supply chain (Seuring & Muller, 2008). Therefore, there is a need for a more comprehensive research in the developing world environment. New findings and validating the existing results in the emerging economies can bring a clearer picture in the area of supply chain sustainability.

The main research problems studied in this thesis can be presented as:

- Investigate the various enablers of a sustainable supply chain by identifying the enablers and interrelationships among them (Chapter 3).
- Develop a supplier selection and order allocation model based on sustainability criteria (Chapter 4).
- Develop a relationship selection model based on the benefits, opportunities, cost and risk of a relationship with a supplier (Chapter 5).
- Develop a model based on hypotheses for a sustainable supply chain (Chapter 7).
- Measure the impact of the buyer-supplier relationship on the sustainability performance of the supply chain (Chapter 7).

This research proposal will be useful to mangers, practitioners, decision makers and academicians in the field of sustainable supply chains and industrial relationship marketing. The main reasons are:

It contributes to the body of literature. It fills existing gaps in the literature. It helps practitioners to deal with the problems of suppliers and relationship selection. It clarifies the

interrelationships among the various enablers of the sustainability supply chain and classifies them to give clearer picture. It also provides the mechanisms of a sustainable supply chain, which will help organizations to develop a sustainable supply chain using industrial relationship marketing strategies.

1.4 Motivation for the present research

Increased concerned towards environmental degradation and the social responsibility of business has put tremendous pressure on focal firms to extend sustainability practices across the supply chain. Most of the burden on society and the environment are due to the operations of suppliers. This issue motivates firms to strictly monitor the sustainability performance of the supplier. In this context, the buyer-supplier relationship is emerging as an important strategy to address the issue. Moreover, the buyer-supplier relationship has been found to positively affect the sustainability performance of the supply chain.

Based on the gaps identified from the literature review (Chapter 2) of which a part is reproduced here, it is very clear that there is enough scope of work for further study in this field.

- The number of papers on sustainable supply chain sustainability has been increased. There are more than fifty journals covering the research on this topic. Most of the papers are published in the Journal of Cleaner Production, Supply Chain Management: An International Journal, Journal of Operation and Production Management, European Journal of Operation Research, Journal of Physical Distribution and Logistics, Industrial Marketing Management, Journal of Business and Industrial Marketing, Journal of Strategic Marketing, and the Journal of Relationship Marketing.
- There are many literature reviews available on the supply chain sustainability. Seuring & Muller (2008) presented a literature review that conceptualizes a framework of a sustainable supply chain and a model to develop a sustainable supply chain. Carter & Roger (2008) also proposed a sustainable supply chain framework. The focus of the paper was on balancing economic, environmental, and social sustainability. Gimenez & Tachizawa (2012) presented recent study on sustainable supply chains. In this paper, the authors attempt to find the impact of a governance mechanism for developing a sustainable supply chain and to find the enablers of this governance mechanism. All these papers focused on validating the conceptual frameworks.

- Sustainable supply chain research is very new to Indian firms. Only one study by Kushwaha (2010) on sustainable development through green supply chain management is available. However, that research neglected the social sustainability of the supply chain in India.
- In the literature review, a clearer understanding of the interrelationships among and classification of the various enablers of the sustainable supply chain is needed. Well-established interpretive structural modeling (ISM) and Fuzzy MICMAC have been used to fill these gaps (Chapter 3).
- In the literature, no studies strictly focused on the supplier selection and order allocation in a sustainable supply chain. One study by Shaw et al. (2012) tried to develop the supplier selection and order allocation model for the low carbon emission supply chain. However, this paper has neglected social sustainability as well as some dimensions of environmental sustainability including waste minimization and minimizing energy use. Additional studies need to be done to address sustainability more comprehensively in the supplier selection and order allocation. A hybrid methodology comprising of Fuzzy AHP and Fuzzy multi-objective linear programming has been used to fill this gap (Chapter 4).
- There is only one study on the buyer-supplier relationship selection in the literature that considers benefits, opportunity, cost, and the risk of developing a relationship. This study by Lee (2009) lacks the incorporation of sustainability criteria in the relationship selection. A model has been developed using Fuzzy AHP as suggested by Lee (2009), considering sustainability criteria to select the best form of a relationship (Chapter 5).
- One of the most important gaps identified from the literature is none of the studies have empirically tested the model of the sustainable supply chain development mechanism. Hence, a model has been developed to fill this gap (Chapter 7).

1.5 Research objectives and research questions

The importance of the buyer-supplier relationship in the sustainability of the supply chain, selection of the best form of supplier-buyer relationship for a sustainable supply chain, supplier selection and allocation on sustainability standards and finding the interrelationships among the enablers of the sustainable supply chain has been identified as important issues to be discussed. From the various gaps identified from the literature, the topic of present study is

finalized as "Sustainability adoption through relationship marketing across the supply chain in Indian firms". The research is based on five objectives. These are as follows:

Objective 1: To analyze the issues related to sustainability adoption in a supply chain.

Objective 2: To develop a model stating the interrelationships and classifications among the enablers of a sustainable supply chain in the Indian automobile sector.

Objective 3: To develop a model for supplier selection and order allocation for developing a sustainable supply chain in the Indian automobile sector.

Objective 4: To develop the best form of a relationship selection model for developing a sustainable supply chain in the Indian automobile sector.

Objective 5: To develop a model to investigate the mechanism for developing a sustainable supply chain.

To achieve these objective following research questions were formulated.

RQ1: What are the factors and items under the following categories: Sustainable supply chain, enablers of supply chain and relationship management strategies? (Chapter 2)

RQ2: How many interrelationships and classifications are among the enablers of a sustainable supply chain? (Chapter 3)

RQ3: What are the benefits, cost, opportunities and risk of developing a relationship in a sustainable supply chain? (Chapter 2 & 5)

RQ4: What are the important criteria for supplier selection and order allocation model (Chapter 4)?

RQ5: How do the various constructs in the sustainable supply chain mechanism model affect each other? (Chapter 7)

H_1: Expected benefits of more sustainable supply chain are positively related to the top management's commitment to adopt sustainability.

H_2: External pressure and support is positively related to top management's commitment to adopt sustainability.

H_{3a}, H_{3b}, and H3c: Top management commitment is directly and positively related to the buyer-supplier relationship management strategies (supplier selection (H3), performance review (H4), and supplier development (H5)).

H_{4a}, H_{4b}, H_{4c}, H_{5a}, H_{5b}, H_{5c}, H_{6a}, H_{6b}, and H_{6c}: Buyer supplier relationship (supplier selection, performance review, and supplier development) is positively related to the sustainability (economical, social, and environmental) performance of the supply chain.

Objectives 1,2,3,4 and 5 are accomplished by the research questions 1, 2, 3, 4 and 5, respectively.

1.6 Methodologies adopted in the preresent research

In this study, most appropriate research techniques have been used for analyzing the problems under consideration.

1.6.1 Interpretative structural modeling ISM and Fuzzy MICMAC

Interpretive structural modeling (ISM) is used for identifying and summarizing relationships among specific variables. Fuzzy MICMAC is used for the classification of a variable under study based on driving and dependence. Fuzzy has been incorporated to get a better understanding of the relationships among the enablers. Several authors have used an ISM MICMAC methodology to address various challenges in supply chain sustainability (Chapter 3).

1.6.2 Fuzzy analytic hierarchy process (Fuzzy AHP) approach

Fuzzy AHP is a multi-criteria decision making (MCDM) approach to assess the priority level of the variables under consideration. Fuzzy set theory helps in dealing with the vagueness and fuzziness of uncertain environments. A selection of alternatives in fuzzy AHP is used by the fuzzy set theory in a conventional AHP. Fuzzy AHP has been used to prioritize the criteria of supplier selection and order allocation in Chapter 4 and is again used for prioritizing the best form of a buyer-supplier relationship in Chapter 5.

1.6.3 Fuzzy multi-objective linear programming

Fuzzy linear programming includes fuzzy goals and fuzzy constraints. It can be solved like a normal linear programming problem after fuzzification. A fuzzy solution is the intersection of all fuzzy sets representing either fuzzy objectives or fuzzy constraints. Fuzzy multi-objective programming has been used in Chapter 4 for order allocation among the suppliers.

1.6.4 Questionnaire based Survey

In the present study, a questionnaire based survey has been used to collect data. A structured questionnaire survey has been conducted to collect the information regarding the buyer-supplier relationship, sustainability performance of the supply chain and various enablers affecting the top management's commitment to adopt sustainability. This questionnaire is divided in four sections. (Chapter 6)

1.6.5 Exploratory factor analysis (EFA)

A well-defined scale development process has been used to measure the corporate sustainability performance of the Indian manufacturing sector. Principal Component Analysis (PCA) has been used to extract the factors to measure the first and second Eigen value of each construct to check the unidimensionality of the block (Chapter 7).

1.6.6 Confirmatory factor analysis (CFA)

A confirmatory factor analysis (CFA) has been applied for the purification and validation of the developed scale. CFA is a multivariate technique to estimate the relationship between observed and latent variables. In addition, it helps in determining the reliability and validity of the scale. In the present study, a CFA has been carried out by using Smart PLS 2.3 software (Chapter 7).

1.7 Overview of present research

The present study begins with an in-depth literature review on the sustainable supply chain and buyer-supplier relationships. The review was followed by an expert survey from the industry as well as academia. The understanding of literature depends upon the researchers understanding. Hence, a detailed discussion helped the researcher to develop a more comprehensive understanding of the literature. In addition to this, personal interviews and brain storming sessions were conducted.

First of all, an ISM based model has been constructed with the help of experts from the Indian automobile industry to assess the interrelationships among the enablers of a sustainable supply chain. The MICMAC was also used to classify the enablers based on their driving and dependence power. This would help managers to understand the relationship and importance of each enabler.

Next to the ISM model, Fuzzy AHP and Fuzzy Multi-objective linear programming models were used to develop a supplier selection and order allocation model. The priorities of selected sustainability criteria have been done by the experts from the Indian automobile industry. Using the weighted criteria, a linear programming model has been developed for supplier selection and order allocation. Fuzzy AHP was again used for the selection of the best form of the buyer-supplier relationship for a sustainable supply chain in the Indian automobile industry.

Next to these, a quantitative model was developed depicting the mechanisms of a sustainable supply chain. Various hypotheses have been checked by using a research instrument. To develop a research instrument, a well-defined scale development procedure has been adopted. The results of the study show the expected benefits of sustainability adoption positively affect the top management's commitment while external pressure also has a positive significant impact on the top management's commitment towards sustainability adoption. Top management commitment is positively related to buyer-supplier relationship management strategies. The buyer-supplier relationship is positively related to the sustainability performance of the supply chain.

1.8 Organization of the thesis

The organization of the present research work has been covered in eight chapters depicted in Figure 1.1. A brief idea of each chapter is as follows:

Chapter 1

This chapter provides an introduction of the present study and sustainable supply chain, buyer-supplier relationships and its impact on the sustainability performance of the supply chain. This chapter also provides brief overview of the thesis, organization of the thesis and conclusion of the chapter.

Chapter 2

This chapter deals with an extensive and in-depth literature review in the field of sustainable supply chain buyer-supplier relationships. This chapter covers the meaning of a sustainable supply chain and its indicators, triggers of the sustainable supply chain, buyer-supplier relationship strategies that include: supplier selection, supplier development and supplier performance review.

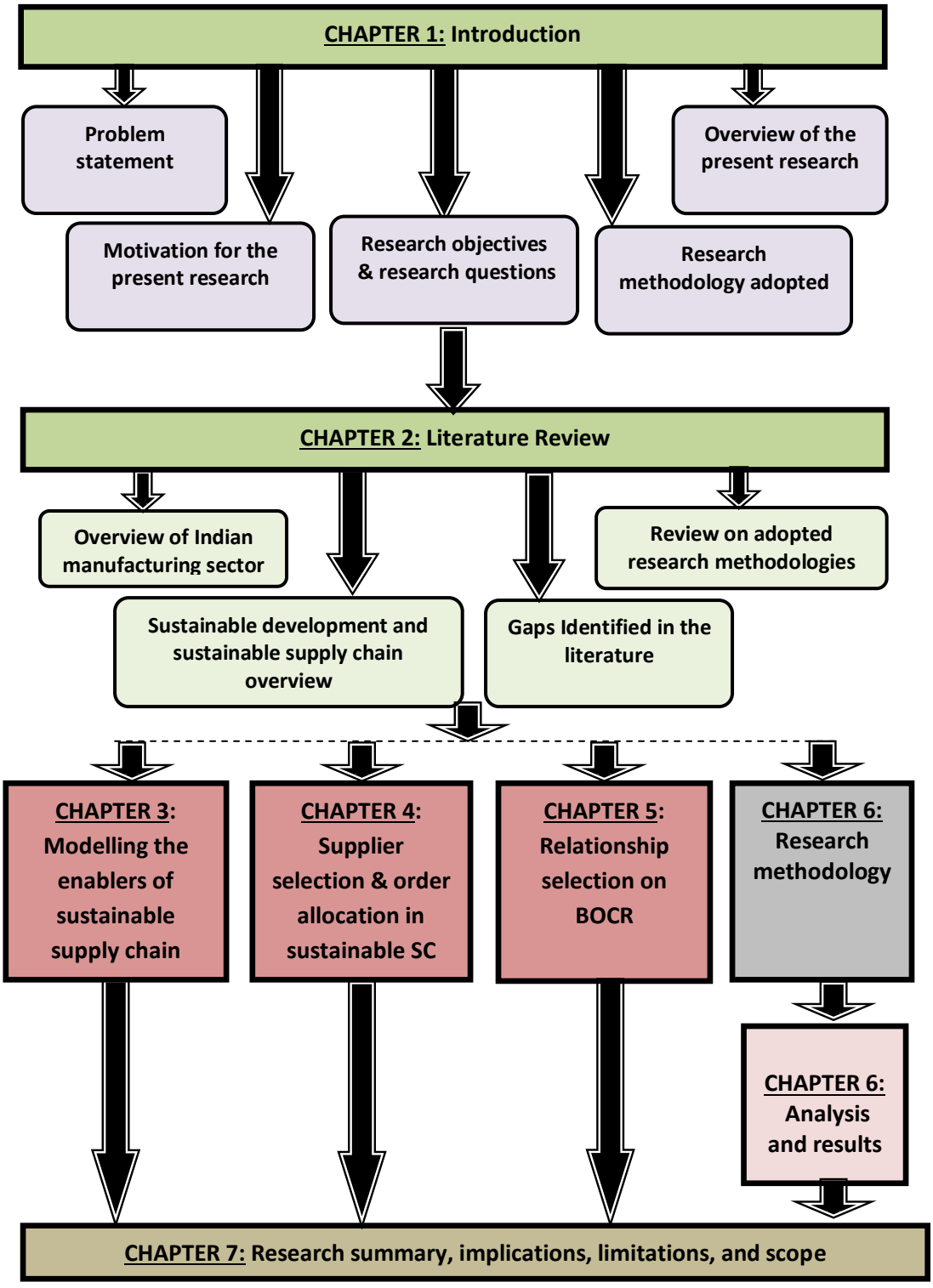

Figure 1.1 Organization of thesis

Chapter 3

This chapter provides details about the various enablers of a sustainable supply chain. It also introduces ISM and Fuzzy MICMAC methodologies. In this chapter, modeling and the classification of enablers has been done. An ISM-Fuzzy MICMAC model has been developed.

Chapter 4

This chapter presents the supplier selection and order allocation model. This chapter also provides information about Fuzzy AHP and its computational procedure. This chapter gives a brief explanation of the fuzzy set theory, linear programming and fuzzy linear programming. Two solution alternatives have been compared in this chapter.

Chapter 5

This chapter is about the buyer-supplier relationship selection. A fuzzy AHP based model has been developed to select the best form of buyer-supplier relationship considering the benefits, opportunities, costs and risk of a relationship in a sustainable supply chain.

Chapter 6

This chapter represents a conceptual framework proposed for sustainable supply chain mechanisms. The elements of this framework are also discussed. In the subsequent part of the chapter, a detailed discussion has been done for the scale development procedure and research methodologies used.

Chapter 7

This chapter presents the application part of statistical techniques mentioned in the last chapter to analyze the data. Hypothesis testing was conducted based on the results and a final conclusion of the chapter is presented. Smart PLS path modeling has been used to test the hypotheses.

Chapter 8

This chapter provides a comprehensive overview of the research study conducted and the major findings along with the contribution of the present study in the existing set of literature. In addition, this chapter also provides the managerial implications of the present

study. The last section of this chapter provides the limitation of the study followed by the future scope in this field study.

1.9 Conclusion

Currently, pressure from various external agencies including consumer groups, government, industry associations, NGO, media, etc., are putting pressure on the entire supply chain to become sustainable. Focal firm is very vulnerable to the unsustainable practices adopted by its suppliers. So in order to curb this pressure, focal firms are now looking for ways to extend sustainability practices across the supply chain. Literature has enough evidence that any new process and technology can be easily adopted by developing proper relationships across the supply chain.

The adoption of sustainability practices by supply chain partners is mainly due to two reasons: 1) external pressure and 2) expected benefits of sustainability adoption. In any case, supply chain partners always face certain barriers in their capacity and capability. Hence, focal firms should always look to develop a very specific relationship with a particular supplier by considering the supply chain partners' capability and capacity. Focal firms should always consider the benefits, opportunity, cost and risk of developing a relationship. For integrating sustainability practices in the supply process, buyer firms should always allocate orders among suppliers according to their sustainability performance. There are many studies on developing a sustainable supply chain, yet a lack of empirical validation of the mechanisms for developing sustainable in the supply chain.

Therefore, this study is an attempt to identify the mechanisms for developing a sustainable supply chain. In the present chapter, an outline of the study has been provided. Initially, after the brief introduction of sustainable supply chain and buyer supplier relationships, the statement of the problem has been provided. Research questions have been derived from the existing gaps of the literature to achieve the objectives of the present study. Next to this, the methodology adopted in the present research has been introduced. The last section discusses the complete organization of the thesis. All sections presented in this chapter have been discussed in detail in the subsequent chapters of the thesis.

Chapter 2
Literature review

Preview

This chapter presents a review of literature on the mechanism of developing sustainable supply chain. The present chapter touches on various issues like sustainable supply chain, buyer supplier relationships, triggers of sustainability adoption, enablers and barriers of sustainability adoption and impact of buyer supplier relationship on sustainability performance of supply chain. This review will also provide a strong foundation for conducting the present study and other areas that need to be explored.

2. Introduction

Although the number of studies on sustainability is on the rise, these studies fail to clearly explain how to implement sustainability practices (Pagell & Shevchenko, 2014; Brindley & Oxborrow, 2014; Seuring & Muller, 2008). Supply chain is a process that involves various stages of production and each stage affects sustainability of the final product (Oelze et al., 2014; Bommel, 2010; Vachon & Klassen, 2006) due to the social and environmental burdens imposed in the initial stages of the supply chain (Darnall, 2008; Micheleson, 2007). Sustainability practices adoption across supply chains has become a matter of increasing concern over time, and come under the scanner of the media and many NGOs (Rao & Holt, 2005). Recently, Apple was under question due to some unsustainable practices followed by one of its suppliers in China (Garside, 2013). In this case, Apple is a 'focal firm' facing pressure from external agencies on sustainability issues. A focal firm is a firm that generally owns a brand, is involved in the designing of products and services, and rules the supply chain (Seuring & Muller, 2008).

Focal firms need to develop a system to promote sustainability across the supply chain to avoid any negative associations that could potentially harm their reputation (Cote et al., 2008). Along with focal firms, supplier firms should also support sustainability practices adoption to avoid any circumstance that may result in loss of business. There generally are two motivating factors behind adoption of sustainability practices by firms in the industrial environment (Hsu et al., 2013): First, the majority of firms adopt sustainability practices due to

external pressure from multiple agencies such as NGOs, governments, customers and other stakeholders (Touboulic et al., 2014; Clemens & Douglus, 2006). Second, companies seek opportunities from sustainability practices adoption in order to gain marketing and competitive advantages, increase employee retention and improve reputation (Walker et al., 2008; Cote et al., 2008). In both situations, the supplier firm faces certain economic, technological and operation-specific barriers. Thus, firms require effective strategies to overcome these barriers in order to make the supply chain more sustainable.

The main problem with adopting sustainability practices is the lack of required capabilities for sustainability management (Kudla et al. 2012). However, this limitation can be overcome if the buyer and supplier firms share one another's capabilities and work in close proximity (Ronchi et al., 2007; Micheleson, 2007). Although a sustainable supply chain is achievable by developing relationships with supply chain partners (Cali, 2008; Walton et al., 1998), literature on buyer-supplier relationship focuses on determining the magnitude of this relationship with respect to specific suppliers, and the tradeoff between cost of relationship and relationship performance (Mtachizawa & Yew Wong, 2014). The magnitude of a relationship depends upon the capacity, capability and intention of the supplier to adopt and accept sustainability standards (Ageron et al., 2011; Vachon & Klassen, 2008; Hall, 2000).

Due to a lack of consensus among existing studies on how to develop a sustainable supply chain, there is a need to determine generally acceptable sustainability practices adoption mechanisms and related activities. Seuring & Muller (2008) presented a review of 191 papers that conceptualized the framework of, and a model to develop a sustainable supply chain. Carter & Roger (2008) also proposed a sustainable supply chain framework focused on balancing economic, environmental and social sustainability. Gimenez & Tachizawa (2012) reviewed 41 research papers on sustainable supply chains and emphasized the importance of a governance mechanism in developing a sustainable supply chain while also identifying the enablers of this governance mechanism.

This study contributes to existing literature on sustainable supply chains by providing a systematic review of literature on sustainability practices adoption through buyer-supplier relationship management across supply chains. The chapter benefits both practitioners and academics; researchers will benefit from the comprehensive information on sustainable supply chain and professionals of supplier and buyer firms will gain a deeper understanding of the

processes, indicators, barriers and enablers of adoption of sustainable practices in the supply chain.

In addition to available reviews on sustainable supply chains, this chapter aims to provide a systematic literature review on sustainability adoption through the buyer-supplier relationship management across the supply chain. More specifically, this chapter examines specific questions: What are the indicators of sustainability in supply chain? What are the barriers to sustainability adoption? What are the enablers of sustainability adoption? Which types of relationship management strategies are discussed in the literature? What is the mechanism of sustainability adoption in the supply chain?

2.1 Research methodology for literature review

Fink (2008) stated, "A literature review is a systematic, explicit, and reproducible design for identifying, evaluating, and interpreting the existing body of recorded document". The following objectives are achieved after the literature review:

1) Relevant patterns, themes and issues are identified and summarized
2) A conceptual framework and corresponding theory for supply chain sustainability are developed.

Due to the voluminous amount of literature on sustainability, it is not viable and practical to search every paper. To maximize the output from the literature review, only newly emerging issues narrowly defined should be considered (Seuring & Muller, 2008). Both qualitative and quantitative aspects should be used to understand the content of the literature.

2.1.1 Literature search and selection

For the purpose of this study, papers published in peer-reviewed journals of management were targeted. The literature review covered papers published over 20 years, from 1994 to 2013. 1994 has been taken as base year because no significant study on sustainability of supply chain was found before that year. Nearly all research papers on sustainable supply chain, green supply chain, reverse logistics, eco-friendly supply chain, eco-efficient supply chain, social standards and green logistics were identified (Tuteberk & Wittstruck, 2010).

Multiple databases such as ABI Inform, Elsevier Science Direct, JSTOR, Emerald, Taylor and Francis, EBSCO (Business source complete), John Willey, and Springer were used to select literature.

Papers were selected based on the following two criteria:

1. The paper must have included an aspect of sustainability (environmental, social and economic) and its implementation in a supply chain.
2. The paper must have discussed relationship management with supply chain partners.

Papers fulfilling these criteria were selected from databases. The initial search was conducted using the following key words: sustainability, environmental supply chain, sustainable supply chain, reverse logistics, green supply chain, social supply chain, and relationship management. Key words related to sustainability and relationship management were used in different combinations (e.g. environmental supply chain–buyer supplier relationship, reverse logistics–relationship management, social supply chain–buyer supplier integration). This search yielded 1,408 papers. After removing duplicates, the number of papers was reduced to 597. A careful reading of abstracts led to further elimination of 350 papers leaving the authors with 247 papers. These papers were then given complete reading and 102 papers were finally selected (Appendix 7).

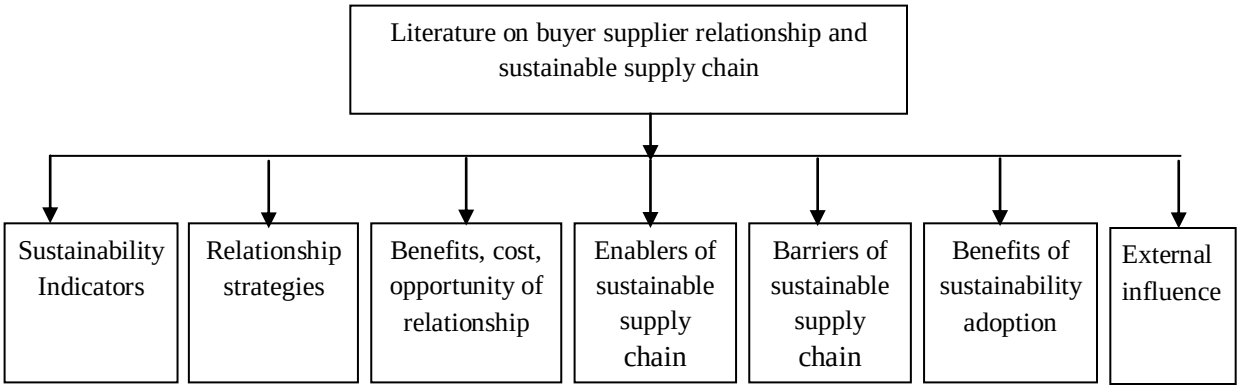

Figure 2.1 Information retrieved from literature review

As discussed in the introduction section of this Chapter, the literature review retrieved information about indicators of a sustainable supply chain, enablers, and barriers of sustainability adoption, relationship marketing strategies, benefits, cost, opportunity, and risk of buyer supplier relationship, benefits of sustainability adoption, and various external agencies that influence the supply chain to adopt sustainability (Figure 2.1).

2.2 Indian automobile industry: an overview

Increased demand, the availability of a skilled workforce and an increase in the number of peoples with a higher purchasing capability will make India one of the top five automobile producers in the world by 2015 (IBEF, 2013). India is becoming a center for producing all types of automobile products including trucks, buses, and passenger vehicles. The Indian automobile industry is witnessing a growth in domestic and international markets. In March 2012, India witnessed a cumulative growth of 17.81 percent as compared to March 2011 for automobile production (SIAM, 2013). Many multinational companies are now coming to India to establish their manufacturing units and developing their units as global production centers (IBEF, 2013). These companies include Ford, Nissan, Isuzu motors, and Daimler India to name a few.

The automobile industry contributes 7 percent to the GDP and provides employment to 19 Million people directly or indirectly (SIAM, 2013). It also contributes 22 percent to the manufacturing sector of the GDP (Business Today, 2013). The automotive industry also attracts 4 percent of the total foreign direct investment in India. Between March 2011 and March 2012, the total FDI in the Indian automobile sector accounted for $923 million (InvestIndia, 2013). The total number of units produced by the Indian automobile industry in the 4/6 and 2/3 wheeler segment is shown in Figures 2.2 and 2.3.

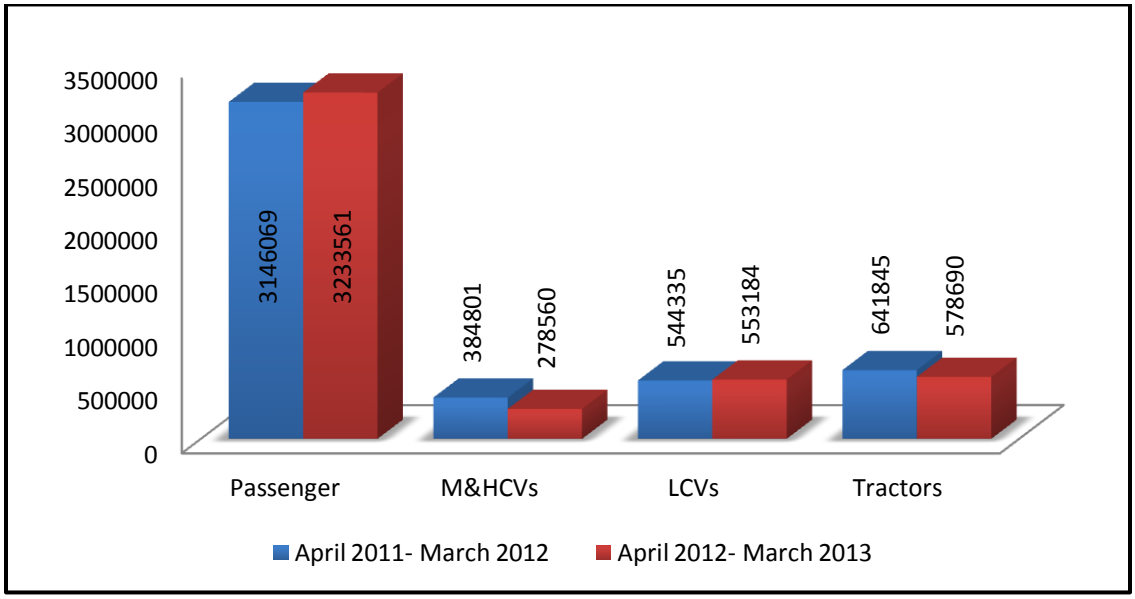

Figure 2.2 Production of 4/6 wheelers (*Source: ACMA Annual report, 2013*)

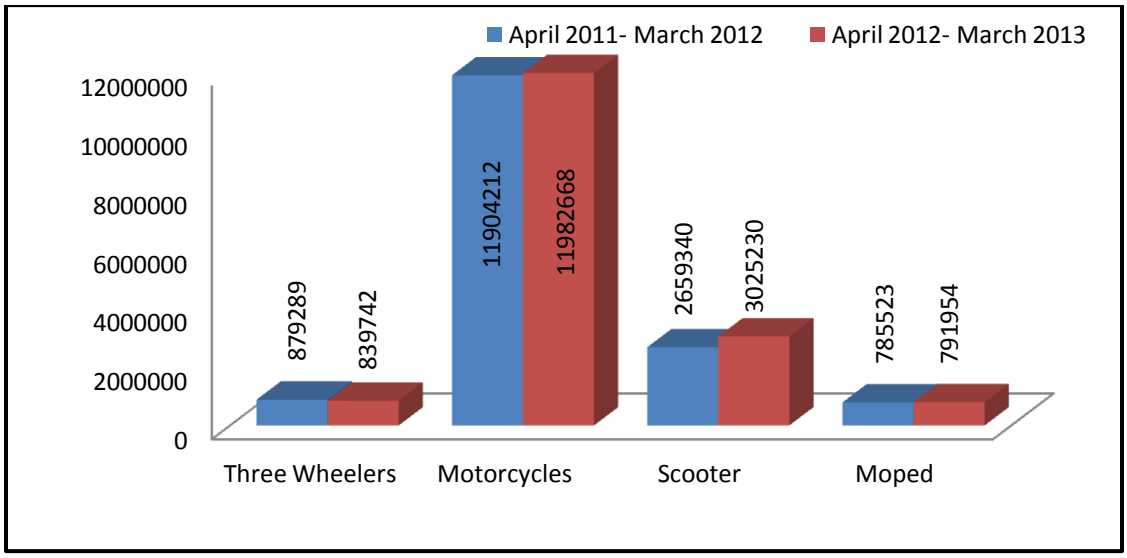

Figure 2.3 Production of 2/3 wheelers (*Source: ACMA Annual report, 2013*)

With the entry of foreign players in the Indian market and an increased reach of Indian companies into foreign markets has helped raise production standards in the automobile sector. Indian firms or foreign firms that have a manufacturing base in India are now dependent on domestic as well as foreign suppliers. The growth story of finished units' exported from India is also positive (Figure 2.4). Hence, Indian automobile manufacturers need to meet international standards and should develop a more sustainable supply chain.

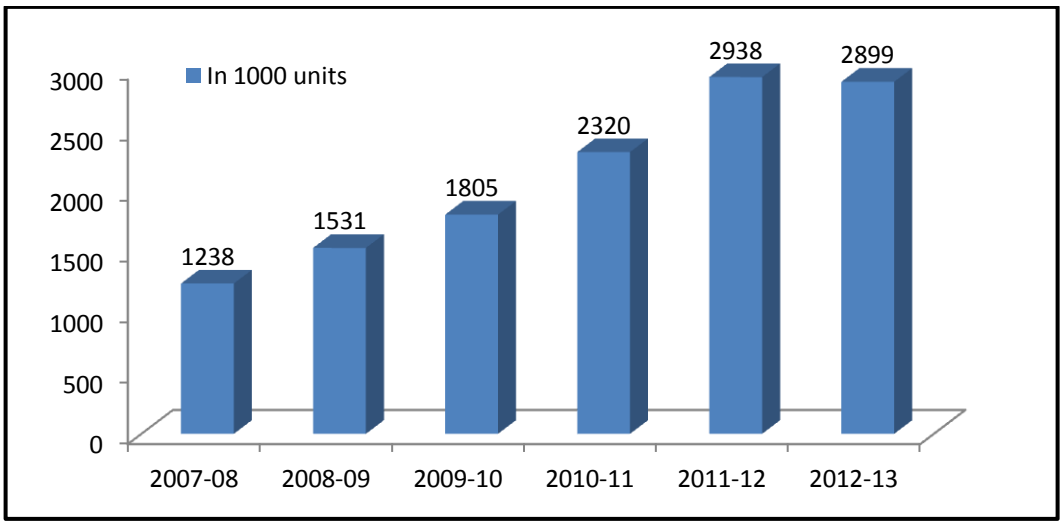

Figure 2.4 Export from Indian automobile industry (*Source: ACMA Annual report, 2013*)

In addition, the Indian automobile industry also exports and imports automotive components. Figure 2.5 gives details of the export and import of auto components by the Indian automobile industry.

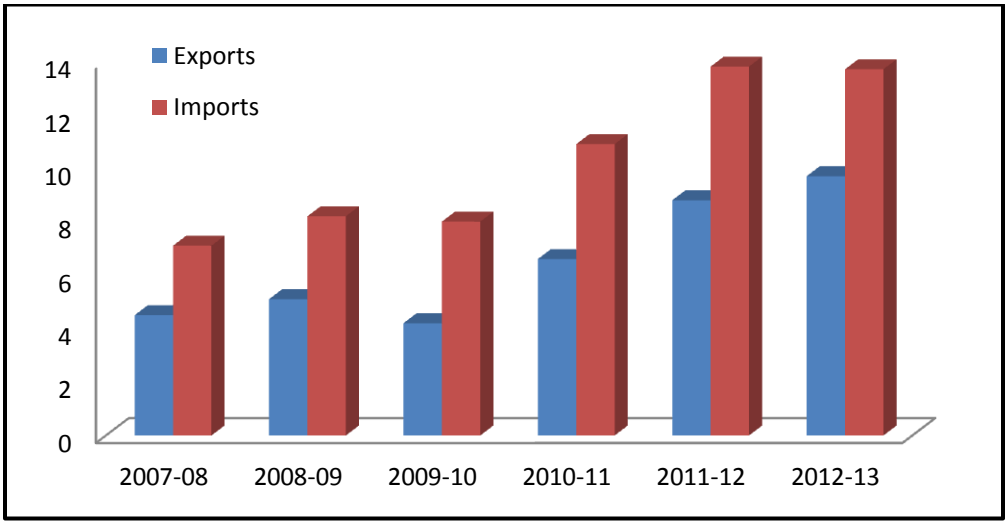

Figure 2.5 Exports-imports of components (*Source: ACMA Annual report, 2013*)

In the Union budget (2012), the Indian government introduced policies to integrate three-dimensional sustainability for the manufacturing sector including the automotive sector (Business Today, 2012). The Indian government's 2013 financial budget announced incentives to promote hybrid and more environment friendly automobile products (Goenka, 2012). Hence, it would be interesting to know how the Indian automobile industry, which is becoming an internationally dominating industry, would incorporate the sustainability and environmental standards in to their practices.

2.3 Sustainability

Sustainability is now the hot topic of discussion in most of the global meetings. Policymakers from industrialized and less developed countries are coming together to deal with it. A great deal of research has been done in the area of sustainability, but still there is no consensus about the ways to deal with 'sustainability' in business practices (Kidd, 1992). A proper balance between meeting current demands and future needs has to be determined. In order to do this, we have to look at the evolution of sustainability.

2.3.1 Evolution of the concept

The meaning of sustainability in the English dictionary is 'act of keep going', ability to sustain and 'system that maintain its own viability' (Oxford dictionary, 2013). Some see it is as an ancient practice mentioned by various religions (Mebratu, 1998). Some authors suggest that the concept of sustainability emerged from the forestry sector. Initially, it was usually used in the same sector regarding the use of forest resources (Filho, 2000). Mebratu (1998) discussed the concept of sustainability from traces of history and tried to describe it as a continuous change. The evolution of the sustainability concept has been divided into three time periods in this section.

2.3.1.1 Sustainability and various theories (Till 1972)

The development of sustainability came from various areas like economics, philosophy, science, and writers from the eighteenth, nineteenth, and early twenty centuries (Lumley & Armstrong, 2004; Holland, 2003; Pepper, 1996). The problem of sustainability started with the evolution and growth of humans. Human adaptation was related to fast migration or 'owning land and domestic animals' for cultivation to feed an increasing population (Meadows, 1992). The idea of capital generated from this change. Human beings started treating things around them like domestic animals, land, labor and machines as resources (Mebratu, 1998). With time and growth, the use of these machines and heavy metals in the production process generated many pollutants and became a major contributor to environmental damage. These things were also related to poor social conditions and status of labor. History itself has witnessed many revolutions headed by labor leaders. These revolutions were in some way related to increasing or preserving sustainability in society. The cruel impact of industrialization on the society and the environment forced policy makers to think about it. In addition, religions also have interpretations regarding the relationship between human and nature. Different religions have interpreted the relationship with nature in different ways, which are focused on the harmony of man with nature and society.

There are many theories that fully or nearly reflect the evolution of today's 'sustainability' concept. Mebratu (1998) quoted some of the old theories, like 'Economics and the theory of limits' and 'Political economy and the scale of organization'. Redclift (1987) linked the evolution of social science research and the awareness of the environment in communities. Some authors believe the concept of sustainability started professionally with the

concept of appropriate technology, by focusing and monitoring skill, population growth and natural resources with respect to the social needs (Farrar & Milton, 1972). The concept has roots in ecology, conservation, biology and in many other fields (Dixon & Fallon, 1989). Fliho (2000) mentioned that sustainability initially started with the forestry sector. The word sustainability was first used in the forestry sector for the optimum use of forest resources. Hence it can be concluded that various field of study came together for the foundation of the concept. Until this time, sustainability focused more on keeping a balance between the impact of human activities and 'society and nature'.

2.3.1.2 Sustainability and global efforts (1972-1992)

This time period witnessed many milestones in the development of the concept of sustainability. The 'UN Conference on Human Environment in 1972' assessed the importance of environment management and emphasized it as a management tool. The World Conservation Strategy (1980) was another milestone in the path of sustainability launched by the 'World Wildlife Fund for Nature and The United Nations Environment Program' (IUCN) (Tryzna, 1995). This concept brought environment and development together and helped develop the idea of sustainability. The idea of sustainability and environment were brought together in the yearbook of the IUCN in 1972. The World Commission on Environment and Development (WCED) (1987) published a report title 'Our Common Future' that focused on sustainable development. It has been proposed that all activities, whether it is social, political, or economical, should be done keeping the environment at the center of attention. The WCED (1987) defined sustainability as "development meets the needs of present without compromising the ability of future generations to meet their own needs". Though this definition has been criticized by different authors (Mitlin, 1992), it is still the most influential definition for developing a global view of sustainability (Mebratu, 1998).

After the WCED report, the UN started an earth summit in 1989 (Holmberg, 1994). The UN conference on Environment and Development (1992) also known as the earth summit at Rio de Janerio, helped spread the concept of sustainability across the world. During this time, most of the studies focused only on the environment, although some researchers came up with social aspects of the sustainability (Lele, 1989). In the 1990s, sustainability became the concept of consuming only to meet current demand and securing environmental resources for the future society.

2.3.1.3 Searching the meaning of sustainability (Since 1992)

Academic research on sustainability has increased since the early 1990s. Several initial works belong to Kidd (1992) who related sustainability with various theories like slow growth, the theory of ecological carrying, the resource environment root, the biosphere root, the critique of technology root and eco-development. Sustainability has been used in research with many different perspectives. After 1992, many researchers described sustainability as creating a balance between society, environment, and economy. It can be summed up as "Be socially and environmentally friendly at a lower cost". Previously, sustainability had a zero impact on nature and society. Now that human activities have imbalanced society and nature, a comparison has been drawn. . One more critical objection that came in during this time is that development cannot be sustainable. People have to decide between sustainability (no development) and development (un-sustainability) (Tijmes & Luijf 1995). On the other side, anthropocentrism advocated for policies and development directed towards human values and welfare (Norton 2005). According to the 'Ecological modernization' (techno centric) theory, sustainability problems can be handled by managers and technical approaches and there is no need to stop the current level or pace of development (Baker, 2007). Hence, sustainability is concerned with activities synchronized with nature, but the approach towards sustainability remains inconclusive and confusing.

In the early 1990s, sustainability focused on development and researchers considered it a government responsibility (Fliho, 2000). Later, many researchers worked on industrial sustainability strategies. A further shift has been observed from a company perspective to a supply chain perspective. Many sustainability strategies like the life cycle analysis, cradle to grave, lean and green supply chain, lead to the concept that sustainability cannot be achieved in an industrial environment until it is adopted across the supply chain (Mahler, 2007). Most of the studies have been accomplished to improve sustainability performance in a particular time period. There is always some negative outcome from every human and business activity, and this time period focused on lowering these impacts (Shaw et al., 2012). This time period also witnessed a shift from company specific sustainability activities to supply chain specific activities (Carters & Rogers, 2008; Mahler, 2007). Concepts like the life cycle analysis, cradle to grave and lean supply were introduced to check product sustainability at each step. Various units have been identified to measure the sustainability performance and one of the most popular is the carbon footprint.

2.3.2 Dimensions of sustainability

As the meaning of sustainability and sustainable development is still inconclusive, the dimension of sustainability since its definition remains disputed (Seghezzo, 2009). The most popular and used dimensions of sustainability were reported by Elkington in 1994. Sustainability has been divided into three parts, which are environmental sustainability, social sustainability, and economical sustainability.

These dimensions are the most widely used and accepted for sustainability research and implementation (Goyal, et al., 2013). Many companies have developed sustainability indicators to check their performance based on these three pillars of sustainability (Azapagic & Perdan, 2000). The Global Reporting Initiative (GRI, 2002a) is also based on these three pillars, which are used by thousands of companies across the globe. Beside this Valentin & Spangenberg, (2000) gave other perspectives on sustainability like environmental, economical, social and institutional. They separated human behaviors and rules from the social dimensions. Zhen et al. (2005) merged both dimensions, social and institutional, and represented it as one. Because of the availability of numerous sustainability indicators, the indicators may vary according to the industry type (Krajnc & Glavič, 2005; Azapagic, 2004). Still, there is a problem of integrating various indicators and setting benchmark results for the industries (Krajnc & Glavič, 2005). The quantification of sustainability indicators is very popular and several authors came up with a mathematical model to calculate sustainability performance. Seghezzo (2009) emphasized the need of humanity other than physiological traits and tried to justify the addition of psychological needs into sustainability. Even so, the three pillars of sustainability remains the most widely used dimension of sustainability (Carters & Rogers, 2008). Most of the papers found in the literature were based on the economic, social, and environmental dimensions of sustainability. Other dimensions are not discussed very much by the researcher (Goyal, et al., 2013).

2.4 Sustainable supply chain

With the development of sustainability as a concept, it has been accepted that a sustainable supply chain can only deliver a sustainable product (Mahler, 2008). Hence, the majority of research on sustainability in the business context is oriented towards the supply chain (Carter & Roger, 2008).

Carter & Roger, (2008) defined Sustainable Supply Chain Management as "*The strategic achievement and integration of an organization's social, environmental, and economic goals through the systemic coordination of key inter-organizational business processes to improve the long-term economic performance of the individual company and its value network*".

Seuring & Muller (2008) gave the definition of Sustainable Supply Chain "*the management of material, information and capital flow as well as cooperation among companies along the supply chain while taking goals from three dimensions of sustainable development, i.e. economic, environmental, and social, into account which is derived from customer and stakeholder requirements*".

These definitions have triggered research on the supply chain with three dimensions of sustainability. These definitions also emphasized on the importance of cooperation among supply chain partners. The various indicators of a sustainable supply chain have been divided into three categories as proposed by Elkington (1994). Those categories are environmental supply chains, social supply chains and economical supply chains.

2.4.1 Environmental supply chain

An environmental supply chain primarily encompasses activities that affect the environment (Simpson & Power, 2005). Literature has discussed dimensions and activities related to environmental sustainability of the supply chain (Table 2.1) and companies adopt these activities to increase the sustainability of the supply chain.

Table 2.1 shows that all the indicators of the environmental supply chain are related to reducing the amount of material used in the production process, handling the emission and waste, minimizing energy use, looking for the substitute input material, designing products according to the environment suitability, reverse logistics and disposal of product and improvement in the packaging. The use of cleaner technology, renewable energy source, and green purchasing are also mentioned in the literature.

Table 2.1 Indicators of environmental supply chain

Dimension	Reference
Packaging improvements	Ageron et al., 2011; Luthra et al., 2011; Bai & Sarkis, 2010; Ni et al., 2010; Muller et al., 2009; Cai et al., 2008; Ciliberti, 2008; Vachon, 2007; Zhu et al., 2007a; Tsoulfas & Pappis, 2006; Handfield et al., 2005; Rao & Holt, 2005; Preuss, 2005; Hall, 2000
Energy efficiency	Kushwaha, 2011; Luthra et al., 2011; Nakano & Hirao, 2011; Smerecnik & Anderson, 2011; Bai & Sarkis, 2010; Closs et al., 2010; Zhu & Sarkis, 2010; Wu & Pagell, 2011; Muller et al., 2009; Ciliberti, 2008; Cote et al., 2008; Vachon & Mao, 2008; Zhu et al., 2008b; Smith, 2007; Zhu et al., 2007b; Matos & Hall, 2007; Vermeulen & Ras, 2006; Zhu & Sarkis, 2004; Carter & Jenning, 2002; Young & Kielkiewicz-Young, 2001
Emission minimization	Hsu et al., 2013; Kudla & Klaas-Wissing, 2012; Ageron et al., 2011; Carbone & Moatti, 2011; Smerecnik & Anderson, 2011; Wu & Pagell, 2011; Bai & Sarkis, 2010; Ni et al., 2010; Zhu & Sarkis, 2010; Muller et al., 2009; Brito et al., 2008; Cai et al., 2008; Carter & Rogers 2008; Ciliberti, 2008; Beske et al., 2008; Vachon & Klassen, 2008; Zhu et al., 2007a; Vachon, 2007; Tsoulfas & Pappis, 2006; Vachon & Klassen, 2006; Klassen & Vachon, 2003; Carter & Jenning, 2002; Rao, 2002; Zsidisin & Hendrick, 1998; Florida, 1996
Waste minimization	Hsu et al., 2013; Ashby et al., 2012; Gopalakrishnan et al. 2012; Ageron et al., 2011; Wu & Pagell, 2011; Smerecnik & Anderson, 2011; Bai & Sarkis, 2010; Buyukozkan & Cifci, 2010; Ni et al., 2010; Zhu & Sarkis, 2010; Fortes, 2009; Muller et al., 2009; ; Beske et al., 2008; Bitzer et al., 2008; Cai et al., 2008; Carter & Rogers 2008; Cote et al., 2008; Ciliberti, 2008; Salam, 2008; Vachon & Mao, 2008; Walker et al., 2008; Zhu et al., 2008a; Matos & Hall, 2007; Markley & Davis, 2007; Zhu et al., 2007a; Preuss, 2005; Rao & Holt, 2005; Carter & Jenning, 2002; Rao, 2002; Bowen et al., 2001; Young & Kielkiewicz-Young, 2001; Green et al., 1998; Zsidisin & Hendrick, 1998; Florida, 1996
Reverse logistics	Hsu et al., 2013; Ageron et al., 2011; Daugherty, 2011; Diabata & Govindan, 2011; Eltayeb et al., 2011; Wu & Pagell, 2011; Bai & Sarkis, 2010; Teuteberg & Wittstruck, 2010; Ni et al., 2010; Olorunniwo & Li, 2010; Fortes, 2009; Svensson, 2009; Holt & Ghobadian, 2009; Muller et al., 2009; Routroy, 2009; Bitzer et al., 2008; Ciliberti, 2008; Vachon & Klassen, 2008; Zhu et al., 2008a; Svensson, 2007; Zhu et al., 2007b; Linton et al., 2007; Lin, 2007; Vachon, 2007; Zhu et al., 2007a; Vachon & Klassen, 2006; Handfield et al., 2005; Preuss, 2005; Rao & Holt, 2005; Carter & Jenning, 2002; Ytterhus, 1999; Zsidisin & Hendrick, 1998; Florida, 1996
Green purchasing	Hsu et al., 2013; Gopalakrishnan et al. 2012; Diabata & Govindan, 2011; Eltayeb et al., 2011; Luthra et al., 2011; Peters et al., 2011; Bai & Sarkis, 2010; Ni et al., 2010; Routroy, 2009; Zhu et al., 2008a; Bitzer et al., 2008; Ciliberti, 2008; Zhu et al., 2007a; Carter & Jenning, 2002; Green et al., 1998

Reducing input material	Smerecnik & Anderson, 2011; Bai & Sarkis, 2010; Ni et al., 2010; Closs et al., 2010; Muller et al., 2009; Salam, 2008; Cai et al., 2008; Bitzer et al., 2008; Ciliberti, 2008; Beske et al., 2008; Vachon & Mao, 2008; Smith, 2007; Zhu et al., 2007a; Vermeulen & Ras, 2006; Carter & Jenning, 2002; Bowen et al., 2001
Green designing	Hsu et al., 2013; Carbone & Moatti, 2011; Eltayeb et al., 2011; Bai & Sarkis, 2010; Holt & Ghobadian, 2009; Hong et al., 2009; Routroy, 2009; Cai et al., 2008; Zhu et al., 2008b; Zhu et al., 2008a; Zhu et al., 2007a; Linton et al., 2007; Markley & Davis, 2007; Carter & Jenning, 2002; Sarkis, 1995
Eco labeling	Vachon, 2007; Vachon & Klassen, 2006; Hamprecht et al., 2005
Renewable energy	Carbone & Moatti, 2011; Bai & Sarkis, 2010; Smith, 2007; Zhu et al., 2007a
Cleaner technology	Bai & Sarkis, 2010; Vachon & Mao, 2008; Zhu et al., 2007b; Vermeulen & Ras, 2006; Rao & Holt, 2005; Zhu & Sarkis, 2004

2.4.2 Socially sustainable supply chain

Researchers use social sustainability indicators to define and analyze social sustainability. Cramer (2007) came up with a step-wise model for organizing corporate social responsibility indicators in product chains. Kortelaine (2008) presented a case study of companies in China to explain social sustainability of the supply chain. Ni et al. (2010) presented a mathematical model for social sustainability of two echelon supply chain. Ciliberti et al. (2008) surveyed Italian companies to determine social standards adoption and found that social sustainability practices followed should be reported along with financial reports of companies to promote sustainability in logistics.

Table 2.2 Indicators of social supply chain

Dimension	Reference	Employee	Community
Working conditions	Marshall et al., 2014; Kudla & Klaas-Wissing, 2012; Closs et al., 2010; Pullman et al., 2010; Muller et al., 2009; Bitzer et al., 2008; Brito et al., 2008; Ciliberti, 2008; Beske et al., 2008; Smith, 2007; Rocha et al., 2007; Markley & Davis, 2007; Blowfield, 2005; Carter & Jenning, 2002; Elkington, 1994	✓	-
Rights to employees	Eltayeb et al., 2011; Ni et al., 2010; Bommel, 2010; Kortelainen, 2008; Carter & Rogers 2008; Ciliberti, 2008; Markley & Davis, 2007; Rocha et al., 2007; Blowfield, 2005; Carter & Jenning, 2002	✓	-
Fair trade and transparency	Peters et al., 2011; Bommel, 2010; Ni et al., 2010; Olorunniwo & Li, 2010; Muller et al., 2009; Rocha et al., 2007	✓	✓

Education of employees	Ni et al., 2010; Closs et al., 2010; Hutchins & Sutherland, 2008; Matos & Hall, 2007; Rocha et al., 2007;	✓	
Career development	Carbone & Moatti, 2011; Closs et al., 2010; Pullman et al., 2010; Ni et al., 2010; Matos & Hall, 2007, Rocha et al., 2007, Markley & Davis, 2007; Ansett, 2007; Zutshi & Sohal, 2004	✓	✓
Work and life balance	Ni et al., 2010; Kortelainen, 2008; Markley & Davis, 2007; Ansett, 2007; Blowfield, 2005; Zutshi & Sohal, 2004	✓	✓
Social welfare	Smith, 2007; Eltayeb et al., 2011; Rocha et al., 2007; Closs et al., 2010; Markley & Davis, 2007; Young & Kielkiewicz-Young, 2001; Kortelainen, 2008	-	✓
Fair wages	Ashby et al., 2012; Ni et al., 2010; Ciliberti, 2008; Koplin et al., 2007; Rocha et al., 2007; Carter & Jenning, 2002	✓	-
Safety	Ni et al., 2010; Pullman et al., 2010; Muller et al., 2009; Ciliberti, 2008; Markley & Davis, 2007; Carter & Jenning, 2002	✓	✓
Health	Eltayeb et al., 2011; Closs et al.; 2010; Ni et al., 2010; Pullman et al., 2010; Closs et al., 2010; Muller et al., 2009; Beske et al., 2008; Ciliberti, 2008; Hutchins & Sutherland, 2008; Markley & Davis, 2007; Matos & Hall, 2007; Rocha et al., 2007; Blowfield, 2005; Carter & Jenning, 2002;	✓	✓
Women specific issues	Ni et al., 2010; Matos & Hall, 2007, Rocha et al., 2007; Blowfield, 2005; Carter & Jenning, 2002	✓	-
Local Purchase	Peters et al., 2011; Kushwaha, 2011; Rocha et al., 2007; Pullman et al., 2010	-	✓
Poverty Reduction	Ni et al, 2010; Kortelainen, 2008; Bitzer et al., 2008;	-	✓
Supply from less developed part of society	Ciliberti, 2008; Markley & Davis, 2007	-	✓
Community connection and support	Closs et al., 2010; Pullman et al., 2010; Brito et al., 2008; Markley & Davis, 2007; Vasileiou & Morris, 2006	-	✓
Local hiring	Pullman et al., 2010	-	✓
Ethical codes	Buyukozkan & Cifci, 2010; Keatinga et al., 2008; Ellis & Higgins, 2006; Vasileiou & Morris, 2006	✓	✓
Population	Ni et al., 2010; Hutchins & Sutherland, 2008	-	✓

Equity of employee and community	Closs et al., 2010; Ni et al., 2010; Hutchins & Sutherland, 2008; Koplin et al., 2007; Matos & Hall, 2007; Markley & Davis, 2007; Rocha et al., 2007; Blowfield, 2005; Carter & Jenning, 2002;	✓	✓

Table 2.2 highlights socially responsible supply chain indicators. The list includes the working condition, career growth opportunity, women and minorities specific issues, role of supply chain in removing poverty and so on. These indicators are related to society inside and outside the supply chain.

2.4.3 Economic supply chain

An economic supply chain is one that enables a firm to timely deliver a product of the best possible quality at least possible cost. Indicators such as optimum asset utilization, reduction in resource use, cost reduction, late delivery and minimum quality-based rejection are part of economic supply chain (Table 2.3).

Table 2.3 Indicators of economic supply chain

Dimension	Reference
Asset utilization	Gopalakrishnan et al. 2012; Carbone & Moatti, 2011; Buyukozkan & Cifci, 2010
Reduction in resource use	Gopalakrishnan et al. 2012; Markley & Davis, 2007; Tsoulfas & Pappis, 2006
Cost reduction	Gopalakrishnan et al. 2012; Holt & Ghobadian, 2009; Walker et al., 2008; Handfield et al., 2005; Rao & Holt, 2005; Zutshi & Sohal, 2004
Late delivery	Walker et al.., 2008; Matos & Hall, 2007; Zhu & Sarkis, 2004
Rejection of input material	Gopalakrishnan et al. 2012; Daugherty, 2011; Brito et al., 2008; Zsidisin & Hendrick, 1998

This sections concludes that a supply chain is sustainable when it consider the environment and society during the life cycle of the product, from raw material to disposal, customer delivery at economical price, and on time that maintains quality.

2.5 Triggers of sustainability adoption

As discussed in the introduction (Section 1.2), companies are adopting sustainability practices due to external pressure as well as voluntarily to avail the benefits of sustainability.

This section will identify the types of external pressure and the types of benefits companies sought from sustainability adoption.

2.5.1 Sustainability adoption due to external pressure

The adoption of the sustainability is derived from pressure by agencies like customer groups, NGOs, and other stakeholders (Spence & Rinaldi, 2014). Clemens and Douglus (2006) have worked on the possibilities of improving sustainability across supply chain by coercion. González-Benito and González-Benito (2007) published a similar work on the role of stakeholder pressure on environmental practices. All the agencies that drive organizations to adopt sustainability are listed in Table 2.4. External pressure from different agencies influence companies to adopt sustainability, not only in their plant operations but it also force them to extend sustainability across their supply chain (Stiller & Gold, S, 2014; Eltayeb et al., 2011; Ni et al., 2010; Holt, 2009; Walker, 2008; Darnall et al., 2008, Zhu et al., 2008a; Smith 2007; Elingkton, 1994).

In the context of sustainability adoption, the stakeholders listed above influence the supply chain. In terms of influence, law, and regulations, pressure from consumer groups and competitors has been discussed most. The pressure exerted on companies is in the form of its negative reputation, penalties, and the fear of business loss.

Table 2.4 External pressure for sustainability adoption

Trade union	Peters et al., 2011; Bommel, 2010; Routroy, 2009
Media	Peters et al., 2011; Darnall, 2008; Markley & Davis, 2007
Industry norms	Ageron et al., 2011; Darnall, 2008
Human right Organizations	Peters et al., 2011; Bommel, 2010; Bitzer et al., 2008; Markley & Davis, 2007; Elkington, 1994
Law and regulations	Ageron et al., 2011; Diabata & Govindan, 2011; Nakano & Hirao, 2011; Peters et al., 2011; Sarkis et al., 2010; Closs et al., 2010; Teuteberg & Wittstruck, 2010; Pullman et al., 2010; Routroy, 2009; Fortes, 2009; Asif et al., 2008; Walker et al., 2008, Bitzer et al., 2008; Zhu et al., 2007b; Koplin et al., 2007, Michelsen, 2007; Markley & Davis, 2007; Clemens & Douglus, 2006; Kogg, 2003; Ytterhus, 1999; Elkington, 1994;
Employee unions	Eltayeb et al., 2011; Holt & Ghobadian, 2009; Asif et al., 2008; Darnall, 2008; Markley & Davis, 2007; Hall, 2000; Elkington, 1994; Ytterhus, 1999;
NGO	Eltayeb et al., 2011; Peters et al., 2011; Sarkis et al., 2010; Muller et al., 2009; Routroy, 2009; Asif et al., 2008; Seuring & Muller, 2008; Lee, 2008; Darnall, 2008; Matos & Hall, 2007; Markley & Davis, 2007; Vachon & Klassen, 2006; Elkington, 1994

Society/Community	Eltayeb et al., 2011; Holt & Ghobadian, 2009; Asif et al., 2008; Darnall, 2008; Markley & Davis, 2007; Hall, 2000; Ytterhus, 1999; Elkington, 1994;
Focal company influence	Nakano & Hirao, 2011; Darnall, 2008; Keatinga et al., 2008; Vachon & Mao, 2008; Markley & Davis, 2007; Rao & Holt, 2005; Hall, 2000
Civil society	Bitzer et al., 2008; Smith, 2007; Clemens & Douglus, 2006; Elkington, 1994
Trade association	Darnall, 2008; Ageron et al., 2011; Lee, 2008; Elkington, 1994
Consumer groups	Diabata & Govindan, 2011; Kushwaha, 2011; Bommel, 2010; Buyukozkan & Cifci, 2010; Closs et al., 2010; Sarkis et al., 2010; Holt & Ghobadian, 2009; Routroy, 2009; Cote et al., 2008; Seuring & Muller, 2008; Vachon & Klassen, 2008; Walker et al., 2008; Smith, 2007; Matos & Hall, 2007; Markley & Davis, 2007; Hamprecht et al., 2005; Hall, 2000
Competitors pressure	Diabata & Govindan, 2011; Closs et al., 2010; Pullman et al., 2010; Holt & Ghobadian, 2009; Darnall, 2008; Seuring & Muller, 2008; Markley & Davis, 2007; Zhu et al, 2007b; Kogg, 2003; Ytterhus, 1999; Elkington, 1994;

2.5.2 Anticipating benefits of sustainability adoption

The benefits of sustainability adoption motivate supply chain partners (Young & Kielkiewicz-Young, 2001). These benefits include new market opportunities, customer satisfaction, and premium pricing. The benefits are listed in the Table 2.5.

Table 2.5 shows the majority of authors recognize that sustainability adoption is related to a competitive and marketing advantage, improved corporate image, and pressure release from external agencies. Bommel (2010) and Hsu et al. (2013) have specifically worked on the influencers of the sustainability adoption. In the last two decades, sustainability in the supply chain has provided the scope for companies to create a competitive advantage and address environmental and social issues (Buyukozkan & Cifci, 2010). Bowen et al. (2001) found that when companies acknowledge the financial, marketing, and other benefits of sustainability, they are likely to adopt appropriate sustainable practices. The same concept was supported by Ytterhus (1999) who concluded that sustainability adoption is related to financial and operational benefits. Additionally, it also increases the environmental standards of the supply chain (Sarkis et al., 2010; Hall, 2000). An increase in profitability and quality are also benefits of sustainability adoption in long run (Rudawska & Renko; 2012; Rao & Holt, 2005).

Table 2.5 Benefits of sustainability adoption

Competition	Diabata & Govindan, 2011; Holt & Ghobadian, 2009; Ytterhus, 1999
Competitive Advantage	Hsu et al., 2013; Ageron et al., 2011; Peters et al., 2011; Olorunniwo & Li, 2010; Ni et al., 2010; Zhu & Sarkis, 2010; Curkovic & Sroufe, 2010; Muller et al., 2009; Hong et al., 2009; Walker et al., 2008; Cote et al., 2008; Vachon & Klassen, 2008; Zhu et al., 2008b; Zhu et al., 2007a; Clemens & Douglus, 2006; Vermeulen & Ras, 2006; Zhu & Sarkis, 2004; Kogg, 2003; Young & Kielkiewicz-Young, 2001; Ytterhus, 1999; Elkington, 1994
Premium Pricing	Eltayeb et al., 2011, Ageron et al, 2011; Ytterhus, 1999
Increase quality	Ashby et al., 2012; Carbone & Moatti, 2011Eltayeb et al., 2011; Ageron et al., 2011; Bitzer et al., 2008; Zhu et al., 2008a; Ytterhus, 1999;
Improve corporate Image/ Reputation	Eltayeb et al., 2011; Vermeulen & Seuring, 2009; Muller et al., 2009; Zhu et al., 2008a; Darnall, 2008; Zhu et al., 2008; Smith, 2007; Simpson et al., 2007; Matos & Hall, 2007; Rocha et al., 2007; Zutshi & Sohal, 2004
Cost Reduction in long term	Hsu et al., 2013; Eltayeb et al., 2011; Bommel, 2010; Holt & Ghobadian, 2009; Hong et al., 2009; Salam, 2008; Zhu et al., 2008b; Walker et al., 2008; Lee, 2008; Zhu et al., 2007b; Rocha et al., 2007; Clemens & Douglus, 2006; Tsoulfas & Pappis, 2006; Vasileiou & Morris, 2006; Rao & Holt, 2005; Zutshi & Sohal, 2004; Green et al., 1998
Improve Operational Processes	Hsu et al., 2013; Ageron et al.; 2011; Bai & Sarkis, 2010; Holt & Ghobadian, 2009; Cai et al., 2008; Rocha et al., 2007; Zutshi & Sohal, 2004
Marketing Advantage	Eltayeb et al., 2011; Darnall, 2008; Zhu et al., 2008b, Bitzer et al., 2008; Markley & Davis, 2007; Zhu et al., 2007a; Smith, 2007; Clemens & Douglus, 2006; Zhu & Sarkis, 2004; Kogg, 2003
New Market Opportunity	Holt & Ghobadian, 2009; Bitzer et al., 2008; Markley & Davis, 2007; Clemens & Douglus, 2006;
Product Differentiation	Kogg, 2003
Customer Satisfaction and value	Kushwaha, 2011; Ageron et al., 2011; Smerecnik & Anderson, 2011; Hong et al., 2009; Hong et al., 2009; Lee, 2008; Smith, 2007
Reduction in fines	Hsu et al., 2013; Kushwaha, 2011; Rocha et al., 2007; Zutshi & Sohal, 2004
Increase Profitability	Eltayeb et al., 2011; Closs et al., 2010; Darnall, 2008; Zhu et al., 2008a; Zhu et al., 2007b; Markley & Davis, 2007; Carter & Jenning, 2002; Ytterhus, 1999

Outcomes from this section:

- The indicator identified from the literature can be used for developing sustainability standards, since there is a lack of industry specific sustainability standards (Kudla & Klaas-Wissing, 2012).

- Based on the literature survey, various external agencies have been identified that exert pressure on the supply chain to implement sustainability. There is a need to identify the degree of influence by each external agency (Zhu et al., 2007).
- External pressure and the benefits of sustainability adoption both motivate top management towards sustainability. The differences of influence between these triggers should be compared, since the benefits of sustainability adoption are realized over a long period of time (Teuteberg & Wittstruck, 2010).
- Following hypothesis can be formed as a result for this section:

  H_1: External pressure and support positively affect the top management commitment for sustainability adoption.

  H_2: Benefits of sustainability adoption positively the top management commitment for sustainability adoption.

2.6 Barrier and enablers of sustainability adoption

Some companies are ready to adopt sustainability voluntarily and others are forced to adopt (Mebratu, 1998). In both situations, supply chain partners encounter many problems in the course of sustainability adoption. These problems are the barriers to sustainability adoption. If companies effectively manage the barriers, either by themselves or with the help of supply chain partners, then sustainability adoption can be fully or partially solved (Kuhtz, 2007). Other factors related to the sustainability adoption are enablers. If favorable conditions for sustainability adoption are developed, it would become easier to extend it across the supply chain.

2.6.1 Barriers of sustainability adoption

A lack of knowledge and expertise within an organization is the main barrier to sustainability adoption (Elkington, 1994; Zutshi & Sohal, 2004)). Vachon (2007) also found that the lack of knowledge transfer, lack of cooperation and organizational resistance for the selection of environmental technologies for green practices are barriers to sustainability. Florida (1996) and Zutshi & Sohal (2004) focused on the resistance from employees and supply chain partners for the development of an environmentally friendly supply chain. Hall (2000) highlighted the lack of interest from suppliers as a barrier. Cost related issues affect the greening of the supply chain (Rao, 2002). Cai et al. (2008) reported that higher investment and

the uncertainty of return as significant barriers for being green. The majority of companies assume that sustainability will increase cost and negatively affect the overall profit (Fortes, 2009). Vermeulen & Ras (2006) found the lack of expertise in supply chain partners and the pressure of lowering cost as the major challenge for greening the supply chain. Markley & Davis (2007) talked about the un-affordability by supply chain partners to develop additional financial and employee resources for sustainability. The lack of government support is also one of the causes for a slower adoption of sustainability (Lin, 2007).

Carter & Roger (2002) and Klassen & Vechon (2003) focused on the perception of cost increase due to introducing socially sustainable in the supply chain. They also emphasized specific barriers like poor control and management of environment related problems. The lack of compliance and support in the supply chain affects the greening of the textile supply chain without a powerful focal company (Kogg, 2003). Sarkis (2004) found cost related factors and the reluctance to share product design with supply chain partners as a barrier to sustainability adoption. A minimum or the complete absence of incentives for green practices like investment in tools and equipment and initiating changes in the supply process affects the commitment of suppliers' top management (Simpson & Power, 2005).

Table 2.6 Barriers to sustainability adoption

Increased cost of adoption	Ageron et al., 2011; Kushwaha, 2011; Luthra et al., 2011; Wu & Pagell, 2011; Bai & Sarkis, 2010; Buyukozkan & Cifci, 2010; Cote et al., 2008; Muller et al., 2009; Cai et al., 2008; Carter & Rogers 2008; Salam, 2008; Walker et al., 2008; Darnall, 2008; Seuring & Muller, 2008; Markley & Davis, 2007; Linton et al., 2007; Simpson & Power, 2005; Rao & Holt, 2005; Zhu & Sarkis, 2004; Rao, 2002; Carter & Jenning, 2002; Bowen et al., 2001
Focus on short term profitability	Wu & Pagell, 2011; Cote et al., 2008
Perception of low economic return	Ageron et al., 2011; Nakano & Hirao, 2011; Luthra et al., 2011; Fortes, 2009; Cai et al., 2008; Keatinga et al., 2008; Simpson & Power, 2005; Bowen et al., 2001
Lack of Money	Lee, 2008; Smith, 2007; Klassen & Vachon, 2003
Lack of integration	Carter & Rogers 2008; Vachon, 2007; Vasileiou & Morris, 2006
No support from government	Lin, 2007; Zutshi & Sohal, 2004
Resistance from suppliers	Lee, 2008; Zutshi & Sohal, 2004
Poor supplier commitment	Diabata & Govindan, 2011; Carter & Rogers 2008; Rao & Holt, 2005

Lack of partner trust	Senge & Prokesch, 2011; Bitzer et al., 2008
Lack of top management commitment	Ageron et al., 2011; Luthra et al., 2011; Walker et al., 2008; Rao & Holt, 2005
Cultural difference	Ageron et al., 2011; Blowfield, 2005
Lack of training	Walker et al., 2008; Zutshi & Sohal, 2004
Lack of education	Kudla & Klaas-Wissing, 2012; Lee, 2008; Zutshi & Sohal, 2004
Lack of human resource Capability	Wu & Pagell, 2011; Luthra et al., 2011; Lee, 2008; Markley & Davis, 2007
Lack of knowledge	Bai & Sarkis, 2010; Lee, 2008; Smith, 2007; Vasileiou & Morris, 2006
Lack of resources	Kudla & Klaas-Wissing, 2012; Lee, 2008; Clemens & Douglus, 2006; Hall, 2000
No capability	Senge & Prokesch, 2011; Lee, 2008; Hall, 200
Outdated auditing standards	Beske et al., 2008; Rao & Holt, 2005; Hamprecht et al., 2005
Poor demand forecasting	Carter & Rogers 2008
No information sharing	Luthra et al., 2011; Lee, 2008; Seuring & Muller, 2008; Vachon, 2007; Zhu & Sarkis, 2004
No technology sharing	Wu & Pagell, 2011; Lee, 2008; Bitzer et al., 2008; Zhu & Sarkis, 2004; Klassen & Vachon, 2003
Lack of awareness	Bitzer et al., 2008; Rao & Holt, 2005

Rao & Holt (2005) pointed out barriers of a green supply chain such as the lack of commitment on the part of management, the lack of awareness about environmental practices across the supply chain, poor auditing standards, and government rules. In terms of capability, the lack of a supplier's ability to innovate and adopt with respect to sustainability of the supply chain creates barriers. Table 2.6 has all the barriers discussed in the literature.

2.6.2 Enablers to sustainable supply chain

Lee and Klassen (2008) distinguished between drivers and enablers. Drivers are the factors that initiate a process and enablers helps to implement the process. In addition to this, we have added one more factor: endures. We have divided the sustainability adoption process into three steps: 1) develop a commitment towards sustainability, 2) implementing sustainability, and 3) putting continuous efforts for sustainability improvement.

There are varieties of activities that may enable sustainability adoption across the supply chain. For example, incentives by different agencies like government, focal firm, and NGOs can enable sustainability adoption by supply chain partners (Seuring & Muller, 2008; Matos & Hall, 2007). Other benefits include tax benefits for sustainability practices to reduce the cost of

adoption, which can stimulate adoption (Lin, 2007). Other enablers are related to support from the focal firm, top management and government in terms of collaboration, integration, knowing supply chain partners' capabilities and problems, and joint development to develop mutual trust and commitment (Rocha et al., 2007; Zhu & Sarkis, 2004). Controlling and monitoring the processes of supply chain partners to prevent deviations can be achieved by developing new auditing standards. In addition, disseminating knowledge about sustainability, providing training and developing technological knowledge will facilitate the implementation of sustainability. The benefits of sustainability spur a continuous motivation for sustainability performance improvement in each time period. A relationship based sustainable supply chain stimulates capacity building and the development of supply chain partners and places sustainability practices in the centre of policies.

Table 2.7 has all the enablers of sustainability adoption. The literature has indicated three types of enablers for sustainability adoption.

1. Enablers for developing the intention to adopt sustainability
2. Enablers for the implementation of sustainability
3. Enablers making sustainability a continuous process

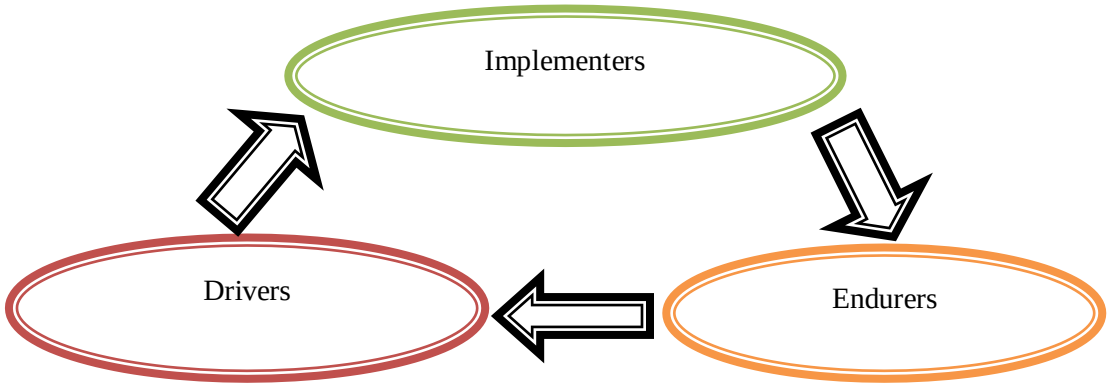

Figure 2.6 Enablers of sustainable supply chain

The interrelation among the various enablers based on the literature finding is shown in Figure 2.6. There is need to create a favorable environment that develops top management commitment towards sustainability adoption with each party willing to share its resources and information (Handfield et al., 2005; Rocha et al., 2007). Supply chain partners should know each other's problems related to sustainability adoption and jointly develop solutions (Lee, 2008; Bitzer et al., 2008). A trust-based relationship among the supply chain partners is

necessary to motivate and sustain long-term relations and develop joint business policies (Rao & Holt, 2005; Darnall, 2008). Capacity building and mutual development help to engage long-term sustainability (Klassen & Vachon, 2003; Wu & Pagell, 2011). In long run, sustainability adoption is related to cost reduction and various other advantages (Elkington, 1994; Nakano & Hirao, 2011). Table 2.7 lists the enablers related to sustainability adoption.

Table 2.7 Enablers of sustainability adoption

S. N.	Enabler	Sources used
1	External pressure	Buyukozkan & Cifci, 2010; Sarkis et al., 2010; Routroy, 2009; Zhu et al., 2008b; Seuring & Muller, 2008; Walker et al., 2008, Lee, 2008; Seuring & Muller, 2008; Zhu et al., 2008a; Smith, 2007; Clemens & Douglus, 2006; Vachon & Klassen, 2008; Darnall, 2008; Lin, 2007; Markley & Davis, 2007; Ytterhus, 1999; Klassen & Vachon, 2003; Ytterhus, 1999
2	Support by various agencies	Bommel, 2010; Seuring & Muller, 2008; Bitzer et al., 2008; Cote et al., 2008; Lin, 2007; Matos & Hall, 2007; Simpson & Power, 2005
3	Demand of customer and other stakeholders	Diabata & Govindan, 2011; Bommel, 2010; Sarkis et al., 2010; Holt & Ghobadian, 2009; Zhu et al., 2008a; Seuring & Muller, 2008; Walker et al., 2008; Rocha et al., 2007; Smith, 2007; Hall, 2000
4	Awareness	Teuteberg & Wittstruck, 2010; Buyukozkan & Cifci, 2010; Zhu et al., 2008b; Walker, et al., 2008; Ellis & Higgins, 2006; Rao & Holt, 2005
5	Top management commitment and support	Ageron et al., 2011; Daugherty, 2011; Closs et al., 2010; Holt & Ghobadian, 2009; Hong et al., 2009; Lee, 2008; Zhu et al., 2008a; Zhu et al., 2007a; Rocha et al., 2007; Ellis & Higgins, 2006; Handfield et al., 2005; Zhu & Sarkis, 2004
6	Sharing resources	Ageron et al., 2011; Wu & Pagell, 2011; Bai & Sarkis, 2010; Ni et al., 2010; Lee, 2008; Bitzer et al., 2008; Lee, 2008; Vachon, 2007; Smith, 2007; Klassen & Vachon, 2003; Young & Kielkiewicz-Young, 2001; Elkington, 1994
7	Capacity building and development	Wu & Pagell, 2011; Ageron et al., 2011; Lee, 2008; Markley & Davis, 2007; Klassen & Vachon, 2003
8	Joint efforts & planning	Peters et al., 2011; Hong et al., 2009; Seuring & Muller, 2008; Rao & Holt, 2005; Zsidisin & Hendrick, 1998; Florida, 1996
9	Monitoring & auditing	Ageron et al., 2011; Darnall, 2008; Beske et al., 2008; Clemens & Douglus, 2006; Rao & Holt, 2005; Hamprecht et al., 2005
10	Competitive and marketing advantage	Ageron et al., 2011; Nakano & Hirao, 2011; Vermeulen & Seuring, 2009; Walker et al, 2008, Seuring & Muller, 2008; Elkington, 1994
11	Information Sharing	Bahl et al., 2011; Nakano & Hirao, 2011; Wu & Pagell, 2011; Walker et al., 2008; Darnall, 2008; Lee, 2008; Seuring & Muller,

		2008; Vachon, 2007; Zhu & Sarkis, 2004
12	Trust and commitment among partners	Senge & Prokesch, 2011; Bai & Sarkis, 2010; Darnall, 2008; Keatinga et al., 2008; Bitzer et al., 2008; Markley & Davis, 2007; Tsoulfas & Pappis, 2006; Rao & Holt, 2005; Matos & Hall, 2000
13	Knowing and solving supply chain partners' problems	Gopalakrishnan et al. 2012; Ageron et al., 2011; Wu & Pagell, 2011; Bai & Sarkis, 2010; Bitzer et al., 2008, Lee, 2008; Bitzer et al., 2008; Lee, 2008; Walker et al., 2008; Cramer, 2007; Smith, 2007; Vachon, 2007; Zutshi & Sohal, 2004; Klassen & Vachon, 2003; Young & Kielkiewicz-Young, 2001; Elkington, 1994
14	Cost Reduction	Gopalakrishnan et al. 2012; Ageron et al., 2011; Buyukozkan & Cifci, 2010; Muller et al., 2009; Brito et al., 2008; Markley & Davis, 2007; Linton et al., 2007; Vermeulen & Ras, 2006; Simpson & Power, 2005; Bowen et al., 2001
15	Long term Partnership	Gopalakrishnan et al. 2012 ; Daugherty, 2011; Bai & Sarkis, 2010; Walker et al., 2008, Lee, 2008; Seuring & Muller, 2008; Attaran & Attaran, 2007; Markley & Davis, 2007; Vermeulen & Ras, 2006, Simpson & Power, 2005; Zsidisin & Hendrick, 1998

Outcomes from this section:

- There are many barriers to sustainability adoption, most of which are related to the capacity and capability of the supplier. The impact of these enablers on suppliers' commitment to adopt sustainability should be checked.
- There are three types of enablers for a sustainable supply chain. Some variables that help in developing top management commitment while others help in the implementation. A third type of enabler exists to make sustainability adoption a continuous process. All the enablers identified from the literature should be classified in one of these categories.

2.7 Buyer-supplier relationship in a sustainable supply chain

In terms of sustainability, it is well known that sustainability practices need to be implemented across supply chain. To accomplish this, companies need to develop relationship management strategies that influence and support its suppliers (Van Hoof & Thiell, 2014). A holistic marketing approach can be used to develop a sustainable business environment. Holistic marketing concept include four marketing activities- Integrated maketing, Internal marketing, Performance marketing and relationship marketing. This theiss is primilarily based

on the relationship marketing which is defined as "set of activities to develop deep, enduring relationships with people and organizations that directly or indirectly affect the success of firms' marketing activities" (Kotler, et al., 2013). RM aims to build mutually satisfying relationships in order to attract, keep and sustaian the business. Relationship marketing have four key constituients which are customers, employees, marketing partners (channels, distributors, supplier, dealers, agenies) and member of financial community (shareholders and investors). The basic concept of relationship marketing is to analyze the capacity, capability, and intention of partner to develop relationship in order to improve the business performance.

In term of sustainability, Sarkis (1995) came with the concept of environment conscious designing with the help of the buyer-supplier relationship. Angeron et al. (2011) argued for the need of strategic partnerships for the proper collaboration between supply chain partners that leads to a sustainable supply chain. Supply chain relationships facilitate the adoption of innovative environmental technologies (Zhu et al., 2007a). Upstream and downstream collaborations with supply chain partners are directly related to the adoption of environmental sustainability practices (Vachon & Mao, 2008; Klassen & Vachon, 2003). Some authors argued that success in environmental sustainability occurs when the buyer and supplier firms visit the others plants to understand their specific obstacles (Simpson & Power, 2005). The leading firm in the supply chain should stimulate the supply chain partners and if that is not possible, then compel them (Michelesen, 2007; Clemens & Douglus, 2006). Companies need to use relationship strategies to motivate their supply chain partners to adopt sustainability and develop trust and commitment for a long-term relationship (Cheung & Rowlinson, 2011). This concept is supported by Angeron et al. (2011) stating that companies need to support and help suppliers install sustainability into their operations. Hence relationship management with customers and suppliers is required for implementing sustainability across the supply chain (Klassen, et al., 2003) and for taking the marketing advantage and profit out of sustainability (Holt, 2009; Zhu, et al. 2008b; Ytterhus, 1999).

Florida (1996) found that the supplier-buyer relationship in a supply chain is essential for the adoption and diffusion of new manufacturing processes. Relationship management has been given importance by many researchers after seeing its contribution to sustainability in the supply chain (Cheung & Rowlinson, 2011). Collaboration and compliance are the two options to develop and maintain supply chain relationships (Simpson & Power, 2005). Gold et al., (2009) advocated for collaboration with supply chain partners to achieve economical, social,

and environmental objectives. Lee (2008) stated that supply chain environmental sustainability could be achieved when all parties are engaged in sustainable practices. Therefore, companies need to focus on the type of relationship they have with their supply chain partners (Sange, 2010). The value of sustainability acquired during a firms operations diminish if it is not aligned with the supply chain partners (Bai & Sarkis, 2010; Angeron et al., 2011; Preuss, 2005).

According to Simpson & Power, 2005

"Supply relationships may provide a key way for business to influence the sustainability of their products and services through better manufacturing".

Relationship management is a better approach to manage relationships in the supply chain and influence supply chain partners towards the adoption of ethical practices (Ellis & Higgins, 2006). Research on 'supply chain partnerships to improve supply chain performance' has given firms the opportunity to incorporate it in to their practices (Linton et al., 2007; Ni et al., 2010). Many researchers conclude that the buyer firm influences the suppliers' firm to extend sustainability initiatives (Simpson et al., 2007; Michelsen, 2007).

2.7.1 Relationship strategies for sustainable supply chain

Various relationship strategies like supplier conferences, conducting on-site visits, and the development of joint buyer-supplier teams are necessary for the socialization of the supply chain (Bommel, 2010; Salo, 2012). Information sharing and mutual commitment are required for improving the performance of a supply chain (Biggemann, 2012; Simpson & Power, 2005). Zutshi et al., (2004) found that training and awareness is required for supplier development. Beside this, companies need to monitor their supply chain partners that may or may not be high on collaboration (Vachon & Klassen, 2006). Keatinga et al. (2008) advocated the need to coordinate in purchasing, manufacturing, and marketing functions. They also suggested the selection and monitoring of suppliers and managing relationships for sustainable business practices. Fortes (2009) focused on the dyadic relationship with the suppliers. There is need for supplier management to address sustainability issues in the supply chain (Buyukozkan & Cifci, 2010). Bommel (2010) made a relationship-based work suggesting the use of various supplier development strategies to maintain the relationship. The need for supplier certification, reducing the supplier base, and exerting pressure are some of strategies discussed. Ciliberti et

al., (2008) included the concept of clear contracts in relationship development to avoid any inconsistencies.

Table 2.8 Supply chain relationship management strategies

Information sharing and gathering	Daugherty, 2011; Kushwaha, 2011; Wu & Pagell, 2011; Olorunniwo & Li, 2010; Bommel, 2010; Sharma et al., 2010; Bai & Sarkis, 2010; Nakano & Hirao, 2011; Seuring & Muller, 2008; Lee, 2008; Bitzer et al., 2008; Ciliberti, 2008; Vachon & Klassen, 2008; Brito et al., 2008; Attaran & Attaran, 2007; Koplin et al., 2007; Rocha et al., 2007; Zhu et al., 2007b; Smith, 2007; Vachon & Klassen, 2006; Handfield et al., 2005; Preuss, 2005; Klassen & Vachon, 2003; Rao, 2002
Cross functional teams	Bommel, 2010; Zhu & Sarkis, 2010; Pullman et al., 2010; Keatinga et al., 2008; Zhu et al., 2008a; Brito et al., 2008; Zhu et al., 2007a; Lin, 2007; Zhu & Sarkis, 2004
Joint teams	Kushwaha, 2011; Bommel, 2010; Bitzer et al., 2008; Zhu et al., 2007b;
Pressure (penalties/fines)	Ageron et al., 2011; Bommel, 2010; Pullman et al., 2010; Keatinga et al., 2008; Michelsen, 2007; Blowfield, 2005
Incentives and financial support	Nakano & Hirao, 2011; Bommel, 2010; Olorunniwo & Li, 2010; Zhu et al., 2008a; Keatinga et al., 2008; Michelsen, 2007; Hamprecht et al., 2005; Simpson & Power, 2005; Kogg, 2003; Rao, 2002; Ytterhus, 1999
Supplier development	Gopalakrishnan et al. 2012; Wu & Pagell, 2011; Bommel, 2010; Seuring & Muller, 2008; Koplin et al., 2007; Michelsen, 2007; Handfield et al., 2005
Technology sharing	Luthra et al., 2011; Hong et al., 2009; Vachon & Klassen, 2008; Lin, 2007; Markley & Davis, 2007; Vachon, 2007; Koplin et al., 2007; Zhu et al., 2007b; Rocha et al., 2007; Rao & Holt, 2005; Zutshi & Sohal, 2004; Kogg, 2003; Hall, 2000; Zsidisin & Hendrick, 1998
Resource allocation	Ageron et al., 2011; Daugherty, 2011; Ni et al., 2010; Brito et al., 2008; Cai et al., 2008; Rocha et al., 2007; Zutshi & Sohal, 2004;
Training program	Pullman et al., 2010; Sarkis et al., 2010; Closs et al., 2010; Holt & Ghobadian, 2009; Seuring & Muller, 2008; Lee, 2008; Koplin et al., 2007; Zhu et al., 2007a; Vermeulen & Ras, 2006; Clemens & Douglus, 2006; Vachon & Klassen, 2006; Simpson & Power, 2005; Zutshi & Sohal, 2004; Kogg, 2003; Rao, 2002;
Awareness programs	Zutshi & Sohal, 2004; Rao & Holt, 2005; Zhu et al., 2007a
Supplier certification	Peters et al., 2011; Wu & Pagell, 2011; Bommel, 2010; Muller et al., 2009; Seuring & Muller, 2008; Smith, 2007; Vachon & Klassen, 2006; Zhu & Sarkis, 2004

Joint development Programs and integration	Ageron et al., 2011; Daugherty, 2011; Kushwaha, 2011; Olorunniwo & Li, 2010; Peters et al., 2011; Sharma et al., 2010; Closs et al., 2010; Hong et al., 2009; Holt & Ghobadian, 2009; Salam, 2008; Cai et al., 2008; Ciliberti, 2008; Seuring & Muller, 2008; Seuring & Muller, 2008; Attaran & Attaran, 2007; Simpson et al., 2007; Matos & Hall, 2007; Vachon & Klassen, 2006; Clemens & Douglus, 2006; Vermeulen & Ras, 2006; Handfield et al., 2005; Rao, 2002; Florida, 1996
Supplier education	Smerecnik & Anderson, 2011; Closs et al., 2010; Sarkis et al., 2010; Muller et al., 2009; Holt & Ghobadian, 2009; Seuring & Muller, 2008; Lee, 2008; Ciliberti, 2008; Zhu et al., 2007b; Clemens & Douglus, 2006; Rao & Holt, 2005; Simpson & Power, 2005; Kogg, 2003; Ytterhus, 1999
Supplier mentoring	Holt & Ghobadian, 2009; Muller et al., 2009; Darnall, 2008; Keatinga et al., 2008; Lee, 2008; Koplin et al., 2007; Smith, 2007; Vachon, 2007, Hamprecht et al., 2005; Vachon & Klassen, 2006; Vermeulen & Ras, 2006; Blowfield, 2005; Handfield et al., 2005; Rao, 2002
Knowledge sharing	Peters et al., 2011; Luthra et al., 2011; Bai & Sarkis, 2010; Vermeulen & Seuring, 2009; Vachon & Klassen, 2008; Darnall, 2008; Bitzer et al., 2008; Zhu et al., 2008b; Vachon, 2007; Rocha et al., 2007; Smith, 2007; Simpson et al., 2007, Vachon & Klassen, 2006; Rao, 2002, Klassen & Vachon, 2003; Zsidisin & Hendrick, 1998
Suppliers evaluation and assessment	Gopalakrishnan et al. 2012; Pullman et al., 2010; Darnall, 2008; Ciliberti, 2008; Brito et al., 2008; Keatinga et al., 2008; Vachon, 2007; Koplin et al., 2007; Vachon & Klassen, 2006; Handfield et al., 2005; Zhu & Sarkis, 2004; Klassen & Vachon, 2003; Ytterhus, 1999;
site visit	Nakano & Hirao, 2011; Ciliberti, 2008; Clemens & Douglus, 2006
Sharing experience	Nakano & Hirao, 2011; Muller et al., 2009; Brito et al., 2008; Zhu et al., 2008a; Rocha et al., 2007; Smith, 2007; Rao, 2002
Supplier audit	Pullman et al., 2010; Vermeulen & Seuring, 2009; Zhu et al., 2008a; Ciliberti, 2008; Seuring & Muller, 2008; Zhu et al., 2008b; Vachon, 2007; Koplin et al., 2007; Hamprecht et al., 2005; Blowfield, 2005; Zhu & Sarkis, 2004; Kogg, 2003; Zsidisin & Hendrick, 1998; Green et al., 1998
Supplier monitoring	Buyukozkan & Cifci, 2010; Pullman et al., 2010; Seuring & Muller, 2008; Keatinga et al., 2008; Ciliberti, 2008; Brito et al., 2008; Smith, 2007; Vachon, 2007; Koplin et al., 2007; Rao & Holt, 2005; Rao & Holt, 2005; Blowfield, 2005; Handfield et al., 2005; Green et al., 1998
Risk Sharing	Olorunniwo & Li, 2010; Hall, 2000; Simpson & Power, 2005
Rating and classification	Michelsen, 2007; Green et al., 1998
Workshop	Cheung & Rowlinson, 2011; Muller et al., 2009; Vachon, 2007; Koplin et al., 2007
Seminar	Koplin et al., 2007; Vachon, 2007

Relationship development and maintaining activities are discussed in the literature of industrial marketing. Hadjikhani & LaPlaca (2013) proposed some theoretical foundations of relationship marketing. The relationship management strategies listed in the above Table 2.8 (from sustainable supply chain literature) certainly matches the foundations of relationship marketing discussed in industrial marketing literature. Those foundations are resource exchange, interdependency, long-term outlook, cooperation, sharing of risk and developing the partner. The majority of them focused on increasing supplier knowledge and monitoring the suppliers. One of the most important outcomes of this section is that 'relationship efforts should be awarded for performance improvement' (Michelsen, 2007; Green et al., 1998). Each time a supplier is selected, an order should be allocated according to their performance on the sustainability standards (Gopalakrishnan et al., 2012). Table 2.8 shows that the majority of authors focused on suppliers. Additional factors like supplier evaluation, monitoring, mentoring, assessment, selection, and supplier development were also discussed with supplier development strategies like workshops, education, technology, and knowledge sharing.

2.7.2 Supplier selection in sustainable supply chain

Developing a relationship with a supplier is a long process (Asslander, & Roloff, 2014; Wilson, 1998; Ford, 1980). In order to develop a sustainable supply chain, buyer firms in the supply chain need to select appropriate suppliers for developing a relationship (Brito et al., 2008; Ciliberti, 2008; Hutchins & Sutherland, 2008; Michelsen, 2007; Tsoulfas & Pappis, 2006; Rao & Holt, 2005). With any kind of relationship, each party has certain expectations; a buyer firm may look for an improved sustainability performance by the supplier firm, while the supplier firm looks for more business from the buyer firm (Rocha et al., 2007; Zutshi & Sohal, 2004). In deciding the allocation of orders, buyer firms should consider suppliers' sustainability performance (Seuring & Muller, 2008; Smith, 2007; Hamprecht et al., 2005). The sustainable supply indicators can be used for the screening and selection of a supplier or group of suppliers (Hutchins & Sutherland, 2008; Michelsen, 2007). The main objective of the supplier selection activity is to make sustainability an integrated part of all business activities. It demonstrates power over the supplier (Michelsen, 2007; Tsoulfas & Pappis, 2006).

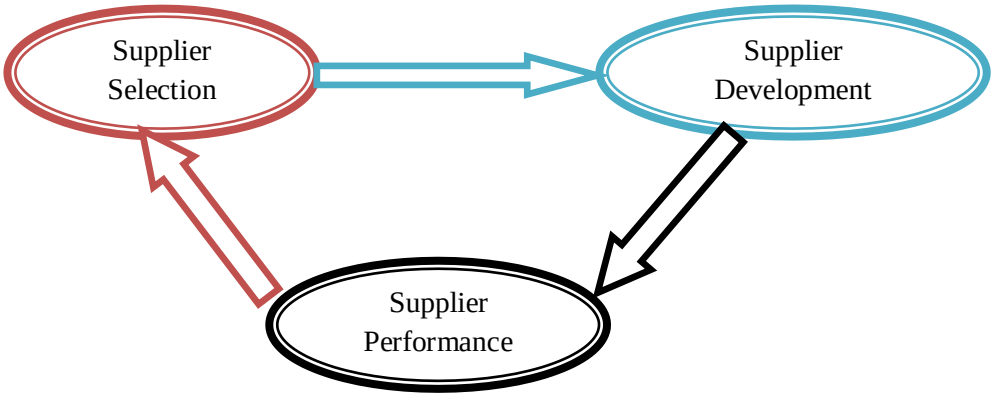

Figure 2.7 Supplier selection in sustainable supply chain

A supplier assessment is necessary to know the needs and willingness of sustainability adoption (Keatinga et al., 2008). Hamprecht et al. (2005) found that developing sustainability quality standards and assessing suppliers on those standards is necessary for sustainability. Figure 2.7 illustrates how a sustainable supply chain works (Wilson, 1998). It starts with supplier selection on sustainability standards (Brito et al., 2008; Ciliberti, 2008; Michelsen, 2007). Then it decides supplier development activities (Peters et al., 2011; Cai et al., 2008; Rocha et al., 2007; Rao & Holt, 2005). Supplier performance is then measured against the sustainability criteria and an order is allocated as the sustainability return (Darnall, 2008; Vachon, 2007; Koplin et al., 2007; Vachon & Klassen, 2006; Klassen & Vachon, 2003; Ytterhus, 1999).

2.7.3 Relationship selection

Many studies argue that relationship marketing is not a good option every time (Dowling & Uncles, 1997). Deciding a relationship is an important task in order to remain profitable and competitive (Kumar et al., 2003). There is a need to be familiar with supply chain partners before moving ahead with a relationship (Ganesan & Hess, 1997). Reinartz & Kumar (2002) stated that relationship selection starts with partner identification and their intention to pursue a relationship, and only after that a relationship should be decided.

Researchers have put in many efforts to classify the different types of relationships in the supply chain (Medlin, 2012). Channel literature first discussed that the relationship in a supply chain vary from arm's length to vertical integration (Golicic et al., 2003; Contractor & Lorange 1988; Webster 1992). Many authors further categorized the relationships based on the

relationship magnitude. Some of the supply chain relationships are partnerships, alliances, joint ventures, network organizations, franchises, license agreements, contractual relationships, service agreements, and administered relationships (Golicic et al., 2003). Beside this, four types of a relationship between buyer and suppliers has been given by Hansen (2006), which are transactional, collaboration, co-production and co-creation in term of exchange. Cannon & Perreautt (1999) reported that relationships could be classified based on similar characteristics and traits. Eight types of relationships were found, which are basic buying and selling, bare bones, contractual transaction, customer supply, cooperative systems, collaborative, mutually adaptive, and customer is king. Rinehart et al. (2004) succeeded by having practitioners to name the relationship based on certain characteristics and types of relationships. Those relationships were non-strategic transactions, administered relationships, contractual relationships, specialty contract relationships, partnerships, joint ventures, and strategic alliances. Leek et al. (2002) found companies use one or more of the following relationship management methods: a formal documented system, personal judgment, and meetings.

In addition to this, following forms of relationship have been used in literature of sustainable supply chain to address supply chain relationships (Table 2.9).

Table 2.9: Relationship key words used in sustainable supply chain

Coordination	Senge & Prokesch, 2011; Bommel, 2010; Hong et al., 2009; Carter & Rogers 2008; Darnall, 2008; Bitzer et al., 2008; Keatinga et al., 2008; Matos & Hall, 2007; Hall, 2000
Trust	Ageron et al., 2011; Daugherty, 2011; Peters et al., 2011; Bai & Sarkis, 2010; Bitzer et al., 2008; Matos & Hall, 2007; Ellis & Higgins, 2006; Carter & Jenning, 2002; Zsidisin & Hendrick, 1998
Long and strong supply chain relationship	Closs et al., 2011; Luthra et al., 2011; Peters et al., 2011; Bommel, 2010; Pullman et al., 2010, Teuteberg & Wittstruck, 2010; Muller et al., 2009; Asif et al., 2008, Brito et al., 2008; Cai et al., 2008; Hutchins & Sutherland, 2008; Keatinga et al., 2008; Zhu et al., 2008b; Attaran & Attaran, 2007; Markley & Davis, 2007; Linton et al., 2007; Tsoulfas & Pappis, 2006; Vermeulen & Ras, 2006, Handfield et al., 2005; Rao, 2002; Carter & Jenning, 2002; Hall, 2000; Walton et al., 1998; Zsidisin & Hendrick, 1998; Sarkis, 1995
Stakeholder relationship and engagement	Peters et al., 2011; Pullman et al., 2010; Sarkis et al., 2010; Muller et al., 2009; Cramer, 2007; Matos & Hall, 2007; Rocha et al., 2007; Ellis &Higgins, 2006; Zutshi & Sohal, 2004; Carter & Jenning, 2002
Cooperation	Cheung & Rowlinson, 2011; Smerecnik & Anderson, 2011; Buyukozkan & Cifci, 2010; Bommel, 2010; Sharma et al., 2010; Cai et al., 2008; Ciliberti,

	2008; Zhu et al., 2008a; Lee, 2008; Vachon & Klassen, 2008; Zhu et al., 2008b; Zhu et al., 2007a; Zhu et al, 2007b, Tsoulfas & Pappis, 2006; Vachon & Klassen, 2006; Vermeulen & Ras, 2006; Handfield et al., 2005; Simpson & Power, 2005; Bowen et al., 2001; Green et al., 1998; Zsidisin & Hendrick, 1998; Elkington, 1994
Supply chain Partners Involvement	Bai & Sarkis, 2010; Holt & Ghobadian, 2009; Hong et al., 2009; Bitzer et al., 2008; Rao & Holt, 2005
Partnership	Ageron et al., 2011; Bommel, 2010; Fortes, 2009; Svensson, 2009; Zhu et al., 2008b; Svensson, 2007; Markley & Davis, 2007; Ellis & Higgins, 2006; Hamprecht et al., 2005; Rao & Holt, 2005; Klassen & Vachon, 2003;
Integration with supply chain partners	Kushwaha, 2011; Bommel, 2010; Bai & Sarkis, 2010; Curkovic & Sroufe, 2010; Olorunniwo & Li, 2010; Fortes, 2009; Muller et al., 2009; Routroy, 2009; Hong et al., 2009; Cai et al., 2008; Carter & Rogers 2008; Ciliberti, 2008; Brito et al., 2008; Walker et al., 2008; Vachon & Klassen, 2008; Rocha et al., 2007; Koplin et al., 2007; Vachon & Klassen, 2006; Rao & Holt, 2005; Handfield et al., 2005; Zhu & Sarkis, 2004; Walton et al., 1998
Collaboration	Kudla & Klaas-Wissing, 2012; Ageron et al., 2011; Cheung & Rowlinson, 2011; Eltayeb et al., 2011; Nakano & Hirao, 2011; Diabata & Govindan, 2011; Peters et al., 2011; Bai & Sarkis, 2010; Buyukozkan & Cifci, 2010; Closs et al., 2010; Ni et al., 2010; Olorunniwo & Li, 2010; Sharma et al., 2010; Zhu & Sarkis, 2010; Vermeulen & Seuring, 2009; Gold et al., 2009; Asif et al., 2008; Salam, 2008; Walker et al., 2008; Lee, 2008; Darnall, 2008; Attaran & Attaran, 2007; Simpson et al., 2007; Koplin et al., 2007; Matos & Hall, 2007; Vachon & Klassen, 2006; Preuss, 2005; Zhu & Sarkis, 2004; Kogg, 2003; Klassen & Vachon, 2003; Zsidisin & Hendrick, 1998
Joint development Programs	Peters et al., 2011;Senge & Prokesch, 2011; Hong et al., 2009; Salam, 2008; Seuring & Muller, 2008; Vachon & Klassen, 2008; Simpson et al., 2007; Rao & Holt, 2005; Zsidisin & Hendrick, 1998; Florida, 1996
Influence- power use and code of conducts	Eltayeb et al., 2011; Michelsen, 2007; Clemens & Douglus, 2006; Hamprecht et al., 2005

Focal firms develop relationships with particular suppliers according to their capacity, capability, and the expected performance and outcome of the relationship. Sometimes, buyer firms want to keep the relationship only at arm's length and in other cases, buyers want to develop a relationship focused on mutual development and growth (Moeller et al., 2006). There are two types relationship evaluation: creating value through relationship and resulting value of relationship (Li, 2011). Former one advocates that relationship value is created through interaction while other advocates that value is the result of relationship.

The types of relationship can be classified by duration of relationship and the investment required developing and maintaining the relationship. The types of relationship depend upon the capability, capacity and intention of the supplier to adopt sustainability (Gao, et al., 2005; Murray et al., 2005).

Developing relationships with the supply chain partners can be a solution for sustainability adoption. However, developing a relationship is not an easy task (Ford, 1980). It includes many stages and efforts from both parties (Dwyer, 1987). In a relationship, both parties should have full involvement. Parties can share assets, funds and other physical and non-physical assets in order to achieve the objectives. Investment by companies would depend on the expected results. Vachon & Klassen (2008) found in their survey that relationship-building activities depend on the environmental performance of the supply chain partners.

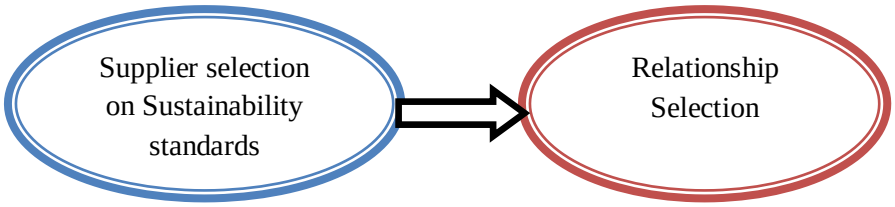

Figure 2.8 Selection of supplier relationship

Figure 2.8 indicates that a buyer firm can develop a supplier selection model for order allocation and then decide the type of relationship to be developed; based on the capacity, capability and current performance of the supplier (Lee et al., 2009). In the selection of the relationship type, the buyer firm should consider the trade-off between the cost and risk, and opportunities and benefits of a relationship with a particular supplier. Walker et al. (2008) found that the buyer-supplier collaboration provides opportunities for a win-win situation.

There is ample evidence in sustainable supply chain and relationship marketing literature that each relationship is related to certain benefits, cost, risks, and opportunities. Some of the benefits quoted in the literature are financial benefits (Eltayeb et al, 2011; Hong et al., 2009; Peters et al, 2011), operational benefits (Daugherty, 2011; Brito et al., 2008; Zsidisin & Hendrick, 1998) and sustainability adoption (Nakano & Hirao, 2011; Seuring & Muller, 2008; Smith, 2007; Rao & Holt, 2005). Cost factors include an increased cost of adoption and the cost of developing and maintaining a relationship.

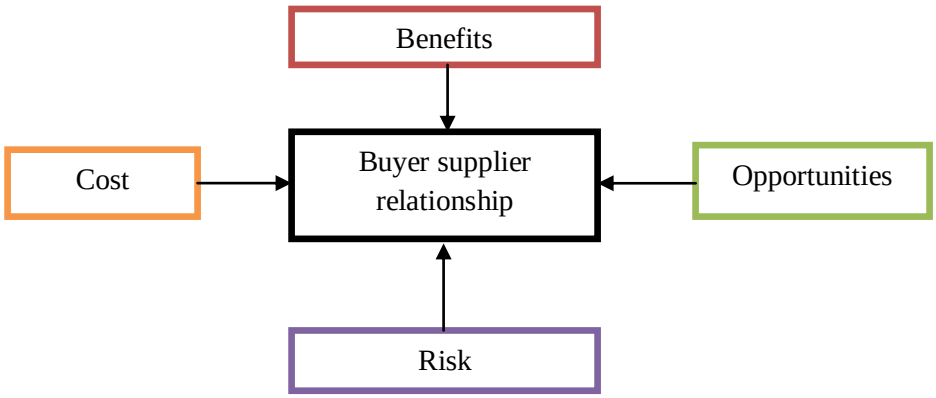

Figure 2.9 BOCR effect on buyer-supplier relationships

Many benefits of a relationship discussed in literature include financial benefits, operational benefits, and sustainability adoption (Figure 2.9). Some of the financial benefits of developing relationships are reduced cost of distribution (Closs et al., 2010), reduced inventory (Attaran & Attaran, 2007) and low cost on information (Hong et al., 2009). Operational benefits includes resource optimization, improved internal process and on time delivery (Zsidisin & Hendrick, 1998; Brito et al., 2008). Sustainability adoption includes low external pressure, improved products from sustainability criteria and a sustainable supply chain (Rocha et al., 2007).

Various opportunities are marketing and competitive advantages, improved technical capabilities of supply chain partners and mutual growth (Ageron et al., 2011; Hall, 2000). Besides this, the formation of every relationship formation incurs a cost. This cost includes the cost of the relationship, relationship performance and the cost of adoption (Buyukozkan & Cifci, 2010). Cost has been found to be the biggest barrier to sustainability adoption. Risk is related to the managerial capability of managing a relationship and achieving the sustainability objectives. Market related risks are dependency on a few suppliers, the bargaining power of the supplier and possible future forward integration by the supplier. Investment related risks include investment for bringing changes, investment for developing the relationship and its performance and dissolving relationship in between (Cramer, 2007). Other papers have discussed legalizing the relationship by contracts to avoid certain risks in the relationships (Ciliberti et al., 2010; Ni et al., 2010; Carter & Rogers, 2008).

Outcomes from this section:

- The impact of various relationship management strategies found in literature should be checked for the sustainability performance of the supply chain.
- There is need to develop a supplier selection model for a sustainable supply chain based on sustainability indicators.
- There is need to develop relationship selection with respect to a particular supplier based on the criteria of benefits, opportunities, cost and risk.
- This section results following hypothesis

  H3: Top management commitment is positively related to the incorporation of buyer supplier relationship (Supplier selection (H_{3a}), performance review (H_{3b}). and supplier development (H_{3a})) activities.

  H_{4a}, H_{4b}, H_{4c}, H_{5a}, H_{5b} H_{5c}, H_{6a}, H_{6b} H_{6c}: Buyer supplier relationships (supplier selection, performance review, and supplier development) positively increase the sustainability (economical, social, and environmental) performance of supply chain.

2.8 Sustainability adoption mechanism: an integrated framework

Since focal firms are more vulnerable to unsustainable practices of the suppliers, they are more interested in having a sustainable supply chain. Due to the increase of concern, each supply chain partner in a supply chain is ready to develop sustainable supplier source which ultimately can make whole supply chain sustainable.

The process of sustainability adoption across the supply chain or by supply chain partners begins with developing top management commitment towards sustainability (Smith, 2007; Rao & Holt, 2005). Commitment can be developed by creating external pressure from appropriate agencies and by creating awareness about sustainability and its expected benefits (Walker et al, 2008). The expectation of support from the different agencies for sustainability adoption helps to develop commitment. For example, tax rebate from the government for increasing sustainability performance and expected support from supply chain partners.

Once the top management is committed towards sustainability adoption, there are challenges in the beginning like the cost of adoption, cost of re-engineering the process, lack of infrastructure, technological requirements, human capabilities and many more.

A buyer firm in a supply chain should first select a supplier based on sustainability standards. This is equivalent to rewarding the efforts of suppliers for increasing sustainability

performance. The selected suppliers need to be scrutinized during the relationship selection process, which is specific to the particular supplier's capabilities and capacities (Hutchins & Sutherland, 2008). Relationship marketing literature indicates that relationship development and reaching the level of joint development is not always economical and successful (Hadjikhani & LaPlaca, 2013). A partner should be selected based on the expected outcomes of the relationship and the required level of investment. Relationship selection should also include other criteria such as s cost, benefits, opportunity, and the risk of each type of relationship with each supplier.

The performance of the relationship should be evaluated in terms of sustainability (Ashby et al., 2012). The relationship selection process helps companies to concentrate on each supplier and their specific needs. Suppliers that demonstrate high performance on sustainability standards will be rewarded with additional order allocations. The performance of a supply relationship can also substantiate a buyer's firm to terminate the relationship or change the relationship type with the supplier if the expected outcomes are not achieved.

The selection of suppliers based on sustainability standards and determining the type of relationship to be developed based on benefits, cost, opportunity, and risk of relationship with supplier. A number of researchers have also reported that environmental and social sustainability contributes to economical sustainability in the long run.

An improved performance of the supply chain will increase the benefits of sustainability adoption. This will reinforce the commitment of buyers and sellers to adopt sustainability. Since sustainability adoption is a continuous and on-going process, it needs continuous support from the supply chain partners. Increased benefits from sustainability adoption and continuous support from various sources, especially supply chain partners, help to develop a long lasting sustainable supply chain. The mechanism for developing sustainable supply chain is shown in Figure 2.10.

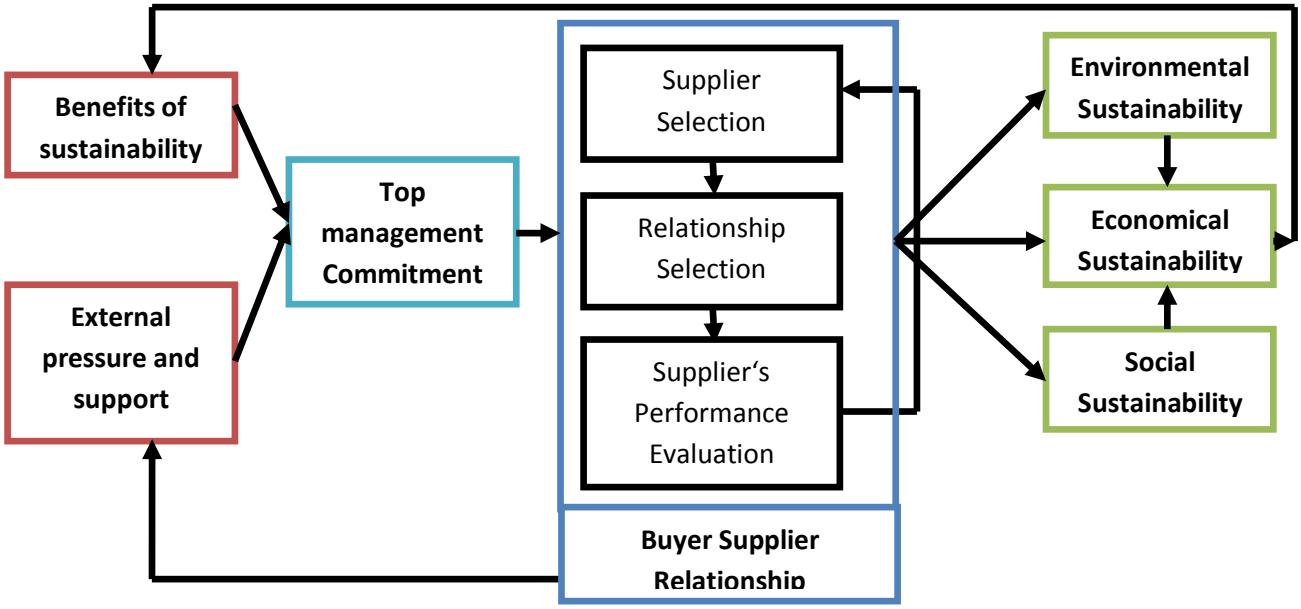

Figure 2.10 Sustainability adoption mechanisms in supply chain

2.9 Distribution of research papers

The number of paper identified for the literature review fulfilling the criteria as discussed in Section 2.2 are 102. The first paper was published in 1994 which discussed sustainable supply (Elkington, 1994). Most recent paper of Hsu et al. is publishes in the year of 2013. Most of the papers are published in the Journal of Cleaner Production which is 13 in number, followed by Supply Chain Management: An International Journal which has 10 papers. Other environment focused journal aggregated to the 11 publication. Business Strategy related journals accounted for the 8 publications. Most of the papers are from the operation and logistics journals like Journal of Operation and Production Management (5), European Journal of Operation Research (1), Journal of Physical Distribution and Logistics (6). Some of the papers were from very wide spectrum of the journals including: Journal of Wine Research, Biological Science, Employee Responsibility and Rights Journals, Corporate Governance and Corporate Environmental Strategy.

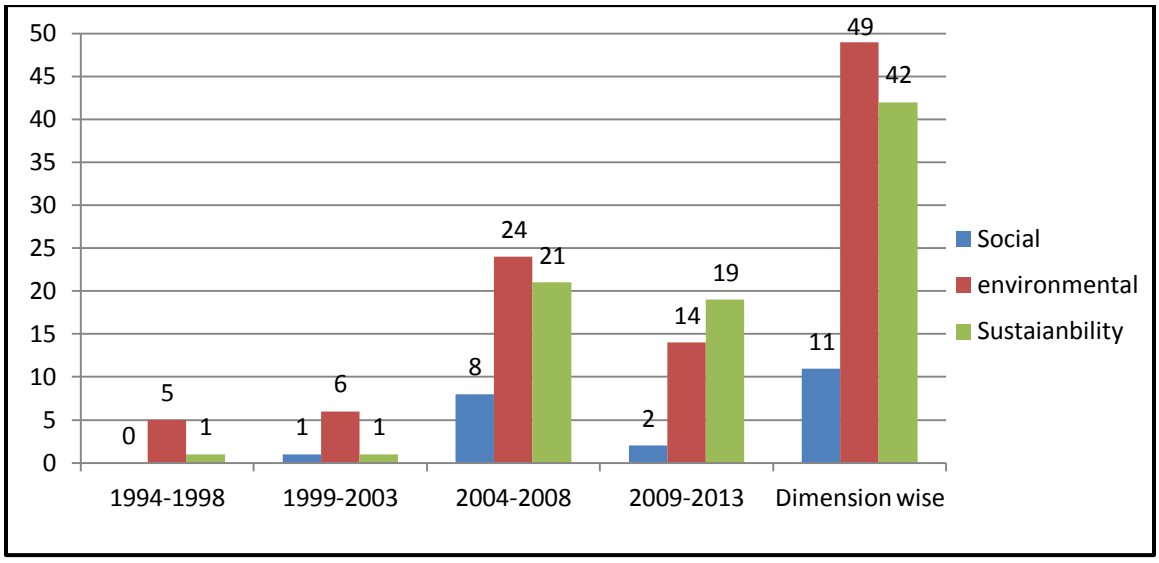

Figure 2.11 Distribution across sustainability dimension and time period

Most of the papers focused upon the environment followed by sustainability. Very few researches have been conducted on considering the social sustainability of the supply chain. First paper came in the time period of 1999-2003. This research was carried out by Carter and Jenning (2002) on the social sustainability and supply chain relationships. The numbers of papers published with respect to the time period are compared in Figure 2.11.

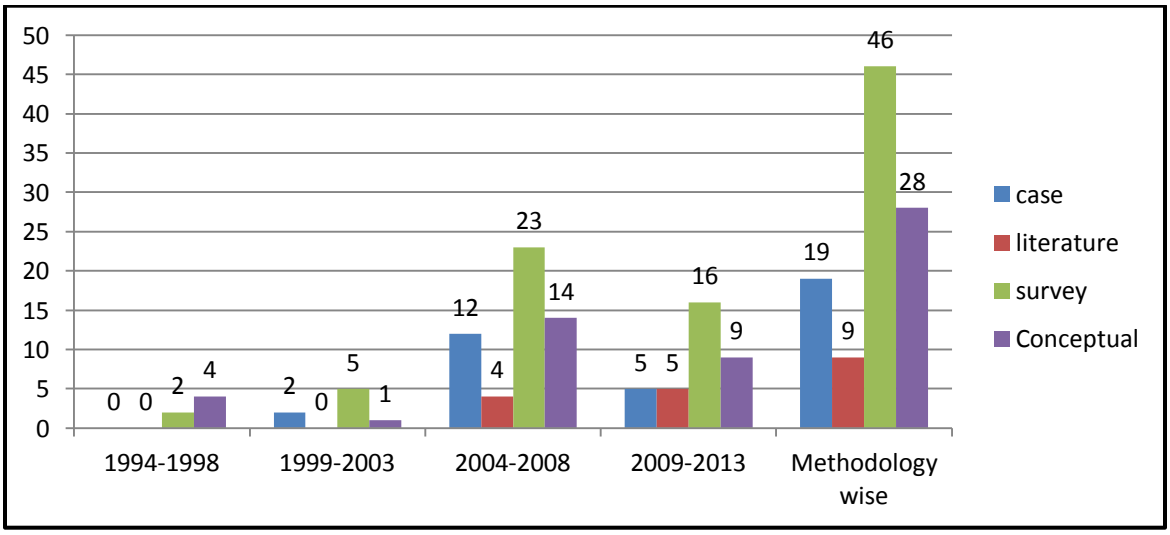

Figure 2.12 Methodology wise distribution

Figure 2.12 shows the distribution of research papers based on the research methodology used with respect to time periods. Nineteen authors used case study in their research. First case study based paper came in the year of 2000 by Hall. In the year of 2005,

there were four case study based research targeting food, manufacturing, automobile, and companies that integrated environmental practices. Forty six studies have used survey method to prove the hypothesis or a proposed model. Thirty seven studies out of 102 papers were literature review (9) and conceptual development (28).

2.10 Review of methodologies used

Earlier, various scholars and researchers have used various methodologies in the field of corporate sustainability performance assessment. On the basis of the gaps and importance highlighted in the various tables and figures earlier of, various tools and techniques have been identified and applied in present research. A snapshot of these methods and techniques has been provided in the following section.

2.10.1 Interpretive structural modeling and MICMAC

Interpretive structural modeling (ISM) is used for identifying and summarizing relationships among specific variables (Warfield, 1974). Fuzzy MICMAC is used for the classification of the variable under study based on the driving and dependence. Fuzzy has been incorporated to get the better understanding of the relationships among the enablers. Several authors have used an ISM MICMAC methodology to address various challenges in supply chain sustainability.

Several authors have used an ISM MICMAC methodology to address various challenges in supply chain sustainability. Diabata & Govindan (2011) used interpretive structural modeling and MICMAC for the modeling of drivers of green adoption in the aluminum industry. Svensson (2008) developed an ISM model to study transparency barriers in supply chain ethics. Qureshi et al. (2008) used ISM Fuzzy MICMAC for third party logistics service provides for developing a competitive advantage as well as for classifying their key criteria. Agarwal et al. (2006) modeled supply chain agility with the help of ISM and MICMAC. Govindan et al. (2009) proposed an ISM-based model for the supplier development criteria in the Indian automobile industry. Gorane & Kant (2013) used the ISM MICMAC approach for obtaining the interrelationship among the enablers of supply chain management.

2.10.2 Fuzzy Analytic Hierarchy Process

Fuzzy AHP is a multi-criteria decision making (MCDM) approach to assess the priorities level of the variables under consideration. Fuzzy set theory helps in dealing with the vagueness and fuzziness of uncertain environments. A selection of alternatives in fuzzy AHP is used by the fuzzy set theory in conventional AHP.

This methodology has been adopted by many authors into their researches. Kahraman et al. (2003) used Fuzzy AHP in multi-criteria supplier selection. Chan et al. (2008) also used this methodology for the global supplier selection. Leung and Cao (2000) used Fuzzy AHP for the comparison and ranking of the alternatives. Kwong and Bai (2003) determined the importance weights for the customer requirements in quality function deployment using Fuzzy AHP. Huang et al. (2008) explained the application of Fuzzy AHP in government funded research and development projects. Güngör (2009) used Fuzzy AHP in personnel selection problem. Similarly many other authors have preferred to use the Fuzzy AHP methodology for the selection, ranking, and comparison of the alternatives (Lee, 2009).

2.10.3 Fuzzy multi-objective linear programming

Fuzzy linear programming that includes fuzzy goals and fuzzy constraints. It can be solved like a normal linear programming problem after fuzzification. A fuzzy solution is the intersection of all fuzzy sets representing either fuzzy objectives or fuzzy constraints. Fuzzy multi-objective programming has been used in Chapter 4 for the order allocation among the suppliers.

Gao & Tang (2003) developed a multi objective linear programming model for order allocation. Kumar et al. (2004) used fuzzy goal programming for vendor selection. Weber et al (2000) used a mixed methodology by combining multi objective programming with DEA. Wang et al. (2009) used the AHP method for supply chain strategy selection and preemptive goal programming for order allocation. Chang & Kumar (2007) developed a model using a Fuzzy extended analytic hierarchy process. Shaw et al (2012) used Fuzzy AHP and Fuzzy multi-objective goal programming for supplier selection in low carbon emission supply chains.

2.10.4 Factor analysis

Factor analysis is a statistical technique that has been applied to assess interrelationship between observed and latent variables. This is mainly a data reduction tool, to extract the

number of factors (Malhotra & Dash, 2009). This technique assessed the co variation among the observed set of variables which collect their information. This technique has been developed by Charles Edward Spearman to use in the field of psychometrics. Since then this technique has been widely applied in various areas like behavioral studies, social sciences, operations management, marketing, CSR, environment performance measurement and other fields those are engaged in huge quantitative data.

Lin (2007) used factor analysis to address the issue of sustainability practices adoption in Taiwan's logistics industry. Zhu et al. (2008) used factor analysis for the confirmation of measurement model of green supply chain management implementation. Similarly, Vachon and Klassen (2008) used factor to analyze the role of collaboration for the environment management and manufacturing performance. Zhu et al. (2007) used factor analysis for knowing the outcomes of green supply chain management practices in Chinese companies.

2.10.5 Multiple regression analysis

Multiple regression analysis is an important statistical tool to investigate the relationship between a single dependent variable and numerous independent or predictor variables. This is "*a statistical technique that simultaneously develops a mathematical relationship between two or more independent variables and one interval scaled dependent variable* (Malhotra & Dash, 2009). This tool is effective in analyzing the causal relationship among the variables. The outcome of the regression analysis is an equation that signifies the best forecasting of a dependent variable from the several independent variables (Coakes et. al., 2006).

Many studies have used multiple regressions to check the causal relationship among the variables. Zhu & Sarkis (2004) used multiple regressions to check the causal relationship between adoption of green supply chain practices and operational performance. This methodology has also been used for the sustainability adoption in food supply chain (Pullman et al., 2010). Similarly, Lee (2009) used regression on the drivers of green practices adoption in supply chain. Eltayeb et al. (2011) used this methodology on the sustainability practices adoption and its impact on sustainability performance.

2.10.6 Structural equation modeling

Structural Equation Modeling is an extension of other multivariate tools, particularly, factor analysis and multiple regression analysis. According to Hair et al. (1987, p. 583) "SEM is a multivariate technique combining aspects of multiple regression and factor analysis to estimate a series of intercorrelated dependent relationships simultaneously". The growing complexity of the research problems in the behavioral and management sciences and the development of numbers of software have raised the significance of SEM (Raykov & Marcoulides, 1999; Kelloway, 1998; Hoyle, 1995). There are more than enough studies in the literature that used SEM.

Rao (2002) used SEM to know the green status of the supply chain. Hong et al. (2009) used this methodology to know the integrated impact of green practices, supplier, and internal process on the environmental performance. Carter & Jenning (2002) used SEM for knowing the relationship between social practices and supply chain performance. Sarkis et al. (2010) has used this methodology innovatively to check the mediating effect of training on the stakeholder holder pressure and its impact on sustainability adoption. Similarly many other studies have used SEM in their research (Hsu et al., 2013; Luo & Bhattacharya, 2011; Chang & Kuo, 2009; Rao & Holt, 2005).

2.11 Gaps identified from the literature

This review suggests that final product's sustainability performance can be improved by improvements in supply chain performance. This research also points out that companies adopt sustainability for two reasons: 1) external influence from multiple agencies like governments, NGOs, media and others and 2) the benefits of sustainability adoption by supply chain partners such as improved reputation, product differentiation, premium pricing and many more.

Relationship marketing is very useful for developing a sustainable supply chain. Firms should be conscious of this when developing a relationship. Suitable tradeoffs between the benefits, opportunity, cost, and risk should be maintained. Before developing a relationship, the selection of the supplier based on sustainability standards should be done. Relationship management increases the sustainability performance of the supply chain and reduces the resistance towards sustainability adoption. Following major gaps can be summarized as:

1) All the identified enablers of the sustainable supply chain should be analyzed for the interrelationship and classification to get the clearer picture.
2) There is need of knowing the influence of external influence and expected benefits of sustainability adoption on top management commitment for developing sustainable supply chain.
3) Buyer supplier relationship strategies should be identified and should be checked for its possible impact on the sustainability performance of the supply chain.
4) A supplier selection and order allocation model should be developed.
5) A relationship selection model should selected specific to suppliers considering the benefits, opportunities, cost, and risk of developing relationship in sustainable supply chain.

2.12 Conclusion

This study endeavoured to address the issue of sustainability adoption across the supply chain. Based on literature, the enablers of sustainability adoption have been identified. Author identified several barriers and enablers from the literature. Many buyer supplier relationship management strategies have been listed from the literature. It has been concluded from the literature that most of the problems related to sustainability adoption can be solved with the help of buyer supplier relationship management. As mentioned earlier, several measures have been taken to avoid compromising the quality of research. A supplier selection and relationship selection model has been proposed for sustainable supply chains. However, in a conceptual development, the thoughts of the researcher are significant in order to comprehend the concept.

Chapter 3
Modeling and classification of enablers of sustainable supply chain

Preview

This chapter provides an overview of enablers of sustainable supply chain. ISM methodology has been used to know the interrelationships among the enablers and Fuzzy MICMAC has been used to classify the enablers in to four categories based on driving and dependence power of the enablers. This chapter helps in developing the better understanding of the enablers of sustainable supply chain.

3 Introduction

The concept of sustainability is extended to supply chain management because of poor supplier quality that brings environmental and social burdens to the supply chain as well as to the finished product (Seuring & Muller, 2008; Mahler, 2007). In line with this, the concept of a sustainable supply chain becomes very interesting for the focal company that generally (i) rules the supply chain (ii) has direct contact with customers and (iii) gets involved in the designing of services or products (Seuring & Muller, 2008). As a result, focal companies are prone to be involved in unsustainable business practices in the supply chain due to suppliers' activities (Walker et al., 2008; Koplin et al., 2007). Deviating from social and environmental standards has negative consequences for a focal firm's reputation (Koplin et al., 2007).

Carter and Rogers (2008) define a sustainable supply chain as the integration of key business processes with supply chain partners to achieve environmental, social, and economical sustainability objectives. Some of the sustainability practices are waste management, pollution, energy management, reverse logistics, and packaging improvements. Social sustainability practices include community and social development, transparency of work and employee development. The motivation to achieve sustainability goals is the result of adoption of a sustainability culture throughout the supply chain. According to Vassalo and Smith (2011), a sustainability culture refers to incorporating a sustainability management system with the organizational goals by providing sufficient resources and support. Evaluating sustainability efforts along with seeking opportunities creates a culture of sustainability. A Sustainability culture also refers to performing comparatively better on sustainability standards, since sustainability is dynamic in nature and has scope for continuous development over time

(Bagheri & Hjorth, 2007). As per the definition proposed by Carter & Rogers (2008), a focal company should initiate the process of relationship building to integrate key processes across the supply chain for achieving sustainability objectives.

Due to an increase in the pressure from stakeholders and the negative effect of a supply chain partners' activities on the sustainability of products, focal firms should identify the factors that can develop a commitment by the top management in the supply chain partners. In addition, it should formulate relationship strategies for supporting supply chain partners during the implementation of sustainability practices to overcome barriers. The focal firm needs to provide enough opportunities for the supply chain partners to collaborate and develop a sustainability culture.

The enablers of a sustainable supply chains have been analyzed using the ISM methodology that demonstrates the interrelationships between enablers and their levels in the ISM model. Further, these enablers are categorized depending upon their driving power and dependence using a Fuzzy MICMAC to understand the relevance of the variables. In doing so, this research intends to contribute by modeling and categorizing the various enablers of sustainability adoption and to suggest directions for practicing managers regarding the management of enablers during the different stages of sustainability adoption by supply chain partners.

3.1 Identification of the enablers of sustainable supply chain

The growing importance of a relationship based supply chain for dealing with sustainability has motivated us to concentrate on a literature search for relationship management and sustainable supply chains. A review of the literature was done to identify the enablers of sustainability supply chains (Table 3.1). In any adoption process, there are three types of enablers required for initiating the process: implementing the process and improving the process continuously. The trends for the types of enablers in sustainability adoption found in literature are listed as: (1) the creation of a favorable environment for sustainability adoption (Seuring & Muller, 2008; Klassen & Vachon, 2003), (2) the implementation of sustainability in the supply chain (Walker et al., 2008; Smith, 2007; Rao & Holt, 2005) and (3) the development of a sustainability culture (Holt & Ghobadian, 2009; Clemens & Douglus, 2006). The interrelations among the categories of enablers are shown in Figure 3.1. In this section, enablers are discussed to get a better understanding of sustainability adoption.

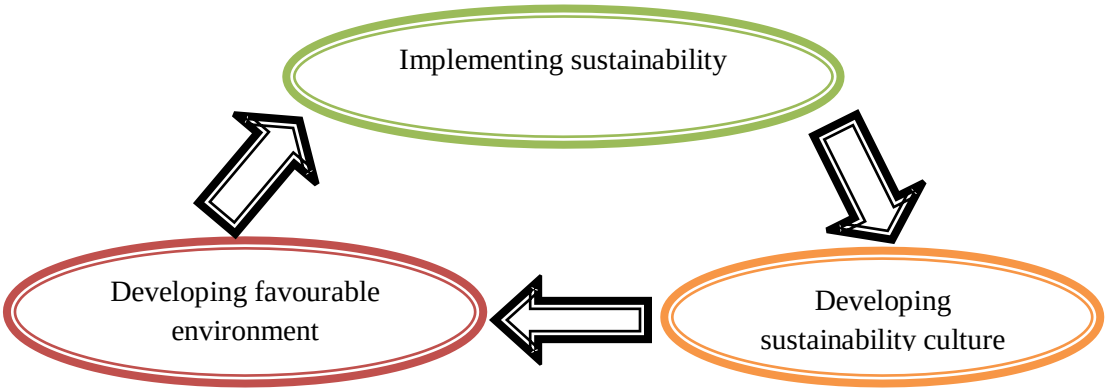

Figure 3.1: Interrelations among types of enablers

3.1.1 External pressure

Many researchers endorse the notion that external pressure on a company plays a vital role in initiating sustainability practices in the supply chain. These external and internal pressures influence companies to adopt sustainability practices resulting in the formulation of sustainability strategies for the supply chain (Bommel 2010). Pressure from various agencies also helps in the adoption of green procurement in the supply chain (Salam, 2008). Similarly, environmental performances are enforced through legislation, laws, and regulations (Holt & Ghobadian 2009; Nakano & Hirao 2011). Zhu et al. (2008) emphasized that legal pressure and community involvement play a key role in initiating sustainability practices. Faisal (2010) talked about regulatory lobbying by competing firms who have developed an environment friendly system. Non-compliance to these pressures results in a fear of losing business (Nakano & Hirao, 2011; Elkington, 1994), negative news in the media and on social networking sites (Darnall 2008; Markley & Davis, 2007), litigation problems (Walker et al., 2008; Clemens & Douglus, 2006) and consumer dissatisfaction (Pandey & Wali, 2011; Closs et al., 2010; Matos & Hall, 2007).

3.1.2 Incentives and support from agencies

Many agencies that support companies during the adoption of sustainability practices provide various incentives (Seuring & Muller, 2008; Lin, 2007). These incentives may range from a government tax rebate to monetary and technological help from stakeholders (Bitzer et al., 2008; Matos & Hall, 2007). Bitzer et al. (2008) explained the role of NGOs in the sustainable coffee supply chain, where these NGOs provide training and consultancy to villagers in the Netherlands. Research-based NGOs help companies become sustainable

through research and development (Muller et al., 2009). Brito et al. (2008) studied many NGOs involved in training skilled labor to enhance their skills for a sustainable fashion retail chain. Likewise, the governments of many countries conduct a variety of motivational programs to encourage environmental sustainability and social actions in business practices (Lin, 2007; Ytterhus, 1999). Focal companies offer support for sharing assets, money, resources and training to supply chain partners' employees. These offers help partners develop the intention to adopt sustainability practices.

3.1.3 Demand from customers and stakeholders

The objective of any business process is to act in accordance with the demands of its stakeholders (Koplin et al., 2007). Rocha et al. (2007) affirmed that the demand for sustainable products by the community is the main reason behind the adoption of sustainability practices by companies. Integration of environmental and social standards increases customer satisfaction and augments the legitimacy of the supply chain (Matos & Hall, 2007; Dasgupta & Sharma; 2009). A similar trend was also found in a green cotton textile supply chain by Kogg (2003). Thus, it can be said that consumer demand acts as the main trigger for a sustainable supply chain (Diabata & Govindan, 2011; Bommel, 2010; Pandey & Wali, 2010).

3.1.4 Awareness

The lack of awareness among buyers and sellers leads to differences in environmental and economic standards across the supply chain (Rao & Holt, 2005). Therefore, awareness of sustainability practices among supply chain partners is essential for the adoption and maintenance of environmental standards in the supply chain (Zutshi & Sohal, 2004). While awareness of sustainability reduces the resistance from supply chain partners (Diabata & Govindan, 2011), it also develops long-term relational perspectives (Ellis & Higgins, 2006). Moreover, awareness regarding the benefits of sustainability like capacity building and development, cost reduction, marketing and competitive advantage, can help in justifying a commitment to sustainability by supply chain partners (Rao & Holt, 2005).

3.1.5 Top management commitment and support

Ageron et al. (2011) and Ellis and Higgins (2006) have demonstrated the vital role of top management's commitment for the internal coordination and adoption of social and ethical

standards across the supply chain through an empirical study of sustainable supply chains. Studies have shown that organizations, which are serious about sustainability, can integrate sustainability into their corporate policy (Seuring & Muller, 2008) and develop relationships with supply chain partners for resource sharing (Zhu et al., 2008; Zutshi & Sohal, 2004). Thus, when the top management is committed, it can bring forth a positive relationship for implementing an environmental management system across the supply chain (Salam, 2008). In addition, the commitment of the focal company is also necessary to influence the supply chain (Nakano & Hirao, 2011; Darnall, 2008).

3.1.6 Resource sharing

Zutshi & Sohal (2004) affirmed that the sharing of resources in the supply chain motivates suppliers to implement an environmental management system (EMS). Sharing resources is integrated with the needs and capabilities of the supply chain partners. The resources include employees, patents, finances (Peters et al., 2011), technology (Lin, 2007) and knowledge (Klassen & Vachon, 2003). Further, Brito et al., (2008) asserted that the optimization of available resources through sharing among the supply chain partners, like transportation resources, improves the sustainability performance of the supply chain. Sharing can be encouraged through seminars, workshops, and education programs for supply chain partners (Seuring & Muller, 2008; Lambert & Cooper, 2000). Focal companies can encourage sharing through the dissemination of skills, technical expertise, and low cost solutions and thus help supply chain partners meet social and environmental standards (Smith, 2007).

3.1.7 Capacity building and development

One of the benefits of adopting sustainability into the supply chain is capacity building and development (Lee, 2008; Klassen & Vachon, 2003). The lack of capability acts as the main hindrance for the adoption of sustainability by supply chain partners (Ageron et al., 2011; Lambert, 2008). This lacuna can be overcome by working together, building, and developing each other's capacities and capabilities for future sustainability (Zhu et al., 2008). Many authors believe that this kind of partnership in the supply chain has already taken centre stage for building and developing supply chain partners' capacity (Zsidisin & Hendrick, 1998). For example, improved understanding of technology among supply chain partners can create a favorable attitude towards the change (Klassen & Vachon, 2003).

3.1.8 Joint effort and planning

Joint effort and planning includes a combined development of technology, jointly setting goals for the supply chain, and conducting joint activities in order to increase the capability of the entire supply chain (Rao & Holt, 2005, Lambert & Cooper, 2000). The activities that can be handled jointly are finding environmental solutions (Vachon & Klassen, 2008; Rocha et al., 2007), launching new materials for products (Olorunniwo & Li, 2010), goal setting (Matos & Hall, 2007), technology development and deployment (Attaran & Attaran, 2007), design (Cilibereti et al., 2008), logistics integration (Fortes, 2009), updating auditing standards (Rao & Holt, 2005) and processes (Rocha et al., 2007). Joint development and planning for long-term relationships is possible through mutual trust among supply chain partners (Hong et al., 2009).

3.1.9 Monitoring and auditing supply chain partners

Monitoring and auditing supply chain partners helps in their development (Koplin et al., 2007). It is necessary for extending sustainability practices across the supply chain (Seuring & Muller, 2008) since most of the negative impacts are due to poor supplier quality (Carter & Rogers, 2008; Walker et al., 2008). Therefore, auditing of supply chain partners on sustainability standards and making sustainability reporting mandatory, is critical for the conceptualization of sustainability in the supply chain (Seuring & Muller, 2008; Blowfield, 2005). This helps in setting a code of conduct for acceptable sustainable behavior and in restricting unethical and unsustainable practices (Cilibereti et al., 2008; Blowfield, 2005). Selection of supplier, including sustainability standards, increases sustainability performance (Koplin et al., 2007; Walton et al., 1998). Improved scrutiny of supply chain partners moves the supply chain towards sustainability (Brito et al., 2008).

3.1.10 Competitive and marketing advantage

A supply chain working collaboratively to achieve sustainability enjoys competitive (Ytterhus, 1999; Kogg, 2003) and marketing (Smith, 2007; Clemens & Douglus, 2006) advantages. Companies, futuristic in approach, adopt sustainability to enjoy their competitive and marketing advantages (Pullman et al., 2010). The various competitive and marketing advantages discussed in the literature are as follows: cost reduction (Eltayeb et al., 2011; Zhu et al., 2008), improved operational performance (Bai & Sarkis, 2010; Rocha et al., 2007),

increased quality (Ytterhus, 1999; Eltayeb et al., 2011) new market opportunities (Markley & Davis, 2007), premium pricing (Ageron et al., 2011), product differentiation (Kogg, 2003), improved corporate and brand image (Simpson et al., 2007; Keatinga et al., 2008) and customer value and satisfaction (Smerecnik & Anderson, 2011; Sagar, et al., 2006).

3.1.11 Information sharing

Bommel (2010) and Lee (2008) suggested that controlling the flow of goods, services, and related information as part of the sustainability integration strategy for a supply chain. The exchange of feelings, ideas, and feedback among supply chain partners reduces the resistance for implementing an environmental management system across the supply chain (Zutshi & Sohal, 2004; Klassen & Vachon, 2003). Limited information and information processing capabilities affect the decision making process of a sustainable supply chain (Wu & Pagell, 2011; Mahdavi et al., 2009; Koplin et al., 2007). Implementing environmental standards in the supply chain requires sharing information about suppliers' environmental impact that includes harmful emission levels, waste minimization, and energy management (Darnall 2008; Seuring & Muller, 2008). Nakano and Hirao (2011) used three case studies to illustrate that gathering of information from the supply chain partners improves the environmental performance of products. Sharing information includes the sharing of real time data about the production process, input materials, source of input materials, available assets, resource requirements and so on (Lambert, 2008; Rahman, 2004; Haq, 1989).

3.1.12 Trust and commitment among partners

A good relationship among supply chain partners develops trust and commitment for each other (Hall, 2000) and diminishes the resistance to change (Klassen & Vachon, 2003). Conversely, with a lack of trust, the relationship hinders the extension of sustainability across the supply chain (Tejpal et al., 2013; Senge & Prokesch, 2010). Trust building activities like collaborative communication and knowledge sharing increase efforts towards sustainability in the supply chain (Bai & Sarkis, 2010; Rao & Holt, 2005). By giving importance to knowing and working to solve a supply partner's problems, a long-term perspective in the relationship is created that increases the trust and commitment among the partners (Blitzer et al., 2008; Keatinga et al., 2008). Trust and commitment increases the assessment of the supply chain partners by removing vagueness, which consequently improves the sustainability performance

of supply chains (Olorunniwo & Li, 2010). Trust based relationships do well in cross-functional teams, management of loosely coupled units, and the adoption of green practices (Peter et al., 2011). Cooperation for achieving sustainability objectives, long-term relationships, collaborating on material procurement, parts, equipment, and services will increase the trust among supply chain partners, which results in increasing the overall sustainability of the final product (Daugherty, 2011; Parashar & Venkataramanaiah, 2008; Venkat & Parashar, 2008). Trust building with stakeholders, including supply chain partners, improves the performance of the supply chain (Vermeulen & Ras, 2006; Carter & Jenning, 2002;).

3.1.13 Knowing and solving supply chain partners' problems

Supply chain partners may have resistance to change (Ageron et al., 2011), but knowing the problems of supply chain partners is the biggest step towards sustainability (Handfield et al., 2005). Some companies do not know how to bring the necessary managerial and technical changes to their organization in order to become sustainable (Lee, 2008). There is need for proper and up to date auditing standards to identify problem areas (Rao & Holt, 2005). The various problems associated with sustainability should be addressed in collaboration with the focal company. For example, Kogg (2003) found that the focal company should help the cotton producing farmers by providing training and education for greening the cotton textile supply chain. Evaluating supply chain partners, based on sustainability standards and then mutually solving the problems and causes of deviance, facilitates the sustainability of the supply chain (Vachon & Klassen, 2006). Knowing the operations of supply firms contribute to the extension of sustainability in the supply chain for dealing with conceptual and practical problems (Senge & Prokesch, 2010; Smerecnik & Anderson, 2011).

3.1.14 Cost reduction

One of the major contributors for the lack of initiative towards sustainability is cost of adoption (Linton et al., 2007; Ageron et al., 2011). Previous studies found that if supply chain partners in collaborated, they could solve this problem (Bowen et al., 2001; Lambert, 2008). The adoption of sustainability includes waste minimization (Zhu et al., 2007), low penalties and fines (Zutshi & Sohal, 2004; Rocha et al., 2007), operational efficiency (Tsoulfas & Pappis, 2006; Eltayeb et al., 2011) and the optimization of resources, which eventually decreases the cost of production (Clemens & Douglus, 2006; Walker et al., 2008). In the long run, cost

reduction is one of the major benefits of adopting sustainability practices. When firms look to sustainability as a cost saving measure, it becomes easier to develop a commitment for sustainability practices across the supply chain (Vermeulen & Ras, 2006; Brito et al., 2008).

3.1.15 Long-term partnership

In the long run, managing relationships in the supply chain increases the sustainability performance (Nakano & Hirao, 2011; Walker et al., 2008). Long-term partnerships increase the socialization among supply chain partners (Bai & Sarkis, 2010; Brito et al., 2008). Working in partnership helps with decision making on sustainability issues by minimizing various uncertainties (Carter and Rogers 2008), as supply chain partners always get updated information about each other's processes (Klassen & Vachon, 2003; Hong et al., 2009). A long-term partnership also increases the trust (Olorunniwo & Li, 2010) and commitment (Carter & Jenning, 2002; Keatinga et al., 2008) among the partners. Upgrading new environmental technology, environmental innovation, increased environmental performance, energy efficiency, and minimizing the cumulative impact of the supply chain on the environment and society are some of the benefits of working in a long-term relationship (Diabata & Govindan, 2011; Vachon, 2007).

Table 3.1 Enablers of sustainable supply chain

S.N.	Enabler	Definition	Sources used
1	External pressure	Pressure from various agencies like NGOs, Media Civil Society etc.	Buyukozkan & Cifci, 2010; Sarkis et al., 2010; Routroy, 2009; Zhu et al., 2008b; Seuring & Muller, 2008; Walker et al., 2008, Lee, 2008; Seuring & Muller, 2008; Zhu et al., 2008a; Smith, 2007; Clemens & Douglus, 2006; Vachon & Klassen, 2008; Darnall, 2008; Lin, 2007; Markley & Davis, 2007; Ytterhus, 1999; Klassen & Vachon, 2003; Ytterhus, 1999
2	Support By various agencies	Expectation of getting support from various sources in term of money, technology, resources etc.	Bommel, 2010; Seuring & Muller, 2008; Bitzer et al., 2008; Cote et al., 2008; Lin, 2007; Matos & Hall, 2007; Simpson & Power, 2005
3	Demand of customer and other stakeholders	Consumer demanding and supply chain partners interested in sustainable products.	Diabata & Govindan, 2011; Holt & Ghobadian, 2009; Zhu et al., 2008a; Seuring & Muller, 2008; Walker et al., 2008; Rocha et al., 2007; Smith, 2007; Hall, 2000

4	Awareness	Awareness about sustainability practices and its benefits among supply chin partners.	Teuteberg & Wittstruck, 2010; Buyukozkan & Cifci, 2010; Zhu et al., 2008b; Walker, et al., 2008; Ellis & Higgins, 2006; Rao & Holt, 2005
5	Top Management Commitment and support	Commitment of supply chain partners' top management to incorporate sustainability practices and providing all possible support.	Ageron et al., 2011; Daugherty, 2011; Closs et al., 2010; Holt & Ghobadian, 2009; Hong et al., 2009; Lee, 2008; Zhu et al., 2008a; Zhu et al., 2007a; Rocha et al., 2007; Ellis & Higgins, 2006; Handfield et al., 2005; Zhu & Sarkis, 2004
6	Sharing resources	Sharing of the required key resources with supply chain partners.	Ageron et al., 2011; Wu & Pagell, 2011; Bai & Sarkis, 2010; Ni et al., 2010; Lee, 2008; Bitzer et al., 2008; Lee, 2008; Vachon, 2007; Smith, 2007; Klassen & Vachon, 2003; Young & Kielkiewicz-Young, 2001; Elkington, 1994
7	Capacity Building and Development	Building the capacity of supply chain partners and developing the existing capacity.	Wu & Pagell, 2011; Ageron et al., 2011; Lee, 2008; Markley & Davis, 2007; Klassen & Vachon, 2003
8	Joint efforts & Planning	Joint development with the supply chain partners for setting and achieving sustainability goals.	Peters et al., 2011; Hong et al., 2009; Seuring & Muller, 2008; Rao & Holt, 2005; Zsidisin & Hendrick, 1998; Florida, 1996
9	Monitoring & auditing Supply chain partners	Monitoring the sustainability performance of supply chain partners and updating the auditing standards to check the deviance.	Ageron et al., 2011; Darnall, 2008; Beske et al., 2008; Clemens & Douglus, 2006; Rao & Holt, 2005; Hamprecht et al., 2005
10	Competitive and marketing Advantage	Outsmarting the competitor, new business opportunities.	Ageron et al., 2011; Nakano & Hirao, 2011; Vermeulen & Seuring, 2009; Walker et al, 2008, Seuring & Muller, 2008; Elkington, 1994
11	Information Sharing	Sharing of two-way real time information on the sustainability efforts and problems faced by supply chain partners.	Bahl et al., 2011; Nakano & Hirao, 2011; Wu & Pagell, 2011; Walker et al., 2008; Darnall, 2008; Lee, 2008; Seuring & Muller, 2008; Vachon, 2007; Zhu & Sarkis, 2004
12	Trust and commitment among partners	Removing the vagueness in sustainability efforts and its results.	Senge & Prokesch, 2011; Bai & Sarkis, 2010; Darnall, 2008; Keatinga et al., 2008; Bitzer et al., 2008; Markley & Davis, 2007; Tsoulfas & Pappis, 2006; Rao & Holt, 2005; Matos & Hall, 2000

13	Knowing and solving supply chain partners' problems	Knowing the point of resistance by supply chain partners and providing solution to remove the resistance.	Gopalakrishnan et al. 2012; Ageron et al., 2011; Wu & Pagell, 2011; Bai & Sarkis, 2010; Bitzer et al., 2008, Lee, 2008; Bitzer et al., 2008; Lee, 2008; Walker et al., 2008; Cramer, 2007; Smith, 2007; Vachon, 2007; Zutshi & Sohal, 2004; Klassen & Vachon, 2003; Young & Kielkiewicz-Young, 2001; Elkington, 1994
14	Cost Reduction	Reduction of cost due to relationship development and sustainability adoption.	Gopalakrishnan et al. 2012; Ageron et al., 2011; Buyukozkan & Cifci, 2010; Muller et al., 2009; Brito et al., 2008; Markley & Davis, 2007; Linton et al., 2007; Vermeulen & Ras, 2006; Simpson & Power, 2005; Bowen et al., 2001
15	Long term Partnership	Setting long term objectives for working together	Gopalakrishnan et al. 2012 ; Daugherty, 2011; Bai & Sarkis, 2010; Walker et al., 2008, Lee, 2008; Seuring & Muller, 2008; Attaran & Attaran, 2007; Markley & Davis, 2007; Vermeulen & Ras, 2006, Simpson & Power, 2005; Zsidisin & Hendrick, 1998

3.2 Introduction to research methodologies

This study has used Intepretive structural modeling for analyzing the relationship among the enablers of the sustainability adoption across supply chain. This methodology is used and recommended by many authors for analyzing the similar type of problems.

3.2.1 Introduction of ISM

Interpretive structural modeling (ISM) is used for identifying and summarizing relationships among specific variables (Warfield, 1974). Several authors have used an ISM MICMAC methodology to address various challenges in supply chain sustainability (Mandal & Deshmukh, 2008; Thakkar et al., 2006). Diabata and Govindan (2011) used interpretive structural modeling and MICMAC for the modeling of drivers of green adoption in the aluminum industry. Svensson (2008) developed an ISM model to study transparency barriers in supply chain ethics. Qureshi et al. (2008) used ISM Fuzzy MICMAC for third party logistics service provides for developing a competitive advantage as well as for classifying their key criteria. Agarwal et al. (2006) modeled supply chain agility with the help of ISM and MICMAC. Govindan et al. (2009) proposed an ISM-based model for the supplier development

criteria in the Indian automobile industry. Gorane & Kant (2013) used the ISM MICMAC approach for obtaining the interrelationship among the enablers of supply chain management.

The ISM establishes the interrelationship among the poorly communicated and structured variables in the literature, based on expert opinion and group discussions (Ravi & Shankar, 2005; Jharkharia & Shankar, 2004; Mandal & Deshmukh, 1994; Warfield, 1974). The number of experts in most of the studies varied from five to fifteen (Qureshi et al., 2008). The unique characteristics of the ISM methodology are as follows (Warfield, 1974; Svensson, 2008; Diabata & Govindan, 2011; Singh et al., 2014):

- It is interpretive, i.e., the judgment of the group decides whether and how the different elements are related.
- It is based on mutual relationships for extracting the structure of the complex set of variables.
- It is a modeling technique for portraying the overall structure of all relationships among variables.

3.2.1.1 Steps of ISM methodology

The steps involved in the ISM technique are (Warfield, 1974; Svensson, 2008) shown in Figure 3.2.

- A pair wise comparison is done to obtain a Structural Self-Interaction Matrix (SSIM) that is checked for transitivity.
- SSIM is used to develop a Reachability Matrix (RM) and is partitioned into different levels.
- A conical matrix is developed from the reachability matrix by rearranging the variables according to the different levels.
- Based on the above steps, a directed graph (digraph) is drawn and transitivity links are removed.
- The digraph is converted into an ISM model by replacing the nodes of the elements with statements.
- The ISM model is checked for conceptual inconsistency and necessary modifications are incorporated.

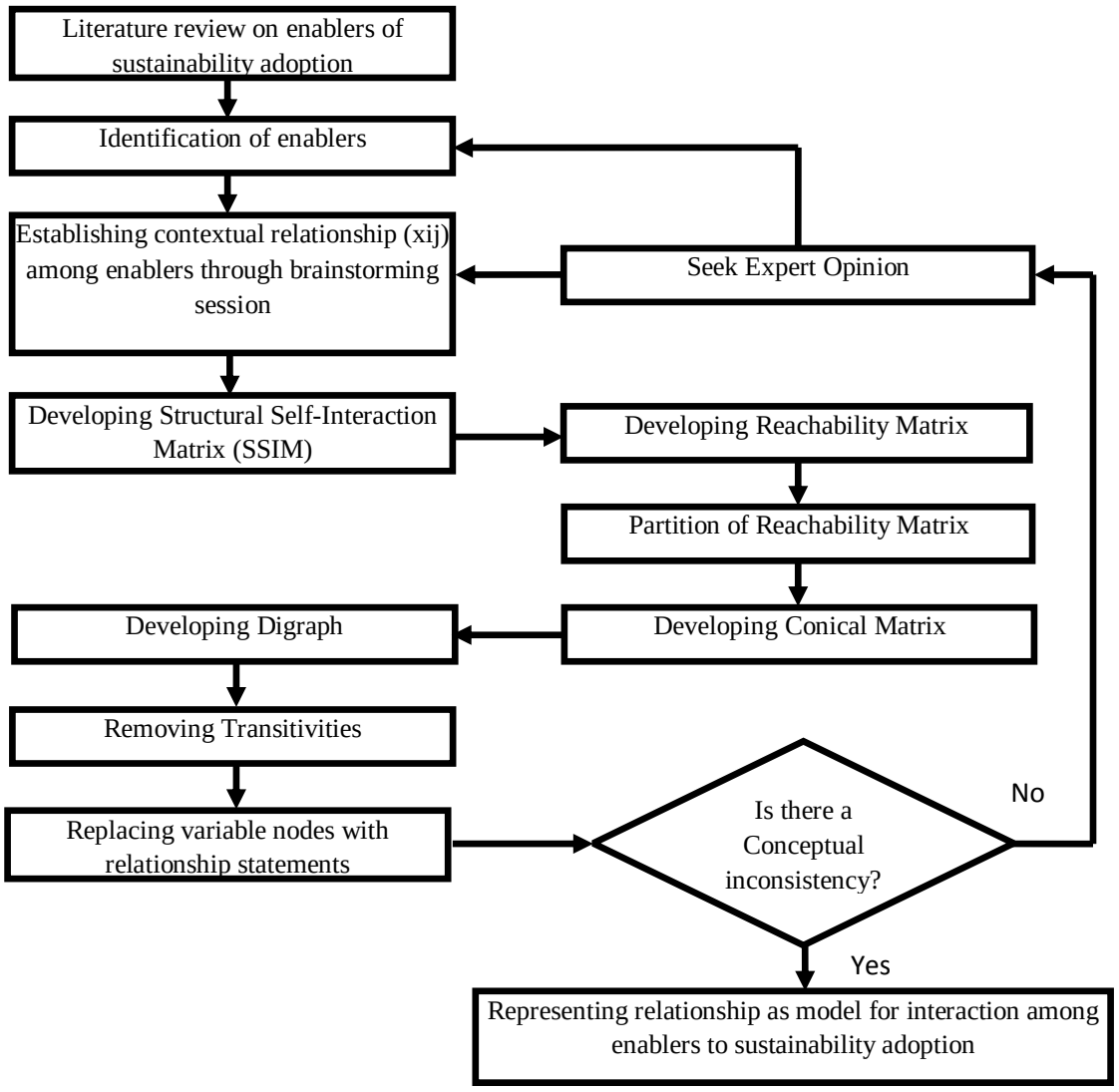

Figure 3.2 ISM methodology flow chart

3.2.2 Introduction of Fuzzy MICMAC

The direct and indirect relationships among the variables were determined using MICMAC (Matrice d'Impacts Croisés Multiplication Appliquée á un Classement). The MICMAC method was first introduced by Duperrin and Godet (1973). As per Watson (1973), MICMAC enables not only confirmation of the importance of certain variables, but also uncovers certain variables that play an important role due to their indirect actions. An examination of the direct relationships may reveal that criteria having a strong direct impact can suppress hidden criteria, which at times may substantially influence the system under consideration (Saxena & Vrat, 1990). The total driving power and total dependence of each criterion are calculated from the direct reachability matrix (DRM) for the classification of

variables. The MICMAC analysis classifies the key criteria into four classifications; dependent criteria, independent criteria, autonomous criteria and linkage criteria.

The Fuzzy theory has been applied to the traditional MICMAC for possible reachability based on the driving power and dependence of each criterion. FMICMAC derived from Fuzzy DRM can be of great help as the importance of a criterion is measured less by its direct interrelationships and more by many indirect interrelationships (Saxena et al., 1992). FMICMAC helps in the critical investigation of each criterion by using a fuzzy scale.

3.3 ISM model and fuzzy MICMAC classification for Indian automobile supply chain

In this study, an automotive supply chain was used for the case development. Brito et al. (2008) had suggested the involvement of experts including retailers, distributors, suppliers, and other service providers from the supply chain to identify sustainability enablers. Care was taken to invite 10 participants (Five suppliers, three distributors, and two experts from an automobile company) having more than ten years of experience in the industry. Many sessions were organized to meet the study objective. In the first session, all the participants were briefed about the objective of the study to prepare them for the brainstorming session. In addition, the problems faced by the supply chain partners were discussed to identify the appropriate enablers.

Enablers identified from the literature were distributed among the participants, who were asked to add or subtract any of the enablers. The literature related to each enabler was also circulated in order to get a proper insight for each one. After ten days, another brainstorming session was organized to establish the inter-relationships among the various enablers. Each participant agreed upon fifteen enablers and their interrelationships after a brainstorming session.

3.3.1 Structural self-interaction matrix

The relationships among the variables were established (e.g., i and j) by comparing a pair of variables and asking “leads to” types of questions. The associated direction of the relation, for example, whether i leads to j or vice versa, was questioned. Four symbols were used for establishing the existing contextual relationship between the two sub-variables (i and j) under consideration. They are as follows:

Table 3.2 Structural self-interaction matrix (SSIM)

S.No	Enablers	15	14	13	12	11	10	9	8	7	6	5	4	3	2
1	Pressure by various agencies	O	O	O	O	O	O	O	O	O	O	V	V	A	O
2	Incentives and support by various agencies	O	O	O	O	O	O	O	O	O	O	V	O	O	
3	Demand of customer and other stakeholders	O	O	O	O	O	O	O	O	O	O	V	V		
4	Awareness	O	O	O	O	V	O	V	O	O	V	V			
5	Top management commitment and support	V	O	O	O	V	O	V	V	O	V				
6	Resource Sharing	V	O	V	V	A	O	A	V	O					
7	Capacity building and development	A	O	A	A	A	V	A	A						
8	Joint efforts and planning	A	V	A	A	A	V	O							
9	Monitoring and auditing Supply chain partners	O	O	V	O	O	O								
10	Competitive advantage	A	A	A	A	A									
11	Information sharing	V	V	O	V										
12	Trust and commitment among partners	X	V	X											
13	Knowing and solving supply chain partners problems	X	O												
14	Cost reduction	A													

V = Variable i will help achieve variable j

A = Variable j will help achieve variable i

X = Variable i and j will help achieve each other

O = Variables i and j are unrelated.

Based on the contextual relationships, the Structural Self Interaction Matrix (SSIM) was developed for the fifteen enablers of sustainability adoption by supply chain partners. The SSIM is depicted in Table 3.2.

3.3.2 Reachability matrix

A structural self-interaction matrix was used to develop the reachability matrix, indicating the relationship between the variables in binary form. The various relationships among the variables depicted by symbols V, A, X, O used earlier in SSIM were replaced by binary digits 0 and 1.

Table 3.3 Initial reachability matrix

S.N.	Enablers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Pressure by various agencies	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
2	Incentives and support By various agencies	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
3	Demand of customer and other stakeholders	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0
4	Awareness	0	0	0	1	1	1	0	0	1	0	1	0	0	0	0
5	Top Management Commitment and support	0	0	0	0	1	1	0	1	1	0	1	0	0	0	1
6	Resource Sharing	0	0	0	0	0	1	0	1	0	0	0	1	1	0	1
7	Capacity Building and Development	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
8	Joint efforts and Planning	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0
9	Monitoring and auditing Supply chain partners	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0
10	Competitive Advantage	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
11	Information Sharing	0	0	0	0	0	1	1	1	0	1	1	1	0	1	1
12	Trust and commitment among partners	0	0	0	0	0	0	1	1	0	1	0	1	1	1	1
13	Knowing and solving supply chain partners problems	0	0	0	0	0	0	1	1	0	1	0	1	1	0	1
14	Cost Reduction	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
15	Long term Partnership	0	0	0	0	0	0	1	1	0	1	0	1	1	1	1

The following rules were used to substitute V, A, X, O of SSIM to get the reachability matrix.

- If the (i, j) entry in the SSIM is V, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0.
- If the (i, j) entry in the SSIM is A, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 1.
- If the (i, j) entry in the SSIM is X, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry also becomes 1.
- If the (i, j) entry in the SSIM is O, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry also becomes 0.

The reachability matrix thus derived is known as the initial reachability matrix and is given in Table 3.3. The final reachability matrix is obtained by incorporating the transitivity. Transitivity is a relation among three elements such that if the relationship holds between the first and second and it also holds between the second and third, then the relationship must necessarily hold between the first and third (i.e., i > j, j > k then i > k). The final reachability matrix is shown in Table 3.4 where transitivity is marked as 1^{a}.

Table 3.4 Final reachability matrix

S. No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Driving
1	1	0	0	1	1	1[a]	0	1[a]	1[a]	0	1[a]	0	0	0	1[a]	8
2	0	1	0	0	1	1[a]	0	1[a]	1[a]	0	1[a]	0	0	0	1[a]	7
3	1	0	1	1	1	1[a]	0	1[a]	1[a]	0	1[a]	0	0	0	1[a]	9
4	0	0	0	1	1	1	1[a]	1[a]	1	1[a]	1	1[a]	1[a]	1[a]	1[a]	12
5	0	0	0	0	1	1	1[a]	1	1	1[a]	1	1[a]	1[a]	1[a]	1	11
6	0	0	0	0	0	1	1[a]	1	0	1[a]	0	1	1	1[a]	1	8
7	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2
8	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	3
9	0	0	0	0	0	1	1	1[a]	1	1[a]	0	1[a]	1	0	1[a]	8
10	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
11	0	0	0	0	0	1	1	1	0	1	1	1	1[a]	1	1	9
12	0	0	0	0	0	0	1	1	0	1	0	1	1	1	1	7
13	0	0	0	0	0	0	1	1	0	1	0	1	1	1[a]	1	7
14	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2
15	0	0	0	0	0	0	1	1	0	1	0	1	1	1	1	7
Dependency	2	1	1	3	5	8	10	12	6	12	6	8	8	9	11	

3.3.3 Partition of reachability matrix

After compiling the final reachability matrix, partitioning was done in order to find the hierarchy of each variable. A partitioned reachability matrix helped to generate a conical matrix, as subsequently explained. The reachability and antecedent set for each variable were obtained from the final reachability matrix (Warfield, 1974). The reachability set includes the variable itself and other variables, which it may help to achieve; likewise the antecedent set consists of itself and the variables that help in achieving it. For example, for enabler 1 (Table 3.5), rechability set includes 1 and other variables which can be achieved by 1 those are 4,5,6,8,9,11 and 15. Similarly, in antecedent set of enabler 1, there is 1 itself and variable 3 which help in achieving enabler 1. Later, the intersection between reachability and the antecedent set was attained. If the membership in the reachability and the intersection set completely agree then top priority is assigned and the variable is excluded from subsequent iterations, until the procedure produces a final iteration, which in turn leads to the lowest level. Table 3.5 shows the first iteration wherein the competitive and marketing advantage (10) was found at level I because the reachability and intersection set for enabler 10 completely agree. Results for iterations II-IX are summarized in Table 3.6.

Table 3.5 Enabler iteration I

SN	Reachability Set	Antecedents Set	Intersection Set	Level
1	1,4,5,6,8,9,11,15	1,3	**1**	
2	2,5,6,8,9,11,15	2	**2**	
3	1,3,4,5,6,8,9,11,15	3	**3**	
4	4,5,6,7,8,9,10,11,12,13,14,15	1,3,4	**4**	
5	5,6,7,8,9,10,11,12,13,14,15	1,2,3,4,5	**5**	
6	6,7,8,10,12,13,14,15	1,2,3,4,5,6,9,11	**6**	
7	7,10	4,5,6,7,8,9,11,12,13,15	**7**	
8	7,8,10,14	1,2,3,4,5,6,8,9,11,12,13,15	**8**	
9	6,7,8,9,10,12,13,15	1,2,3,4,5,9	**9**	
10	10	4,5,6,7,8,9,10,11,12,13,14,15	**10**	**1**
11	6,7,8,10,11,12,13,14,15	1,2,3,4,5,11	**11**	
12	7,8,10,12,13,14,15	4,5,6,9,11,12,13,15	**12, 13, 15**	
13	7,8,10,12,13,14,15	4,5,6,9,11,12,13,15	**12,13,15**	
14	10,14	4,5,6,8,11,12,13,14,15	**14**	
15	7,8,10,12,13,14,15	1,2,3,4,5,6,9,11,12,13,15	**12,13,15**	

Table 3.6 Enabler level iteration II-IX

Iteration	Element	Reachability Set	Antecedents Set	Intersection Set	Level
I	10	10	4,5,6,7,8,9,10,11,12,13,14,15	10	1
II	7	7	4,5,6,7,8,9,11,12,13,15	7	2
II	14	14	4,5,6,8,11,12,13,14,15	14	2
III	8	8	1,2,3,4,5,6,8,9,11,12,13,15	8	3
IV	12	12,13,15	4,5,6,9,11,12,13,15	12, 13, 15	4
IV	13	12,13,15	4,5,6,9,11,12,13,15	12,13,15	4
IV	15	12,13,15	1,2,3,4,5,6,9,11,12,13,15	12,13,15	4
V	6	6	1,2,3,4,5,6,9,11	6	5
VI	9	9	1,2,3,4,5,9	9	6
VI	11	11	1,2,3,4,5,11	11	6
VII	5	5	1,2,3,4,5	5	7
VIII	2	2	2	2	8
IX	1	1,4	1,3	1	9
IX	3	1,3,4	3	3	9
IX	4	4	1,3,4	4	9

3.3.4 Developing a conical matrix

A conical matrix was achieved from the partitioned reachability matrix by rearranging the elements according to their level, which means that all the elements having the same levels were clubbed together, and then used for developing a final digraph. Element 10 was found at level I, whereas elements 7, 14 and 8 were at level II, and similarly all the elements were clubbed as per their level partitions as shown in Table 3.6. After rearranging, a conical matrix was obtained and is displayed in Table 3.7.

3.3.5 Development of digraph

Based on the conical form of the reachability matrix, the initial digraph, including transitive links, was obtained. If required, the indirect links may be removed for the sake of simplicity. As per the conical matrix, the variable identified first was placed at the top. In this case, variable 10 had level I, hence it was placed on the top, followed by two variables 7 and 14, which were found at level II, thus all the variables were placed at a predefined level as displayed in the conical matrix. The connectivity was shown among the variables as per the final reachability matrix. The final digraph was obtained by removing the indirect links. The final digraph is shown in Figure 3.3.

Table 3.7 Conical matrix

S.N.	10	7	14	8	12	13	15	6	9	11	5	2	1	3	4
10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
14	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
8	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
12	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
13	1	1	1^a	1	1	1	1	0	0	0	0	0	0	0	0
15	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
6	1^a	1^a	1^a	1	1	1	1	1	0	0	0	0	0	0	0
9	1^a	1	0	1^a	1^a	1	1^a	1	1	0	0	0	0	0	0
11	1	1	1	1	1	1^a	1	1	0	1	0	0	0	0	0
5	1^a	1^a	1^a	1	1^a	1^a	1	1	1	1	1	0	0	0	0
2	0	0	0	1^a	0	0	1^a	1^a	1^a	1^a	1	1	0	0	0
1	0	0	0	1^a	0	0	1^a	1^a	1^a	1^a	1	0	1	0	1
3	0	0	0	1^a	0	0	1^a	1^a	1^a	1^a	1	0	1	1	1
4	1^a	1^a	1^a	1^a	1^a	1^a	1^a	1	1	1	1	0	0	0	1

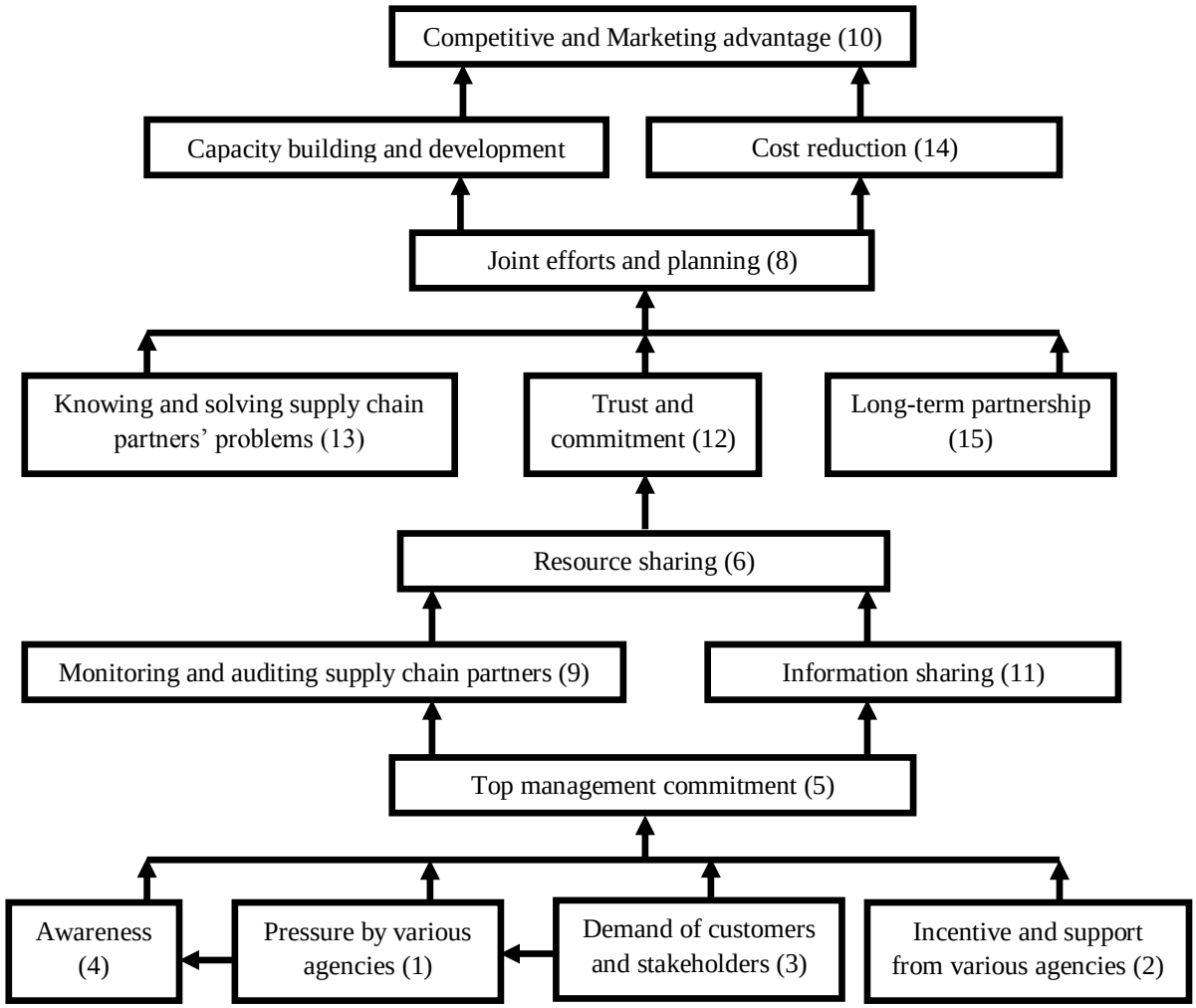

Figure 3.3 ISM model

3.3.6 Integration of ISM and FMICMAC

The analysis can be improved by considering the possibility of reachability instead of the mere consideration of reachability that was used. The conventional MICMAC considers only binary types of relationships, so we have used the fuzzy set theory to increase the former's sensitivity. In the fuzzy MICMAC, an additional input of the possibility of interaction between the elements was introduced. The possibility of interaction can be defined by a qualitative consideration on a 0–1 scale as shown in Table 3.8 (Qureshi et al., 2008).

Table 3.8 Fuzzy scale (Qureshi et al., 2008)

Possibility of Reachability	No	Negligible	Low	Medium	High	Very High	Full
Value	0	0.1	0.3	0.5	0.7	0.9	1.0

3.3.6.1 Development of fuzzy direct relationship matrix (FDRM)

A direct reachability matrix was obtained by examining the direct relationships among the criterion as given in Table 3.3. The transitivity was ignored and the diagonal entries were converted to zero. The derived direct reachability matrix is shown in Table 3.9.

Table 3.9 Binary direct reachability matrix

S.N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
3	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	1	1	0	0	1	0	1	0	0	0	0
5	0	0	0	0	0	1	0	1	1	0	1	0	0	0	1
6	0	0	0	0	0	0	0	1	0	0	0	1	1	0	1
7	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
8	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0
9	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	1	1	1	0	1	0	1	0	1	1
12	0	0	0	0	0	0	1	1	0	1	0	0	1	1	1
13	0	0	0	0	0	0	1	1	0	1	0	1	0	0	1
14	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
15	0	0	0	0	0	0	1	1	0	1	0	1	1	1	0

Table 3.10 Fuzzy direct reachability matrix

S.N.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Sum
1	0	0	0	0.3	0.7	0	0	0	0	0	0	0	0	0	0	1
2	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0.5
3	0.3	0	0	0.7	0.7	0	0	0	0	0	0	0	0	0	0	1.7
4	0	0	0	0	0.3	0.3	0	0	0.7	0	0.3	0	0	0	0	1.6
5	0	0	0	0	0	0.7	0	0.5	0.7	0	0.7	0	0	0	0.5	3.1
6	0	0	0	0	0	0	0	0.5	0	0	0	0.7	0.3	0	0.7	2.2
7	0	0	0	0	0	0	0	0	0	0.9	0	0	0	0	0	0.9
8	0	0	0	0	0	0	0.5	0	0	0.7	0	0	0	0.9	0	2.1
9	0	0	0	0	0	0.1	0.3	0	0	0	0	0	0.7	0	0	1.1
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0.5	0.5	0.5	0	0.3	0	0.7	0	0.3	0.5	3.3
12	0	0	0	0	0	0	0.5	0.9	0	0.3	0	0	0.5	0.3	0.7	3.2
13	0	0	0	0	0	0	0.7	0.5	0	0.7	0	0.5	0	0	0.7	3.1
14	0	0	0	0	0	0	0	0	0	0.9	0	0	0	0	0	0.9
15	0	0	0	0	0	0	0.7	0.5	0	0.7	0	0.7	0.3	0.5	0	3.4
Sum	0.3	0	0	1	2.2	1.6	3.2	3.4	1.4	4.5	1	2.6	1.8	2	3.1	

The possibility of a numerical value of reachability is superimposed on the direct relationship matrix (DRM) to obtain a fuzzy direct relationship matrix (FDRM). The BDRM and FDRM pertaining to the present case study are given in Tables 3.9 and 3.10, respectively.

3.3.6.2 Fuzzy indirect relationship analysis

The fuzzy direct relationship matrix was taken as the base to start the process of finding the fuzzy indirect relationship of the enablers. The matrix was multiplied repeatedly up to a power at which the hierarchies of the driver power and dependence were stabilized. The multiplication process follows the principle of fuzzy matrix multiplication.

Fuzzy matrix multiplication is a generalization of Boolean matrix multiplication. According to fuzzy set theory (FST), when two fuzzy matrices are multiplied, the product matrix is also a fuzzy matrix. Multiplication follows the given rule: Product of the fuzzy set A and fuzzy set B is fuzzy set C.

$$C = A * B = \max_k[\min(a_{ik}, b_{kj})]$$

Where, $A = (a_{ik})$ and $B = (b_{kj})$ are two fuzzy metrics.

3.3.6.3 Stabilization of fuzzy matrix

A stabilized matrix was achieved at the sixth stage, and is shown in Table 3.11. The driving power of the criterion in the Fuzzy MICMAC was derived by summing the entries of possibilities of interactions in the rows, and the dependence of the criterion was determined by summing the entries of the possibilities of interactions in the columns. The ranks of the driving power of the criterion decided the hierarchy of the criterion in the system. The objective behind the classification of the enablers of sustainability adoption was to analyze the driving and the dependence power of the enablers that influence sustainability adoption by the supply chain partners.

3.3.6.4 Fuzzy MICMAC analysis

In the Fuzzy MICMAC, all the criteria were clustered into four categories similar to the MICMAC analysis, as shown in Figure 3.4. Cluster I portrays the autonomous criteria having weak driving power and weak dependence, which are relatively disconnected from the system, as they possess a few weak links with other variables. Cluster II portrays the dependent criteria having weak driving power but strong dependence. Cluster III portrays the linkage criteria having strong driving power and strong dependence. These variables are changeable based upon changes in the driving variables. Consequently, changes in the linkage variables change the dependent variables. These are very important for achieving dependent variables. Cluster IV portrays the independent criteria having strong driving power but weak dependence.

Table 3.11 Fuzzy stabilized matrix

Enablers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Sum	Rank
1	0	0	0	0	0	0	0.7	0.7	0	0.7	0	0.7	0.5	0.7	0.7	4.7	1
2	0	0	0	0	0	0	0.5	0.5	0	0.5	0	0.5	0.5	0.5	0.5	3.5	11
3	0	0	0	0	0	0	0.7	0.7	0	0.7	0	0.7	0.5	0.7	0.7	4.7	1
4	0	0	0	0	0	0	0.7	0.5	0	0.7	0	0.7	0.5	0.7	0.5	4.3	5
5	0	0	0	0	0	0	0.7	0.7	0	0.7	0	0.7	0.5	0.7	0.7	4.7	1
6	0	0	0	0	0	0	0.7	0.7	0	0.7	0	0.7	0.5	0.7	0.7	4.7	1
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
9	0	0	0	0	0	0	0.5	0.7	0	0.7	0	0.5	0.5	0.5	0.7	4.1	8
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
11	0	0	0	0	0	0	0.5	0.7	0	0.7	0	0.5	0.5	0.5	0.7	4.1	8
12	0	0	0	0	0	0	0.7	0.5	0	0.7	0	0.7	0.5	0.7	0.5	4.3	5
13	0	0	0	0	0	0	0.7	0.5	0	0.7	0	0.7	0.5	0.7	0.5	4.3	5
14	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0	0.3	12
15	0	0	0	0	0	0	0.5	0.7	0	0.7	0	0.5	0.5	0.5	0.7	4.1	8
Sum	0	0	0	0	0	0	6.9	6.9	0	7.8	0	6.9	5.5	6.9	6.9		
Rank	8	8	8	8	8	8	2	2	8	1	8	2	7	2	2		

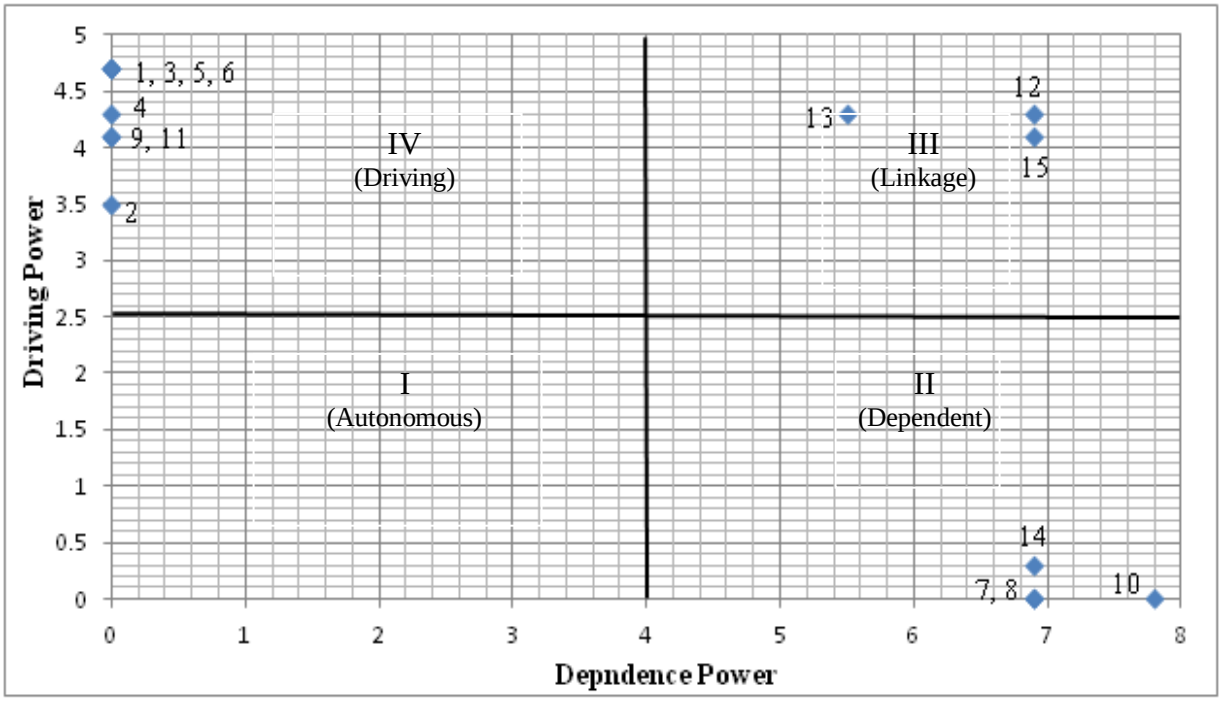

Figure 3.4 FMICMAC clustering of enablers

In this study, (Cluster IV) demand from various stakeholders (3), incentives and support (2), pressure from various agencies (1), awareness (4), top management commitment (5), auditing and monitoring (9), information sharing (11) and resource sharing (6) have strong driving power and week dependency power. This illustrates the importance of these enablers

for initiating the sustainability adoption process. Cluster III has three enablers, trust and commitment (12), long term relationship perspectives (15) and knowing and solving supply chain partners' problem (13). These are the linking variables that help in achieving the enablers in Cluster II. These enablers are very important for the implementation of sustainability. Enablers in Cluster II have high dependence power on the other enablers and weak driving power, which are joint development (8), competitive and marketing advantages (10), cost reduction (14), and capacity building and development (7). There are no autonomous enablers in our case. Figure 3.5 shows the final ISM model that consist the MICMAC classification too.

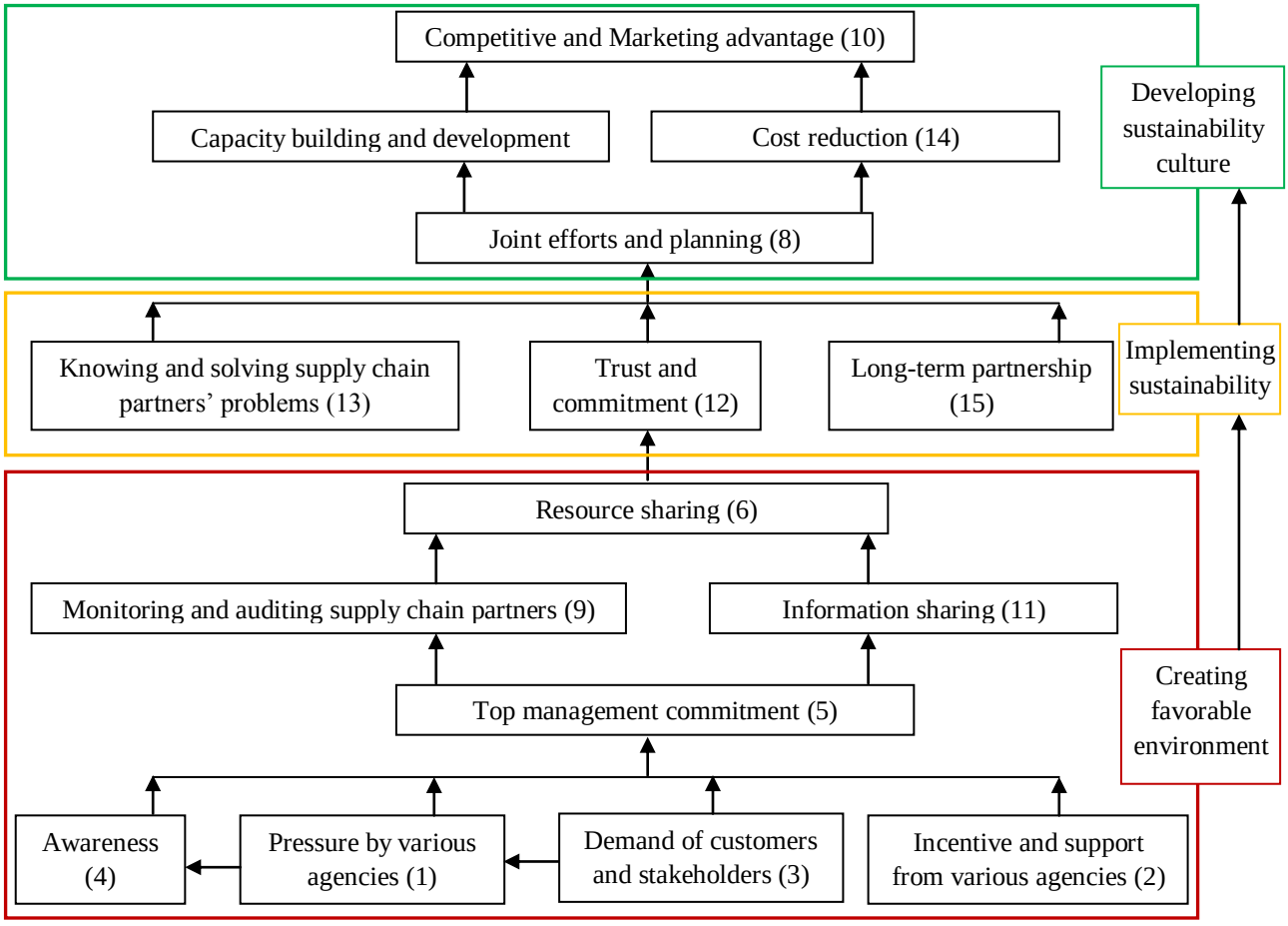

Figure 3.5 ISM model with Fuzzy MICMAC classification

3.4 Discussion

This study was based on the premise that many variables work as enablers in the adoption of sustainability adoption in a supply chain. These variables are termed enablers and are placed into three categories: enablers for creating a favorable environment, enablers for

implementation, and enablers for creating awareness about the benefits of sustainability adoption. By linking the findings with the relationship management process, adoption of sustainability can be seen as the cumulative efforts taken by the supply chain partners, such as developing an intention to adopt sustainability, implementing sustainability, and making sustainability a continuous process.

The sustainability enablers' modeling, as presented in this study (Figure 3.5) indicates that some enablers have a low dependency power. Pressure from various agencies, awareness, incentives, and support, and demand from the customers and other stakeholders has been found at the bottom of the ISM model. However, the persistence of these enablers does affect the supply chain partners' top management commitment towards sustainability. The sustainability of a product or business depends upon its supply chain and should be facilitated by all supply chain partners, especially the focal company (Seuring & Muller, 2008, Mahler, 2007). It has been found in our research that sharing resources and information are key enablers that initiate supply chain sustainability.

'Auditing and monitoring' supply chain partners are the demonstration of power by the buyer firm that is necessary for the development of the relationship (Meehan & Wright, 2012). Some authors quoted that enablers, like sharing resources, information, and auditing and monitoring supply chain partners, are effective for the implementation of sustainability across the supply chain (Zhu & Sarkis, 2004; Nakano & Hirao, 2011). In our case, these enablers have a high driving power and fall in to the category of creating a favorable environment. To add further to this issue, we went to some of the experts who were present at the time of the initial brainstorming. They suggested that these enablers are the basic activities to be followed by the focal firm that help in developing a favorable environment, as they do affect trust and commitment, long term relationships and knowing and solving supply chain partners' problems (Rao & Holt, 2005; Walker et al., 2008).

Enablers like trust and commitment, knowing and solving supply chain partners' problems, and long term relationships have high driving power and high dependency power. These enablers are unstable and can change if there are changes in the high driving variables (Qureshi et al., 2008). In a MICMAC analysis, these factors are known as linkage variables. A linkage variable has an impact on the highly dependent variables, which are joint effort and planning, capacity building and development, cost reduction and competitive and marketing advantages. According to the literature, these enablers are necessary for developing a

sustainability culture by jointly setting goals and providing sufficient resources to achieve the expected goals (Vasallo & Smith, 2011).

On the other hand, the literature on relationship marketing in the industrial environment suggests that partners need to initiate some activities to develop trust and commitment (Kumar, 1996). Since sustainability efforts are central to the quality of a relationship, focal companies should make concerted efforts to solve the problems of their supply chain partners. The consequences of incorporating these activities are trust and commitment among partners, which is a key enabler of relationship development. Joint development and planning for mutual sustainability objectives is the result of successful relationship marketing strategies (Frazier, 1983; Hong et al., 2009). Focal firms should formulate relationship-marketing strategies for establishing, developing, and maintaining relationships with supply chain partners (Morgan & Hunt, 1994). Creating awareness on the benefits of sustainability adoption can also motivate supply chain partners to make a continuous effort in gaining a competitive advantage, capacity building, and cost reduction (Markley & Davis, 2007; Elkington, 1994).

On the other hand, despite the intention to adopt sustainability, the decision to bring changes in the process depends upon the initial support provided to the supply chain partners, like sharing resources and information. The sustainability enablers like trust and commitment, joint development and a long-term relationship are dynamic in nature and change with the vagaries of the business environment and sustainability standards (Chang et al., 2007). Current understanding of the adoption process argues that managers seek a balance between cost and benefits. The supply chain partners incur the investment cost for sharing resources and information, bringing changes to the business process and working jointly (Wu & Pagell, 2011; Carter & Rogers 2008), which is to be balanced by the competitive and marketing advantages, capacity building and development, and by reducing the cost of adopting future sustainability activities (Markley & Davis, 2007; Zutshi & Sohal, 2004).

3.5 Managerial implications

This model provides an overview of enablers' interaction with each other, which can help managers in formulating a relationship based strategy with suppliers based on their commitment, capability, and capacity. Managers can have a better understanding of enablers at each stage of adoption with the ISM model and MICMAC categorization. The adoption of any practice in the supply chain involves the supply chain partners. The decision depends on the

supply chain partners' interest as well as the perceived benefits of the adoption. The model illustrates that this perception has been developed by external influences, awareness programs, and the focal firm's initiatives. For managers, the study highlights the variables that have a high driving power to initiate the sustainability adoption process.

The focal firm's ability to induce changes in the supply chain depends upon the willingness of supply chain partners to support and accept the change. The focal companies should identify and target the managers of supply chain partners in order to develop the intention to adopt sustainability. The focal firm can use following approaches to develop future relationships with supply chain partners: supplier selection on the environmental, social, and economical criterion and monitoring and auditing supply chain partners based on sustainability standards. The focal companies should also assume the important roles of observing the challenges faced by supply chain partners and in providing support to overcome them. There is an opportunity for focal firms to negotiate with supply chain partners to introduce sustainability in their business processes in exchange for more business and support. The focal company should allocate the ordering units among supply chain partners based upon their sustainability performance. When the choice between sustainability adoption and the cost and benefit of facilitating sustainability adoption due to stakeholders' pressure is narrowed down, organizations should align their business strategies to adopt and achieve sustainability.

It is known that a relationship based supply chain can effortlessly adopt the necessary changes. Hence a good relationship with a long-term perspective, trust, and commitment and solving supply partners' problems would facilitate the adoption process. This model also illustrates various relationship development strategies for sustainability adoption. The implementation of sustainability practices becomes easier when the focal companies increase their efforts to persuade supply chain partners through sharing expertise, knowledge, and technology. Focal companies should conduct activities that build trust and commitment. These activities can include the sharing of resources, information, organizing workshops, and visiting supply chain partners' premises and intentionally sharing sustainability performance of focal companies. From the manufacturing industry point of view, focal firms should interact with supply chain partners for jointly developing product design and process design to minimize the environmental impact. Once the supply chain partners accept sustainability adoption, the focal company should continuously engage them in joint efforts and planning for future sustainability performance by developing mutual capability and capacity. The focal firm should reward

supply chain partners by allocating more unit orders using sustainability criteria to optimize the overall sustainability of the supply chain. Getting more orders by improving their performance would create a continuous motivation for the supply chain partners and, consequently, develop an ongoing sustainability culture.

3.6 Conclusion

Previous research examining the modelling of enablers has ignored the sustainable supply chain. In this chapter, our model has taken care of social, environmental, and economical sustainability. This chapter has drawn on existing understanding of sustainability enablers, has concluded that adoption of sustainability practices is interactive in nature and based on the relationship development among supply chain partners. Each stage of sustainability adoption is related to specific enablers. Focal companies need to regulate these enablers based upon the sustainability adoption of supply chain partners and their capabilities. ISM and fuzzy MICMAC provide an insight overview of enablers of sustainable supply chains by developing interrelationships and categorization.

Chapter 4
Supplier selection and order allocation in sustainable supply chain

Preview

This chapter deals with the supplier selection and order allocation problem in the supply chain. The selection criteria have been identified with the help of experts. Fuzzy AHP has been used to give the priorities to the selection criteria. Fuzzy Multi-objective linear programming has been used for the order allocation among the selected supplier based on their performance on sustainability standards. Comparison of two approaches namely: symmetric and asymmetric has been done in order to show the importance of priority of each selection criterion.

4 Introduction

Supplier selection is a very important activity in managing the sustainability of a supply chain (Hutchins & Sutherland, 2008; Rao, 2002). All business entities involved in the supply chain of a product, directly or indirectly, affect the environmental and social spheres in wealth creation (Seuring & Muller, 2008; Mahler, 2007). Many researchers (Walker et al., 2008; Koplin et al., 2007) have confirmed the negative consequences of suppliers' activities on the sustainability of the final product. Previous studies have mostly considered environmental sustainability and cost minimization for supplier selection (Wu & Pagell, 2011; Zhu & Sarkis, 2008). Recent works include supplier selection for a lower carbon emission supply chain by Shaw et al. (2012). They focused upon the carbon emissions of the suppliers and in optimizing orders for minimizing such carbon emissions.

The literature has indicated that pressure from stakeholders and consumer demand has influenced companies in ceasing business with unsustainable suppliers (Diabata & Govindan, 2011; Teuteberg & Wittstruck, 2010). Companies have started adopting sustainability practices to lower this pressure from stakeholders (Bommel, 2010). A supplier's tendency to adopt sustainable practices to increase the sustainability of the supply chain is one of the criteria for supplier selection (Ellis & Higgins, 2006; Zutshi & Sohal, 2004). A buyer firm needs to identify the selection and evaluation criteria for the supplier selection (Ciliberti et al., 2008; Blowfield, 2005) and the same approach should be applied to the supplier for ensuring the sustainability of the supplier's supplier (2nd tier). However, very few suppliers have knowledge

of sustainable product procurement for their supply chain (Shaw et al., 2012). Hence, screening and ranking each time a supplier is selected, increases the sustainability of the supply chain. Therefore, a company needs to measure the sustainability performance and put targets for performance improvement of its suppliers (Ageron, et al., 2011). This helps in developing a sustainability culture in the supply chain (Vasallo & Smith, 2011).

Sustainability culture refers to the ongoing efforts by companies for the continuous improvement in sustainability performance over a period of time (Vasallo & Smith, 2011). Selection of a supplier is one of very important activities for the sustainability improvement of the supply chain (Figure 4.1). The need for suppliers' selection of sustainability standards comes into the picture due to pressure from stakeholders (Bitzer et al., 2008). In addition to this, companies should also handle sustainability issues in order to gain competitive and marketing advantages (Peters et al., 2011; Kogg, 2003; Ytterhus, 1999). In gaining these advantages, a company needs to support its supply chain partners and evaluate their sustainability performance (Ageron et al., 2011; Lee, 2008; Florida, 1996).

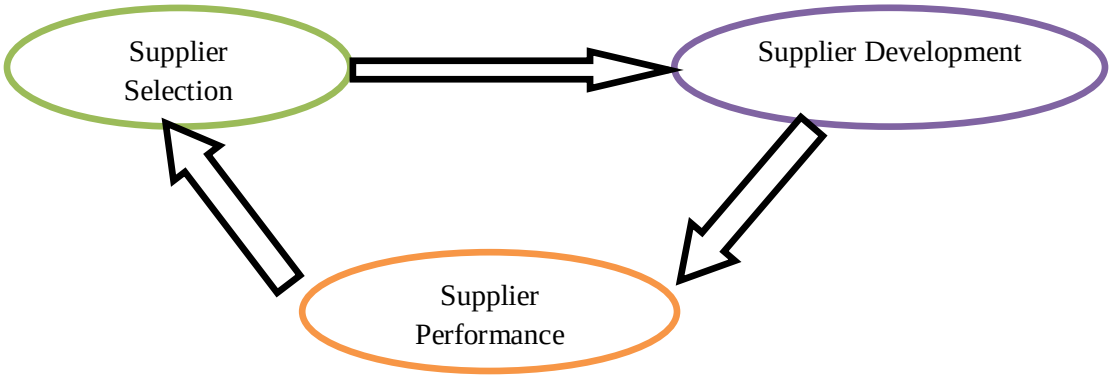

Figure 4.1 Supplier selection in sustainable supply chain

The literature indicates sufficient support to show a correlation between relationship building and the increase of sustainability performance in the supply chain (Handfield, 2005; Attaran & Attaran, 2007). It starts with the identification of a committed supplier for sustainability adoption and then process a joint development (Olorunniwo & Li, 2010; Matos & Hall, 2007). Creating a favorable environment for sustainability adoption by a supply chain partner is the result of pressure and support. Companies share resources (Zutshi & Sohal), information (Klassen & Vachon, 2003) and develop long term relationships (Nakano & Hirao, 2011) in order to know and solve the problems faced by suppliers. The performance of a

relationship for improving sustainability helps in the continuation of the relationship and decides on its magnitude (Shaw et al., 2012; Holt & Ghobadian, 2009; Clemens & Douglus, 2006). The buyer firm should allocate order units with respect to the sustainability performance of the suppliers.

Some researchers have worked on supplier selection models for sustainable supply chains. Bai & Sarkis (2008) proposed a green supplier evaluation model based on environmental, social, and economic criteria. Bommel (2010) proposed various supplier centered activities for local companies to influence suppliers for sustainability adoption, supplier selection is being of importance. Hutchins & Sutherland (2008) explored measures of social sustainability and proposed that all the activities inside the supply chain should be aligned. For this, there is a need for a proper supplier selection based on social sustainability standards and in maintaining a relationship with them (Peters et al, 2011; Ciliberti et al., 2008). Development of local suppliers to reduce the ordering cost has been supported by some authors (Smerecnik & Anderson, 2011). Similarly, supplier selection based on environmental standards is necessary for ensuring the sustainability of raw materials (Tsoulfas & Pappis, 2006).

Supplier selection is basically a multi-criteria problem (Kahraman, 2003). Earlier studies have used various methodologies for developing supplier selection models mostly focused on environmental sustainability. Hsu & Hu (2009) proposed a model using an analytical network process. Kuo et al. (2010) have used artificial neural networking (ANN), data envelopment analysis, and analytic network process (ANP) for developing a supplier selection model. Lu et al. (2007) developed an analytic hierarchy program (AHP) and fuzzy logic based model. Awasthi et al. (2010) came up with a fuzzy topsis model for evaluating the environmental performance of a supply chain. A rough set theory was used by Bai & Sarkis (2010) to develop a green supplier evaluation model. Gao & Tang (2003) developed a multi objective linear programming model for order allocation. Kumar et al. (2004) used fuzzy goal programming for vendor selection. Weber et al. (2000) used a mixed methodology by combining multi objective programming with DEA. Wang et al. (2009) used the AHP method for supply chain strategy selection and preemptive goal programming for order allocation. Chang & Kumar (2007) developed a model using of a Fuzzy extended analytic hierarchy process. Shaw et al. (2012) used Fuzzy AHP and Fuzzy multi-objective goal programming for supplier selection in low carbon emission supply chains.

Some of the previous studies have used ANP, Fuzzy ANP, AHP, Fuzzy AHP, Topsis and Rough set theory. The quantification of allocation units is not possible with these methodologies. Hence the robustness of these models is questionable (Shaw et al., 2012). In order to solve this problem, an asymmetric model using Fuzzy AHP and Fuzzy linear programming was used for supplier selection and order allocation (Shaw et al., 2012). Some studies have also used Genetic Algorithm (Haq, 2002; Haq et al., 1991).

Most of the earlier studies have focused upon environmental and economical sustainability. So far, there has not been a study of sustainability management in order allocation. This study fills this gap by optimizing ordering among supplier according to the sustainability performance indicators. Quantifiable sustainability indicators were identified with the help of experts in the literature and used for suppliers' selection. The buyer can allocate an order among suppliers with respect to their performance on these indicators. This study deals with highly sustainable product procurement and sustainability management for supplier selection and order allocation in order to maximize the sustainability performance with available resources.

4.1 Identification of supplier selection criteria

Identification of sustainability criteria for supplier selection is very complex (Lee et al., 2011). Present research should have tried to identify sustainability criteria in three categories; economical, environmental and social, as proposed by Elkington (1994). The number of selection criteria in a suppliers' selection model are based on expert' decision-making and literature support in specific problems (Shaw et al., 2012). In terms of economic sustainability, previous researchers have done enough research. The indicators taken for the economic and operational acceptability of suppliers are as follows: rejection percentage on a quality basis (Walker et al., 2008; Matos & Hall, 2007), percentage of late delivery items (Daugherty, 2011; Zsidisin & Hendrick, 1998) and cost of the sourcing item (Holt & Ghobadian, 2009; Zutshi & Sohal, 2004). Social sustainability indicators discussed in the literature are as follows: child labor (Muller et al., 2009; Koplin et al., 2007), working conditions (Bommel, 2010; Carter & Rogers 2008), rights of employees (Ni et al., 2010; Ciliberti, 2008; Rocha et al., 2007) and poverty reduction (Ni et al., 2010; Bitzer et al., 2008). Employees' rights include education, safety, health, career opportunities, and many others. The current literature indicates that there are two types of social responsibilities: towards society and towards employees. Companies can

develop measurable indicators for social sustainability which are specific to employees and society.

Environmental sustainability includes packaging improvements (Tsoulfas & Pappis, 2006; Hall, 2000), energy efficiency (Nakano & Hirao, 2011; Wu & Pagell, 2011), pollution and emission minimization (Ciliberti, 2008; Florida, 1996), waste minimization (Bitzer et al., 2008; Matos & Hall, 2007), reverse logistics (Ni et al., 2010, Carter & Jenning, 2002;), green purchasing (Ni et al., 2010; Bitzer et al., 2008), green designing (Bai & Sarkis, 2010; Holt & Ghobadian, 2009), using renewable energy (Prashar & Mathur, 2013; Smith, 2007; Zhu et al., 2007) and disposal (Olorunniwo & Li, 2010; Vachon & Klassen, 2006).

Only some of the indicators discussed in the literature are quantifiable on per unit item and are used as the consequences of adopting sustainable practices. Some of the indicators are qualifying in nature and some are conditional. Waste management, energy management, emission at a supplier's facility can be recorded and measured. While green sourcing, disposal of hazardous products, and child labor are essential in nature and mostly protected by strict laws. Reverse logistics, the use of cleaner technology, animal and plant life, minority development and local suppliers are conditional in nature. This depends upon the environment and society in which a company is based.

4.2. Introduction to methodologies

Present research uses fuzzy AHP and Fuzzy multi-objective linear programming. In this section Fuzzy analytic hierarchy programming with Fuzzy set theory, Fuzzy linear programming, and Supplier selection modeling is discussed.

4.2.1 Fuzzy analytic hierarchy programming (FAHP)

Fuzzy set theory helps in dealing with the vagueness and fuzziness of uncertain environments (Zadeh, 1965). This can be managed by developing healthy models for decision making (Lee et al, 2012; Yu, 2002). In order to avoid being mislead by the decision making model, it should be comprised of fuzziness. In this case the fuzzy set theory can do its role, which is to remove the uncertainty of decision-making and quantifying the qualitative values (Lee, et al., 2005). In Analytical hierarchy programming (AHP), pair wise comparison is done but its appropriateness can be questioned in real life decisions (Shaw et al., 2012; Sachdeva et al., 2008). To solve this problem, decision models should incorporate a fuzzy theory to deal

with the uncertainty (Lee, 2009; Yu, 2002). A selection of alternatives in fuzzy AHP is used by the fuzzy set theory in conventional AHP (Bozbura, et al., 2007). Fuzzy AHP is frequently used in the research area for decision making, and various methods have been proposed for calculating fuzziness (Lee, 2009; Lee et al., 2005; Chang, 1996; Chen, 1996; Buckley, 1985). Considering the simplicity of calculations and the advantages of one method over another, Chang (1996) used the extent analysis method for Fuzzy AHP. This approach deals with the uncertainty of decision making and is more robust in nature (Chan & Kumar, 2007). It uses a triangular fuzzy number for a pair wise comparison of different decision variables. In addition, extent analysis is used to find the synthetic value from the pair wise comparison.

A triangular fuzzy number M can be represented by (a, b, c) with its membership function as shown in Figure 4.2 (a) (Wong et al., 2012; Lee, 2009a, Lee, 2009b; Lee et al., 2005).

$$\mu_m(x) = \begin{cases} \frac{x-a}{b-a} & (a \le x \le b) \\ \frac{c-x}{c-b} & (b \le x \le c) \\ 0 & otherwise \end{cases} \quad (1)$$

with $-\infty < a \le b \le c \le \infty$.

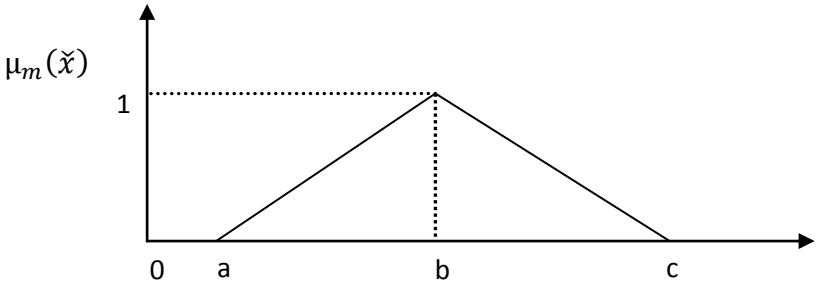

Figure 4.2. (a) Triangular fuzzy number

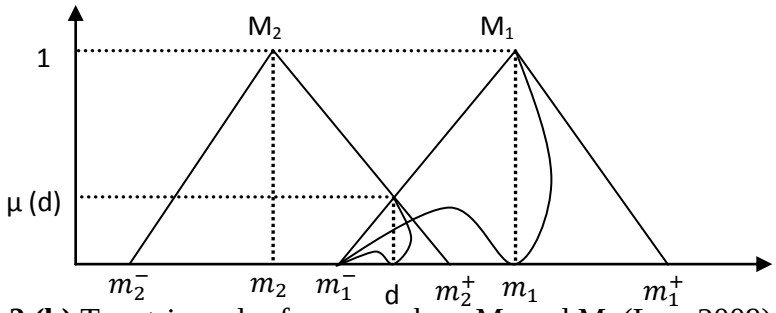

Figure 4.2 (b) Two triangular fuzzy numbers M_1 and M_2 (Lee, 2009).

The strongest grade of membership is the parameter b that is, f_M (b) = 1, while a and c are the lower and upper bounds. Two triangular fuzzy numbers M_1 (m_1^-, m_1, m_1^+) and M_2 (m_2^-, m_2, m_2^+) are shown in Figure 4.2 (b).

When, $m_1^- \geq m_2^-,\ \ m_1 \geq m_2,\ \ m_1^+ \geq m_2^+$) (2)

The degree of possibility is represented in equation (3):

$V(M_1 \geq M_2) = 1$ (3)

Otherwise, the ordinate of the highest intersection point is calculated as (Chang, 1996; Zhu, et al., 1999; Lee, 2009; Shaw et al, 2012).

$$V(M_2 \geq M_1) = hgt(M_1 \cap M_2) = \mu(d) = \frac{m_1^- - m_2^+}{(m_2 - m_2^+) - (m_1 - m_1^-)} \quad (4)$$

Equation (5) to (11) can be used for the calculation of the fuzzy synthetic extent value (Chang, 1996; Zhu et al., 1999; Lee, 2009; Shaw et al., 2012).

$$Fi = \sum_{j=i}^{m} M_{gi}^j \otimes \left(\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j \right)^{-1}, \qquad i = 1,2, \ldots\ldots n \quad (5)$$

$$\sum_{j=i}^{m} M_{gi}^j = \left(\sum_{j=i}^{m} M_{ij}^-, \sum_{j=i}^{m} M_{ij}, \sum_{j=i}^{m} M_{ij}^+ \right) \qquad i = 1,2, \ldots\ldots n \quad (6)$$

$$\left(\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^j \right)^{-1} = \left[\frac{1}{\sum_{i=1}^{n} \sum_{j=1}^{m} M_{ij}^+}, \frac{1}{\sum_{i=1}^{n} \sum_{j=1}^{m} M_{ij}}, \frac{1}{\sum_{i=1}^{n} \sum_{j=1}^{m} M_{ij}^-} \right] \quad (7)$$

A convex fuzzy number can be defined as,

$V(F \geq F_1, F_2 \ldots F_K) = \min V(F \geq F_i)$, $i = 1, 2, \ldots\ldots k$ (8)

$d(F_i) = \min V(F \geq F_k) = W_i'$ $k = 1, 2, \ldots\ldots$, n and $k \neq i$ (9)

Based on the above procedure, the weights, W_i' of the factors are

$W' = (W_1', W_2', \ldots\ldots, W_n')^T$ (10)

After normalization, the priority weights are as follows

$W' = (W_1, W_2, \ldots\ldots, W_n)^T$ (11)

4.2.2 Multi-objective supplier selection model

Some assumptions are considered in developing the multi objective supplier selection model. The index set, decision variable, and parameters are defined as follows:

(i) Only one type of product is purchased from each supplier.

(ii) There is no quantity discount in this model.

(iii) There is no shortage of items for any supplier.

(iv) Lead time is constant.

(v) Decision variables taken in this model only affect decisions by the decision makers.

4.2.2.1 Index

i for suppliers, for i = 1,2,. . . , N.

j for objectives, for j = 1,2,. . . , J.

k for constraints, for k = 1,2,. . . ,K.

4.2.2.2 Decision variable

x_i order quantity allocated to the i^{th} supplier.

4.2.2.3 Parameters

D - aggregate demand of the item over a fixed time period under consideration.

n - number of suppliers competing for selection.

C_i - emission for units of product supplied by supplier i.

E_i - energy use of units of products supplied by the supplier i.

W_i - waste generated from unit of products product supplied by the supplier i.

S_i - money used for social development for product supplied by supplier i

P_i - cost of ordering product from supplier i.

Q_i - percentage of the rejected units delivered by the supplier i.

L_i - percentage of the late delivered units by the supplier i.

U_i – maximum capacity of the supplier i.

4.2.2.4 Model

A supplier selection model for a sustainable supply chain using linear programming is formulated as follows

$$\text{Minimise } Z_1 = \sum_{i=1}^{n} C_i X_i \qquad (12)$$

$$\text{Minimise } Z_2 = \sum_{i=1}^{n} E_i X_i \qquad (13)$$

$$\text{Minimise } Z_3 = \sum_{i=1}^{n} W_i X_i \quad (14)$$

$$\text{Maxmise } Z_4 = \sum_{i=1}^{n} S_i X_i \quad (15)$$

$$\text{Minimise } Z_5 = \sum_{i=1}^{n} P_i X_i \quad (16)$$

$$\text{Minimise } Z_6 = \sum_{i=1}^{n} Q_i X_i \quad (17)$$

$$\text{Minimise } Z_7 = \sum_{i=1}^{n} L_i X_i \quad (18)$$

Subjected to

$$\sum_{i=1}^{n} x_i = D \quad (19)$$

$$x_i \leq U_i \quad (20)$$

$$x_i \geq 0 \quad (21)$$

Objective function (12) minimizes carbon emission.

Objective function (13) minimizes energy use per product.

Objective function (14) minimizes waste generated per product.

Objective function (15) maximizes the percentage of profit to social development.

Objective function (16) minimizes the ordering cost.

Objective function (17) minimizes the percentage of rejection on quality issues.

Objective function (18) minimizes the percentage of late delivery of items.

Constraint (19) ensures total aggregate demand of the item.

Constraint (20) ensures all the variables are greater than zero.

Constraint (21) ensures that all variables are integer.

In supplier selection, there is vagueness in the decision making. Therefore, the suitability of deterministic models is always questioned as these models cannot take care of vagueness (Kumar et al., 2006). Fuzzy set rules can be used to handle the uncertainty of the decision making. Hybrid model using fuzzy set rules and linear programming can be used.

In this method, preference is given to the overall objective function instead of satisfying the constraints (Shaw et al., 2012). There are two approaches used for decision making: symmetric and asymmetric. In the former approach, the weights of objectives and constraints are taken as the same, but in the later case, the weights of objectives and constraints are taken as different, based on their importance (Sakawa, 1993; Zimmermann, 1978). Crisp linear programming is formulated by using multi-objective programming that considers fuzziness in goals and constraints (Zimmermann, 1978). In the case of an asymmetric approach, the weight of each factor is considered during the optimization of the decision variables using a weighted additive model (Tiwari, et al., 1987). The weighted additive model considers the different weights of fuzzy objectives and fuzzy constraints for managing real life situations. The weights of fuzzy objectives and fuzzy constraints can be calculated by incorporating the fuzzy AHP extent method (Chang, 1996).

4.2.3 Fuzzy linear programming

Zimmermann (1978) proposed fuzzy linear programming that included fuzzy goals and fuzzy constraints. It can be solved like a normal linear programming problem after fuzzification. Zimmermann (1978) proposed a conventional linear programming problem as given below (22)–(24).

$$\text{Minimize } Z = Cx \tag{22}$$

Subject to constraints,

$$Ax \leq b \tag{23}$$

$$x \geq 0 \tag{24}$$

After fuzzification the equation can be represented like this (25) – (27),

$$\check{C}X \precsim Z \tag{25}$$

$$\tilde{A}X \precsim b \tag{26}$$

$$X \geq 0 \tag{27}$$

The symbol $\precsim$ in the constraint set denotes ‘essentially smaller than or equal to’ and allows one to reach some aspiration level where $\check{C}$ and $\tilde{A}$ represent the fuzzy values.

4.2.3.1 Membership function

A fuzzy set was proposed by Bellman and Zadeh (1970). The fuzzy set A in X is defined as (28):

$$A = \{x, \mu A(x)/x \in X\} \quad (28)$$

A where $\mu A(x): x \rightarrow [0,1]$ is called the membership function of A and $\mu_A(x)$ is the degree of membership to which x belongs to A. The fuzzy set A is thus uniquely determined by its membership function $\mu_A(x)$ and the range of the membership function is a subset of the non-negative real numbers whose value is finite and usually finds a place in the interval [0, 1].

This model considers a linear membership function for all fuzzy parameters. There are certain characteristics of a linear membership function.

1. It increases or decreases over the range of parameters.
2. Acceptability of the parameters is decided by upper and lower values.

Hence, a fuzzy objective $\check{Z} \in X$ is a fuzzy subset of X characterized by its membership function $\mu A(x): x \rightarrow [0,1]$. The linear membership function for the fuzzy objectives is:

For minimization:

$$\mu_{zj}(x) = \begin{cases} 1 & \text{if } Z_j(x) \leq Z_j^{min} \\ \frac{Z_j^{max} - Z_j(x)}{Z_j^{max} - Z_j^{min}} & \text{if } Z_j^{max} \leq Z_j(x) \leq Z_j^{max}, \text{where } j = 1,2,\ldots,j \\ 0 & \text{if } Z_j(x) \geq Z_j^{max} \end{cases} \quad (29)$$

For maximization:

$$\mu_{zj}(x) = \begin{cases} 0 & \text{if } Z_j(x) \leq Z_j^{min} \\ \frac{Z_j(x) - Z_j^{min}}{Z_j^{max} - Z_j^{min}} & \text{if } Z_j^{max} \leq Z_j(x) \leq Z_j^{max}, \text{where } j = 1,2,\ldots,j \\ 1 & \text{if } Z_j(x) \geq Z_j^{max} \end{cases} \quad (30)$$

In (31) Z_j^{min} is $\min_j Z_j(x^*)$ and $\max_j Z_j(x^*)$ and x^* is the optimum solution.

A fuzzy constraint $\check{C} \in X$ is a fuzzy subset of X characterized by its membership function $\mu c(x): x \rightarrow [0,1]$. The linear membership function for the fuzzy constraints is given by (31):

$$\mu_{ck}(x) = \begin{cases} 1 & \text{if } g_k(x) \leq b_k \\ [1 - \{g_k(x) - b_k\}/d_k] & \text{if } b_k \leq g_k(x) \leq b_k + d_k \\ 0 & \text{if } b_k + d_k \leq g_k(x) \end{cases} \quad (31)$$

For all fuzzy parameters k=1,2,….,j, and d_k is taken as the tolerance interval.

4.2.3.2 Solution to the formulation

A fuzzy solution is the intersection of all fuzzy sets representing either fuzzy objectives or fuzzy constraints (Bellman & Zadeh, 1970). Equation 32 represents the membership function of the fuzzy solution.

$$\mu_s(x) = \mu_z(x) \cap \mu_c(x) = min\left[\mu_z(x);\ \mu_c(x)\right] \quad (32)$$

In Eq. (32) $\mu_Z(x)$, $\mu_C(x)$ and $\mu_S(x)$ represent the membership functions of the objectives and k constraints and solution respectively. The solution of the supplier section model for the j fuzzy multiple objectives and k constraints may be represented as (33)

$$\mu_s\ (x) = \left(\bigcap_{j=1}^{j} \mu_z(x)\right) \cap \left(\bigcap_{k=1}^{k} \mu_c(x)\right)$$

$$= \min\left[\min_{j=1,2,\ldots,j}\ \mu_{Z_j}\ (x),\ \min_{k=1,2,\ldots,k}\ \mu_{C_k}\ (x),\right] \quad (33)$$

The optimum solution of the supplier selection model is calculated by the highest degree of membership value (34).

$$\mu_s\ (x^*) = \max_{x\ \in S}\ \mu_s\ (x) = \max_{x\ \in S} \min\left[\min_{j=1,2,\ldots,j}\ \mu_{Z_j}\ (x),\ \min_{k=1,2,\ldots,k}\ \mu_{C_k}\ (x)\ \right] \quad (34)$$

4.2.3.3 Crisp formulations of the supplier selection model

Crisp formulation for a fuzzy programming model can be represented by (35) to (40). This model consists of j objective and k constraints.

Maximise λ (35)

$\lambda\ (Z_j^{max} - Z_j^{min}) + Z_j(x) \leq Z_j^{max}$ for all j, j=1,2,…..J (36)

$\lambda\ (d_x) + g_k(x) \leq b_k + d_k$ for all k, k= 1,2,……., K (37)

$A_x \leq b$ for all deterministic constant, (38)

$x \geq 0$ and integer (39)

$0 \leq \lambda \leq 1$ (40)

Each objective function should be solved for maximization and minimization for calculating the lower bound (Z_j^{min}) and upper bound (Z_j^{max}) values respectively (Zimmerman,

1978). Equations (41) – (44) show the calculation for obtaining the lower bound value (Z_j^{min}) for objective function j.

Minimize $Z_j(x)$ for all j, j= 1,2,….,J (41)

Subjected to

$g_k(x) \leq b_k + d_k$ for all k, k= 1,2,……,K (42)

$A_x \leq b$ for all deterministic constant, (43)

$x \geq 0$ and integer (44)

The upper bound of the optimal values (Z_j^{max}) is obtained by solving a similar supplier selection problem as a linear programming problem (45) – (48).

Maximize $Z_j(x)$ for all j, j= 1,2,….,J (45)

Subjected to

$g_k(x) \leq b_k + d_k$ for all k, k= 1,2,……,K (46)

$A_x \leq b$ for all deterministic constant, (47)

$x \geq 0$ and integer (48)

In the supplier selection problem proposed by Zimmermann (1978), the weight of the objective function and constraints are the same as in the crisp formulation. However, the weight of all the objectives and constraints cannot be same in a real life supplier selection problem because it would decrease the value of the important objective function. The solution obtained in that case cannot be optimal. To avoid this, many researchers have used a weighted additive model for multi objective optimization problems. The weighted additive model proposed by Tiwari et al. (1987) is shown in (49)–(50). In these models, the priority weights of each objective function is multiplied by their respective weights and added to obtain a weighted utility function.

$$\mu_D(x) = \sum_{j=1}^{j} w_j \mu_{Z_j}(x) + \sum_{k=1}^{k} \beta_k \mu_{g_k}(x) \quad (49)$$

$$\sum_{j=1}^{j} w_j + \sum_{k=1}^{k} \beta_k = 1, \qquad w_j, \beta_k \geq 0 \quad (50)$$

In (49) and (50), w_j *and* β_k are the weight coefficients that present the relative importance among the fuzzy goals and fuzzy constraints.

The following crisp single objective programming (51) – (57) is equivalent to the above fuzzy model.

$$\text{Maximise} \sum_{j=1}^{j} w_j \lambda_j + \sum_{k=1}^{k} \beta_k \gamma_k \quad (51)$$

Subject to,

$\lambda_j \leq \mu_{Z_j}(x)$, j = 1, 2,……, J (52)

$\gamma_k \leq \mu_{g_k}(x)$ k = 1, 2,……, J (53)

$g_p(x) \leq b_p$ p = 1, 2,……, J (54)

λ_j, $\gamma_k \in [0, 1]$, j = 1, 2,……, J and k = 1, 2,……, J (55)

$$\sum_{j=1}^{j} w_j + \sum_{k=1}^{k} \beta_k = 1, \qquad w_j, \beta_k \geq 0 \quad (56)$$

$x_i \geq 0$ i = 1, 2,……, n (57)

4.2.3.4 Application of fuzzy linear programming for supplier selection

A supplier selection model has been proposed using fuzzy linear programming. This model considers following criteria for supplier selection: the emission per product, energy use per product, waste generated per product, money for social development per product, purchasing cost per product, percentage of rejection on quality, and percentage of late delivered items. The fuzzy equation for each objective function and constraint are interpreted as follows.

$$\sum_{i=1}^{n} C_i X_i \precsim Z_1 \quad (58)$$

$$\sum_{i=1}^{n} E_i X_i \precsim Z_2 \quad (59)$$

$$\sum_{i=1}^{n} W_i X_i \precsim Z_3 \quad (60)$$

$$\sum_{i=1}^{n} S_i X_i \precsim Z_4 \quad (61)$$

$$\sum_{i=1}^{n} P_i X_i \precsim Z_5 \quad (62)$$

$$\sum_{i=1}^{n} Q_i X_i \precsim Z_6 \quad (63)$$

$$\sum_{i=1}^{n} L_i X_i \precsim Z_7 \quad (64)$$

$$\sum_{i=1}^{n} x_i \cong D \quad (65)$$

$$x_i \leq U_i \quad (66)$$

$$x_i \geq 0 \quad (67)$$

4.2.4 Computational procedure

In this study, we use a hybrid model by combining fuzzy AHP and fuzzy multi objective linear programming. Fuzzy AHP can be used to determine the relative weights of the supplier selection criteria (Ku et al., 2010). These weights are used in the weighted additive model for multiplying with the respective membership function to obtain the crisp equation.

The computational procedure of the model is as follows:

Step 1: The supplier selection criteria for a sustainable supply chain are identified.

Step 2: A nine-point scale questionnaire is developed for pair wise comparison by the experts. Experts are included from the supply chain and operation management department of the company.

Step 3: The response of the experts is used to calculate fuzz importance weight. Experts' opinions are combined to obtain a triangular fuzzy number Ď (Lee, 2009). The characteristic function of the fuzzy number is shown in Table 4.1 (Lee, 2009).

$\check{D} = (h^{-}, h, h^{+})$

Where,

$$h^{-} = \left(\prod_{t=1}^{s} l_t\right)^{\frac{1}{s}}, \qquad \forall t = 1, 2 \ldots s.$$

$$h = \left(\prod_{t=1}^{s} m_t\right)^{\frac{1}{s}}, \qquad \forall t = 1, 2 \ldots s.$$

$$h^{+} = \left(\prod_{t=1}^{s} n_t\right)^{\frac{1}{s}}, \qquad \forall t = 1, 2 \ldots s.$$

and (l_t, m_t, u_t) is the lower, middle and upper limit of fuzzy response from expert *t*.

Table 4.1 Fuzzy scale

Fuzzy Number	Membership Function
$\tilde{1}$	(1,1,2)
$\tilde{x}$	(x-1, x, x+1) for x= 2,3,4,5,6,7,8
$\tilde{9}$	(8,9,9)
$1/\check{1}$	$(2^{-1}, 1^{-1}, 1^{-1})$
$1/\check{x}$	$((x+1)^{-1}, x^{-1}, (x-1)^{-1})$ for x= 2,3,4,5,6,7,8
$1/\check{9}$	$(9^{-1}, 8^{-1}, 8^{-1})$

Step 4: Fuzzy extent analysis method developed by Chang (1996) is used to obtaining the crisp relative priority of criteria.

Step 5: Formulation of supplier selection objective functions.

Step 6: All the objective functions are solved for minimization and maximization for obtaining lower bound and upper bound optimal values respectively.

Step 7: Values calculated in step 6 and weights obtained from step 4 are used to formulate crisp formula using the weighted additive model.

Step 8: The crisp formulation of fuzzy multi-objective linear programming is solved and the results are obtained.

4.3 A case illustration

A case study was conducted with a multinational automobile company (ABC), at the corporate office based in Noida (India), to illustrate the effectiveness of the model. The company has four manufacturing units, one research centre and five sales offices across India.

The company is mainly domestic demand oriented and partially export oriented. The company produces electrical, thermal, electronic, as well as power train products for both two wheelers and four wheelers. The company procures products from various suppliers, in both semi-finished and finished forms.

Due to increasing sustainability practices across the industry, the ABC Company is looking to incorporate sustainability related criteria in its procurement processes. The company found that having excellent relationship management makes a supplier more sustainable and loyal. The relationship between the two parties depends upon the capability and capacity of individual suppliers, if selected. Management invited experts from the marketing, production, quality, and research departments for involvement in supplier selection. There were total six experts.

A brainstorming session was organized to develop the sustainability criteria that can be quantified on a product unit basis. Management gave preference to criteria that are widely discussed in the relevant literature; carbon emission, energy use and waste management, which can be quantified per unit product. This information is readily available from the suppliers. In terms of social sustainability, it was a complex task to obtain accurate measures. The committee came up with the percentage of profit that is used for social development. Social development means the contribution a company makes to society. The opportunity for employee social development has been established by the argument that only the suppliers qualified for order allocation abide by the social norms such as like no child labor, safety, and healthcare. An expert pointed out that the attrition rate of the employees of suppliers can be used to measure the social atmosphere. This is very interesting since it is directly related to the satisfaction of the employees in the present organization. Employee satisfaction is a combination of the quality of the facilities at suppliers' premises and future career opportunities. This criterion, however, could not be quantified per unit product and was removed.

Finally, the committee decided on seven criteria: CO_2 emission, energy use per product, waste generated per product, percentage of profit in social, and community development, ordering cost, rejection on quality basis and late delivery. In addition to seven criteria, demand has been included in the comparison matrix. Four suppliers were selected by the committee for sourcing the material. A brain storming session was conducted to prioritize the criteria using FAHP. The fuzzy pair wise comparison among the criteria is shown in Table 4.2.

Table 4.2 Comparison of Selection criteria

	Ordering Cost	Rejection on Quality	Late Delivery	Social welfare	Emission	Energy use per product	Demand	Waste Generation
Ordering Cost	1.00,1.00,1.00	1.51,1.82,2.94	0.48,0.66,0.93	1.59,2.08,3.17	1.59,2.08,2.83	1.62,1.91,3.05	1.35,1.82,2.62	1.59,2.08,3.17
Rejection on Quality	0.34,0.55,0.66	1.00,1.00,1.00	1.00,1.44,2.00	1.59,2.08,3.17	1.59,2.08,3.17	1.51,1.82,2.94	2.14,2.85,3.96	1.26,1.44,2.24
Late Delivery	1.07,1.52,2.08	0.50,0.69,1.00	1.00,1.00,1.00	1.41,1.73,2.52	1.51,2.18,2.94	1.91,2.62,3.70	1.51,2.04,3.14	1.59,2.08,3.17
Social welfare	0.31,0.48,0.63	0.31,0.48,0.63	0.40,0.58,0.71	1.00,1.00,1.00	1.00,1.12,2.14	0.46,0.56,0.87	0.41,0.45,0.78	0.92,1.07,1.73
Emission	0.35,0.48,0.63	0.31,0.48,0.63	0.34,0.46,0.66	0.47,0.89,1.00	1.00,1.00,1.00	1.26,1.44,2.52	1.00,1.00,1.41	1.41,1.73,2.83
Energy use per product	0.33,0.52,0.62	0.34,0.55,0.66	0.27,0.38,0.52	1.15,1.78,2.15	0.40,0.69,0.79	1.00,1.00,1.00	1.12,1.20,1.59	1.26,1.44,2.52
Demand	0.31,0.48,0.63	0.45,0.69,0.79	0.31,0.48,0.63	0.58,0.93,1.09	0.35,0.58,0.71	0.40,0.69,0.79	1.00,1.00,1.00	0.89,0.89,1.78
Waste generation per product	0.38,0.55,0.74	0.25,0.35,0.47	0.32,0.49,0.66	1.29,2.24,2.42	0.71,1.00,1.00	0.63,0.83,0.89	0.56,1.12,1.12	1.00,1.00,1.00

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = (1,1,1) + (1.51,1.82,2.94) + \cdots + (1,1,1)$$

$$= (57.94, 74.71, 103.15)$$

$$\left(\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right)^{-1} = \left(\frac{1}{103.15}, \frac{1}{74.71}, \frac{1}{57.94}\right) = (0.0097, 0.0134, 0.0173)$$

$$\sum_{j=1}^{m} M_{g1}^{j} = (1,1,1) + (1.51, 1.82, 2.94) + \cdots + (1.59,2.08,3.17)$$

$$= (10.72,\ 13.44,\ 19.71)$$

$$\sum_{j=1}^{m} M_{g2}^{j} = (10.43,13.27,19.15), \sum_{j=1}^{m} M_{g3}^{j} = (10.51,13.87,19.55), \sum_{j=1}^{m} M_{g4}^{j} = (4.82,5.74,8.48)$$

$$\sum_{j=1}^{m} M_{g5}^{j} = (6.15,7.48,10.68), \sum_{j=1}^{m} M_{g6}^{j} = (5.87,7.57,9.86), \sum_{j=1}^{m} M_{g7}^{j} = (4.30,5.757.43),$$

$$\sum_{j=1}^{m} M_{g8}^{j} = (5.14,7.59,8.30)$$

$$F_1 = \sum_{j=1}^{m} M_{gi}^{j} \otimes \left[\sum_{\mathrm{i=1}}^{\mathrm{n}}\sum_{\mathrm{j=1}}^{\mathrm{m}} \mathrm{M}_{\mathrm{gi}}^{\mathrm{j}}\right]^{-1} = (10.72, 13.44, 19.71) \otimes (0.0097, 0.0134, 0.0173)$$

= (0.10, 0.18, 0.34)

$F_2 = (10.43,13.27,19.15) \otimes (0.0097, 0.0134, 0.0173) = (0.10, 0.18, 0.33)$

$F_3 = (10.51,13.87,19.55) \otimes (0.0097, 0.0134, 0.0173) = (0.10, 0.19, 0.34)$

$F_4 = (4.82,5.74,8.48) \otimes (0.0097, 0.0134, 0.0173) = (0.05, 0.08, 0.15)$

$F_5 = (6.15,7.48,10.68) \otimes (0.0097, 0.0134, 0.0173) = (0.06, 0.10, 0.18)$

$F_6 = (5.87,7.57,9.86) \otimes (0.0097, 0.0134, 0.0173) = (0.06, 0.10, 0.17)$

$F_7 = (4.30,5.757.43) \otimes (0.0097, 0.0134, 0.0173) = (0.04, 0.08, 0.13)$

$F_8 = (5.14,7.59,8.30) \otimes (0.0097, 0.0134, 0.0173) = (0.05, 0.10, 0.14)$

V ($F_1 \geq F_2$) = 1, V ($F_1 \geq F_3$) = 1, V ($F_1 \geq F_4$) = 1, V ($F_1 \geq F_5$) = 1,

V ($F_1 \geq F_6$) = 1, V ($F_1 \geq F_7$) = 1, V ($F_1 \geq F_8$) = 1

Similarly,

V ($F_2 \geq F_1 F_3 F_4 F_5 F_6 F_7 F_8$) = (1, 1, 1, 1, 1, 1, 1)

V ($F_3 \geq F_1 F_2 F_4 F_5 F_6 F_7 F_8$) = (1, 1, 1, 1, 1, 1, 1)

V ($F_4 \geq F_1 F_2 F_3 F_5 F_6 F_7 F_8$) = (0.375, 0.444, 0.444, 1, 1, 1, 0.857)

V ($F_5 \geq F_1 F_2 F_3 F_4 F_6 F_7 F_8$) = (0.143, 0.25, 0.25, 0.80, 1, 0.833, 0.667)

V ($F_6 \geq F_1 F_2 F_3 F_4 F_5 F_7 F_8$) = (0.286, 0.375, 0.375, 1, 1, 1, 0.833)

V ($F_7 \geq F_1 F_2 F_3 F_4 F_5 F_6 F_8$) = (0.143, 0.25, 0.25, 0.80, 1, 0.833, 0.667)

V ($F_8 \geq F_1 F_2 F_3 F_4 F_5 F_6 F_7$) = (0.429, 0.50, 0.50, 1, 1, 1, 1)

The weight vectors are calculated as follows:

d (f_1) = Min V ($F_1 \geq F_2 F_3 F_4 F_5 F_6 F_7 F_8$) = Min (1, 1, 1, 1, 1, 1, 1) = 1

d (f_2) = Min V ($F_2 \geq F_1 F_3 F_4 F_5 F_6 F_7 F_8$) = Min (1, 1, 1, 1, 1, 1, 1) = 1

d (f_3) = Min V ($F_3 \geq F_1 F_2 F_4 F_5 F_6 F_7 F_8$) = Min (1, 1, 1, 1, 1, 1, 1) = 1

d (f_4) = Min V ($F_4 \geq F_1 F_2 F_3 F_5 F_6 F_7 F_8$) = Min (0.375, 0.444, 0.444, 1, 1, 1, 0.857) = 0.375

d (f_5) = Min V ($F_5 \geq F_1 F_2 F_3 F_4 F_6 F_7 F_8$) = Min (0.143, 0.25, 0.25, 0.80, 1, 0.833, 0.667) = 0.143

d (f_6) = Min V ($F_6 \geq F_1 F_2 F_3 F_4 F_5 F_7 F_8$) = Min (0.286, 0.375, 0.375, 1, 1, 1, 0.833) = 0.286

d (f_7) = Min V ($F_7 \geq F_1 F_2 F_3 F_4 F_5 F_6 F_8$) = Min (0.143, 0.25, 0.25, 0.80, 1, 0.833, 0.667) = 0.143

d (f_8) = Min V ($F_8 \geq F_1 F_2 F_3 F_4 F_5 F_6 F_7$) = Min (0.429, 0.50, 0.50, 1, 1, 1, 1) = 0.429

W' = (d (f_1) d (f_2) d (f_3) d (f_4) d (f_5) d (f_6) d (f_7) d (f_8))^T

= (1,1,1, 0.375, 0.143, 0.286, 0.143, 0.429)^T

= (0.229, 0.229, 0.229, 0.086, 0.033, 0.065, 0.033, 0.98)

The above analysis shows that ordering cost, rejection rate and late delivery ranked the highest and have an equal weight. Most of the weight is allocated to these three variables. This shows the importance of these variables in any type of supply chain. Experts commented that these variables may have different weights when only compared with each other. The other sustainability indicators, social development, emission, energy use, and waste management have weights 0.086, 0.033, 0.065, and 0.098, which have a cumulative weight of 0.274, are very significant, and would affect the suppliers' selection decision. In our case, all sustainability indicators will be taken separately for making the supplier selection model more comprehensive.

4.3.1 Fuzzy linear programming

In this model, four suppliers were considered on seven purchasing criteria;CO_2 emission, energy use per product, waste generated per product, percentage of profit into social and community development, ordering cost, rejection on quality and late delivery. Capacity is treated as the constraint for the model. Demand has been taken as a fuzzy variable. The supplier quantitative values are given in Table 4.3. The average values were used for calculating the emission per product, energy use per product, waste generation per product, money for social development per product and ordering cost per product. Rejection based on quality and late deliveries are taken by percentage. The following formulas are used for the calculation of quantitative information about the supplier.

$$\text{Emission per product (C)} = \frac{\text{Total emission in one year}}{\text{Total number of units produced}} \text{Kg}$$

$$\text{Energy use per product (E)} = \frac{\text{Total enrgy use in one year}}{\text{Total number of units produced}} \text{Watts}$$

$$\text{Waste generation per product (W)} = \frac{\text{Total waste generated in one year}}{\text{Total number of units produced}} \text{Kg}$$

$$\text{Social development per product (S)} = \$ \frac{\text{Total money used for social development}}{\text{Total number of units produced}}$$

These calculations provide the following quantitative information about the suppliers.

Table 4.3 Suppliers' quantitative information

Supplier	Emission / product (kg)	Energy/ product (Watt)	Waste/ product (kg)	Social development ($/product)	Ordering Cost per Product ($)	Rejection on quality (Percentage)	Late Delivery (percentage)	Capacity
1	1.6	2	0.6	0.020	4	0.05	0.04	13,000
2	2.3	1.7	0.4	0.025	3	0.06	0.05	8,000
3	2.2	1.9	0.5	0.015	5	0.04	0.06	12,000
4	1.4	2.1	0.3	0.010	2	0.03	0.03	10,000

Numerical examples of multi objective linear programming are given below. Objective Z_1 minimizes CO_2 emission. Objective Z_2 minimizes energy use per product. Objective Z_3 minimizes waste generated per product. Objective Z_4 maximizes the percentage of total profit used for social and community development. Objective Z_5 minimizes ordering cost per product. Objective Z_6 minimizes the percentage of rejection on quality issues. Objective Z_7 minimizes the late delivery of ordered items.

$Z_1 = 1.6x_1 + 2.3x_2 + 2.2x_3 + 1.4\ x_4$

$Z_2 = 2x_1 + 1.7x_2 + 1.9x_3 + 2.1\ x_4$

$Z_3 = 0.6x_1 + 0.4x_2 + 0.5x_3 + 0.3x_4$

$Z_4 = 0.02x_1 + 0.025x_2 + 0.015x_3 + 0.01x_4$

$Z_5 = 4x_1 + 3x_2 + 5x_3 + 2\ x_4$

$Z_6 = 0.05x_1 + 0.06x_2 + 0.04x_3 + 0.03x_4$

$Z_7 = 0.04x_1 + 0.05x_2 + 0.06x_3 + 0.03x_4$

$x_1+x_2+x_3+x_4 = 30{,}000$

$x_1 \leq 13000$

$x_2 \leq 8{,}000$

$x_3 \leq 12{,}000$

$x_4 \leq 10{,}000$

$x_1 \geq 0,\ x_2 \geq 0,\ x_3 \geq 0,\ x_4 \geq 0,$

$x_1,\ x_2,\ x_3$ and x_4 are integers.

According to the steps in the computation procedure, the objective Z_1 was minimized and maximized using the constraints for getting the lower and upper bounds on the objective function. The same process is repeated for all remaining six objectives (Z_2, Z_3, Z_4, Z_5, Z_6, and

Z_7). The minimum and maximum value of CO_2 emission, energy use per product, waste generated per product, percentage of profit into social, and community development, ordering cost, rejection on quality and late delivery are presented in Table 4.4.

Table 4.4 Lower and upper bounds of the membership function

Serial Number	Objective Function	μ = 0	μ = 1
1	Z_1	60800	**50200**
2	Z_2	60300	**56400**
3	Z_3	15800	**12200**
4	Z_4	**595**	440
5	Z_5	127000	**92000**
6	Z_6	1490	**1180**
7	Z_7	1520	**1170**

The weights calculated by fuzzy AHP are used for the crisp formulation by following the weighted additive model (Eq. 49-50). The additive value of the membership function of the constraints and objectives are maximized (Eq. 51-57). In crisp formulation, the first seven are a membership function of the objective function (Z_1, Z_2, Z_3, Z_4, Z_5, Z_6, and Z_7) and the eighth term (γ_1) is the membership function of the demand constraint.

4.3.2 Formulation of fuzzy linear programming

Two approaches are used to compare the results. The first approach is an asymmetric approach that allocates the weight of the variables according to their importance in supplier selection, while the other is due to Zimmerman which allocates the same weight for all the variables in the objective function.

4.3.2.1 Asymmetric Approach

The weighted additive method is used for the formulation of multi objective fuzzy linear programming. (Using Eq.30 and 31)

Maximize λ ($0.0326 * \lambda_1 + 0.0653 * \lambda_2 + 0.0980 * \lambda_3 + 0.0856 * \lambda_4 + 0.229 * \lambda_5 + 0.229 * \lambda_6 + 0.229 * \lambda_7 + 0.0326 * \gamma_1$)

Subject to

$$\lambda_1 \leq \frac{60800 - (1.6\,x_1 + 2.3\,x_2 + 2.2\,x_3 + 1.4\,x_4)}{10600}$$

$$\lambda_2 \leq \frac{60300 - (2\,x_1 + 1.7\,x_2 + 1.9\,x_3 + 2.1\,x_4)}{3900}$$

$$\lambda_3 \leq \frac{15800 - (0.6\,x_1 + 0.4\,x_2 + 0.5\,x_3 + 0.3\,x_4)}{3600}$$

$$\lambda_4 \leq \frac{(2\,x_1 + 2.5\,x_2 + 1.5\,x_3 + 1\,x_4) - 44000}{15500}$$

$$\lambda_5 \leq \frac{127000 - (4\,x_1 + 3\,x_2 + 5\,x_3 + 2\,x_4)}{35000}$$

$$\lambda_6 \leq \frac{1490 - (0.05\,x_1 + 0.06\,x_2 + 0.04\,x_3 + 0.03\,x_4)}{310}$$

$$\lambda_7 \leq \frac{1520 - (0.04\,x_1 + 0.05\,x_2 + 0.06\,x_3 + 0.03\,x_4)}{350}$$

$$\gamma_1 \leq \frac{30{,}100 - (x_1 + x_2 + x_3 + x_4)}{100}$$

$$\gamma_1 \leq \frac{(x_1 + x_2 + x_3 + x_4) - 29{,}850}{150}$$

$x_1 \leq 13000$

$x_2 \leq 8{,}000$

$x_3 \leq 12{,}000$

$x_4 \leq 10{,}000$

$x_1 \geq 0$, $x_2 \geq 0$, $x_3 \geq 0$, $x_4 \geq 0$ and

x_1, x_2, x_3, x_4 are integers.

The optimal solution is obtained by using Lingo (Version 13).

The objective value is $\lambda = 0.7426$ and values of $\lambda_1 = 0.8679$, $\lambda 2 = 0.4358$, $\lambda_3 = 0.6666$, $\lambda_4 = 0.6451$, $\lambda_5 = 1.0$, $\lambda_6 = 0.3548$, $\lambda_7 = 0.9714$ and $\gamma_1 = 1$ and the values of $x_1 = 12000$, $x_2 = 8000$, $x_3 = 0$ and $x_4 = 10000$.

$Z_1 = 51{,}600$, $Z_2 = 58{,}600$, $Z_3 = 13{,}400$, $Z_4 = 540$, $Z_5 = 92{,}000$, $Z_6 = 1380$, $Z_7 = 1180$

4.3.2.2 Symmetric Approach

The symmetric approach **(**Zimmermann, 1978) is used again in order to dilute the dominance of late delivery, rejection on quality and ordering cost. Considering that the objective function has five out of eight variables representing social and environmental sustainability. With this approach, all the factors are treated with the same weight, and λ is the overall objective function. Hence λ is maximized in this case.

Maximize λ

Subject to

$$\lambda \leq \frac{60800 - (1.6\,x_1 + 2.3\,x_2 + 2.2\,x_3 + 1.4\,x_4)}{10600}$$

$$\lambda \leq \frac{60300 - (2\,x_1 + 1.7\,x_2 + 1.9\,x_3 + 2.1\,x_4)}{3900}$$

$$\lambda \leq \frac{158000 - (6\,x_1 + 4\,x_2 + 5\,x_3 + 3\,x_4)}{36000}$$

$$\lambda \leq \frac{(2\,x_1 + 2.5\,x_2 + 1.5\,x_3 + 1\,x_4) - 44000}{15500}$$

$$\lambda \leq \frac{340000 - (10\,x_1 + 15\,x_2 + 5\,x_3 + 10\,x_4)}{100000}$$

$$\lambda \leq \frac{127000 - (4\,x_1 + 3\,x_2 + 5\,x_3 + 2\,x_4)}{35000}$$

$$\lambda \leq \frac{1490 - (0.05\,x_1 + 0.06\,x_2 + 0.04\,x_3 + 0.03\,x_4)}{310}$$

$$\lambda \leq \frac{1520 - (0.04\,x_1 + 0.05\,x_2 + 0.06\,x_3 + 0.03\,x_4)}{350}$$

$$\lambda \leq \frac{30{,}100 - (x_1 + x_2 + x_3 + x_4)}{100}$$

$$\lambda \leq \frac{(x_1 + x_2 + x_3 + x_4) - 28{,}850}{150}$$

$x_1 \leq 13000$

$x_2 \leq 8{,}000$

$x_3 \leq 12{,}000$

$x_4 \leq 10{,}000$

$1.6x_1 + 2.3x_2 + 2.2x_3 + 1.4x_4 \leq 65000;$

$2x_1 + 1.7\,x_2 + 1.9\,x_3 + 2.1x_4 \leq 65000;$

$0.6x_1 + 0.4\,x_2 + 0.5\,x_3 + 0.3x_4 \leq 16000;$

$0.02x_1 + 0.025x_2 + 0.015x_3 + 0.01x_4 \geq 400;$

$x_1 \geq 0,\ x_2 \geq 0,\ x_3 \geq 0,\ x_4 \geq 0$ and

x_1, x_2, x_3, x_4 are integers.

The values obtained are as follows:

λ = 0.5012, x_1 = 10,577, x_2 = 5323, x_3 = 6562 and x_4 = 7464

Z_1 = 54,502, Z_2 = 58,345, Z_3 = 13,995.6, Z_4 = 518, Z_5 = 106,015, Z_6 = 1335, Z_7 = 1307

The summarized solutions are shown in Table 4.5. In the range of demand, 29850 to 30100, the optimized values of emission, energy use, waste generated, money for social development, ordering cost, rejection on quality and late delivery are 51,600 kg, 58,600 watts, 13,400 kg, $ 540, $ 92,000, 1380 units, and 1180 units. When this problem is solved with the symmetric (Zimmermann) approach, the optimized values of emission, energy use, waste generated, money for social development, ordering cost, rejection on quality and late delivery are 52974 kg, 58,345.3 watts, 13171.4 kg, $ 517.685, $ 95,871, 1334.63 units, and 1237.13 units. With the asymmetric approach, the quota for Supplier 3 is zero. However, in the case of the symmetric approach 11.3 percent of the quota is allocated to Supplier 3.

Table 4.5 Comparison between symmetric and asymmetric approach

S. N.	Objective Function	Asymmetric	Symmetric
1	Z_1	51,600	52,974.3
2	Z_2	58,600	58,345.3
3	Z_3	13,400	1,3171.4
4	Z_4	540	517.685
5	Z_5	92,000	95,871
6	Z_6	1,380	1,334
7	Z_7	1,180	1,237

Table 4.6 gives a comparison of quota allocation for both the symmetric and asymmetric approach. The variance in the quota is mainly due to the low weight given to the environmental and social factors. When the Zimmerman approach is used, the balance between environmental and social factors and economic factors is maintained, result in decrease of the quota of Supplier 1 and Supplier 4.

Supplier 4 got a full quota with respect to its capacity with the asymmetric approach because of a better performance on late delivery, ordering cost and net rejection, which carries more weight than the other parameters. Most of the objectives are well optimized with the asymmetric approach with a better fulfilment of demand, 30,000 in comparison to 29,926 using the symmetric approach (Table 4.6).

Table 4.6 Supplier's quota allocation

Supplier	Capacity	Order allocation (asymmetric approach)	Quota allocation	Order allocation in (symmetric approach)	Quota allocation
1	13,000	12000	40.0	9309	31.1
2	8,000	8000	26.7	7225	24.1
3	12,000	0	00	3392	11.3
4	10,000	10000	33.3	10000	33.4
Demand	30,000	30000		29926	

Forty percent of the quota is allocated to Supplier 1. The highest quota allocation for Supplier 1 is due to the highest capacity that might have gone to Supplier 2 and Supplier 4. Supplier 4 ranked the best based on the lowest rejection, the lowest ordering cost, the lowest late delivered items, the lowest emission, and the lowest waste generation. However, Supplier 4 does not have enough capacity. Alongside this, Supplier 2 got its capacity filled because of its low energy use and ranked highest on social development contribution. Supplier 4 got its full capacity quota, and now 4 needs to work on its capacity. As discussed in the literature, the buyer firm can also help in developing the capacity of Supplier 4. In the case of supplier 3, the buyer firm needs to work hard. The transfer of the required resources to supplier 3 can increase its quota.

The main drawback of symmetric approach is that it gives equal importance to each variable that result in allocation of orders to low performing supplier. Like overall objective is better maximized by asymmetric approach and most of the objectives are better optimized in that approach. For example (Table 4.6), Supplier 3 has been allocated order even though it is worst performer on sustainability criteria (social and environmental).

Variability of individual goals with respect to the objective function has been checked, by changing the objective values from 0 to 0.7426. Figure 4.3 shows the variability in the achievement of the carbon emission goal (λ_1), energy minimization goal (λ_2), waste reduction goal (λ_3), and social development goal (λ_4) with respect to the total achieved goal (λ). Figure 4.4 shows the variability of function of the cost of the product (λ_5), rejection (λ_6) and late delivery (λ_7) with respect to the overall objective (λ). Figure 4.5 shows the order allocation to the suppliers with respect to the objective function. The variability can be observed in the order allocation with respect to the value of the objective function.

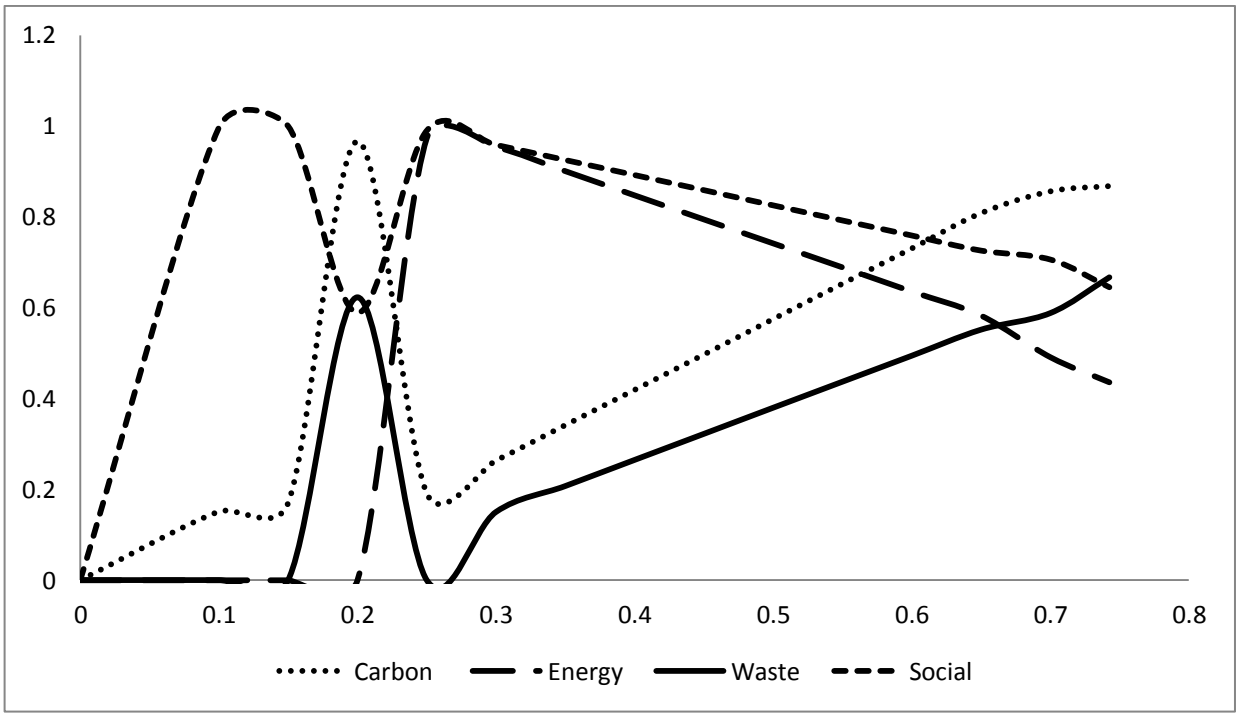

Figure 4.3 Variation of social and environmental objective with respect to overall goal

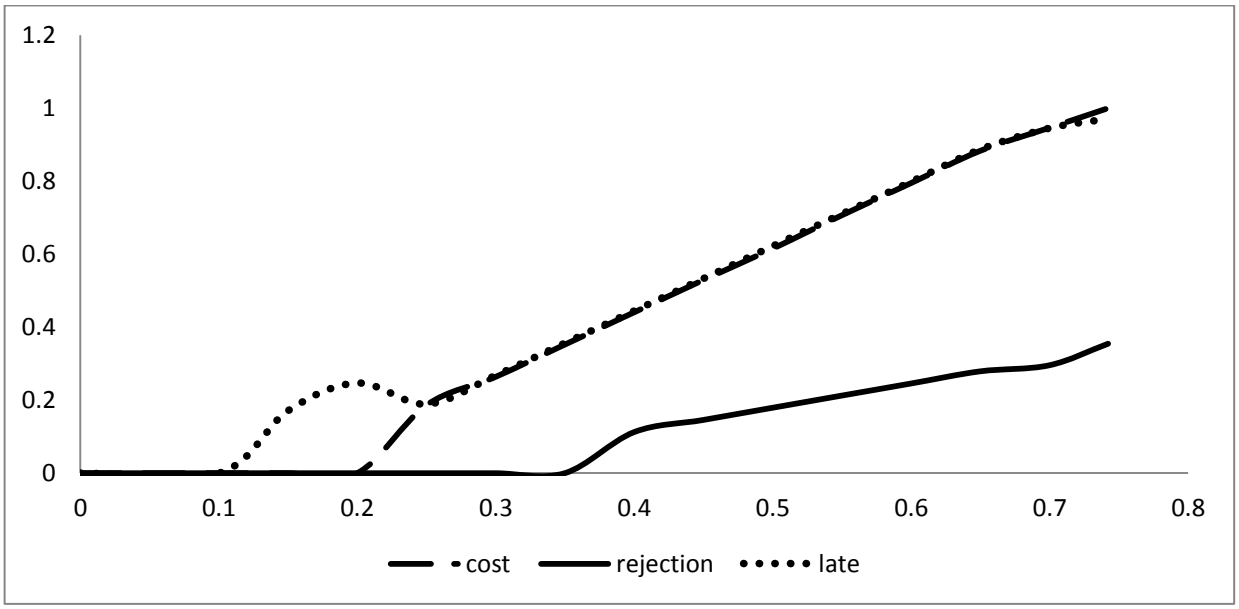

Figure 4.4 Variation of Cost, rejection and late delivery with respect to overall goal

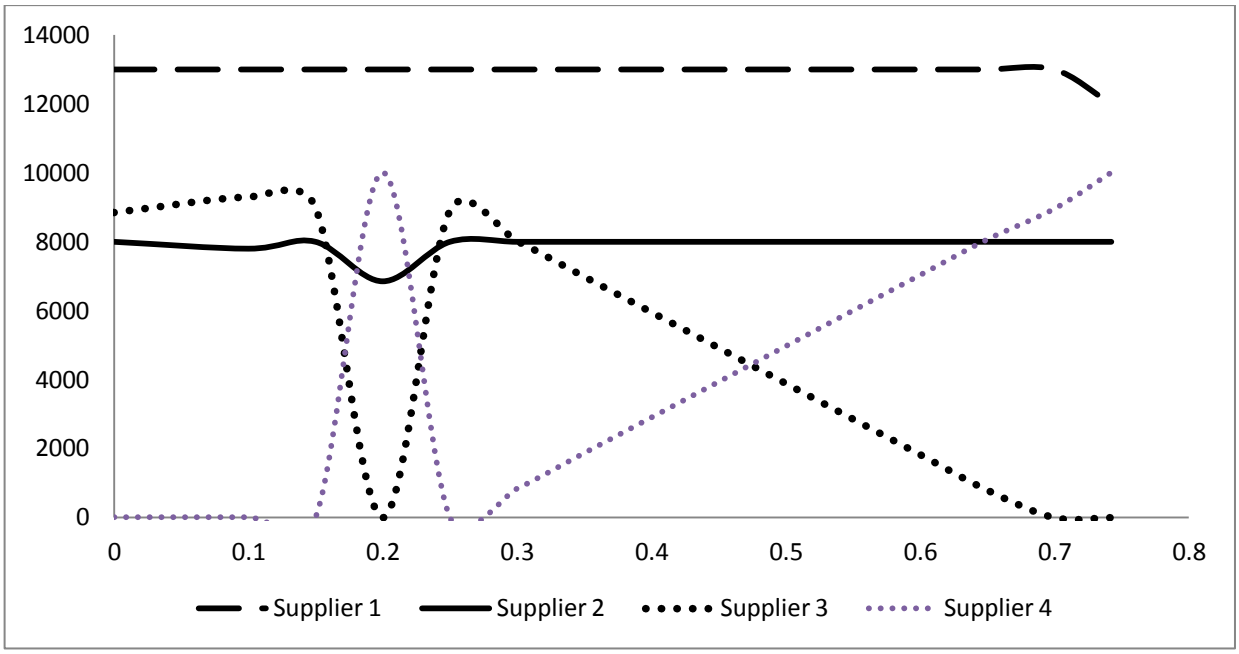

Figure 4.5 Variation of order allocation with respect to the overall goal

With change in the objective function value, the degree of each fuzzy goal also changed, affecting the order allocation. The order allocation to Supplier 1 is constant for λ values from 0 to 0.7, and then it is 12,000 at the maximized value of the objective function. Supplier 2 has a very weak change in the order allocation which may due to its better performance on all the indicators of sustainability. In the case of Supplier 3, there is a dip between 0.15 to 0.25, and the same dip is seen for the achievement goal of social development. Since the performance of Supplier 3 on the social and environmental criteria is adequate, the performance on the cost of product, rejection of items and late delivery has led to taking away of all its order. It should be kept in mind that the coefficient for cost; rejection and late delivery are much higher than social and environmental factors in the supplier selection criteria comparison. Allocation of order to Supplier 4 is zero till 0.15 then it increases to the maximum capacity of 10,000. It again decreases to zero at 0.25 and from there; there is a continuous increase with respect to the overall objective function. For a λ value of 0.7426, the order allocation is 10,000.

The achievement of the individual objectives with respect to the objective function and supplier quantitative information (Table 4.3) reveals some very interesting information. The quota of Supplier 3 is totally lost because of the low performance on waste management and emission, instead of having a lower number for quality rejection, late delivery and ordering

cost. Supplier 3 also spends the least on social development. Supplier 4 received orders to match capacity because of their better performance on all indicators. The buyer firm can help this supplier in capacity building while maintaining its sustainability performance. Supplier 1 lost having the highest capacity and could not get orders according to its capacity. The loss in the order of Supplier 1 is due to its low performance on waste management and energy use.

4.4 Managerial implications

From a managerial perspective, supplier selection is important for managing the sustainability of the final product. Rather than ranking suppliers on sustainability standards, companies can now allocate the ordering units among them. The existing literature on supplier selection has focused on various multi criteria decision-making techniques for supplier selection. However, these techniques lack the ability to allocate the order among suppliers in order to maximize the sustainability performance of available suppliers and their resources. This study will help managers to use the sustainability criteria in sustainability adoption.

The proposed supplier selection and order allocation method can be used in a way that particularly suits the need of the supply chain, by weighing and comparing the different selection criteria. Rather than using a symmetric approach, managers should apply an asymmetric approach when dealing with the importance of the criteria in real life problems. This approach includes the managers' decisions and implementation in real time situations. On the one hand, our approach deals with the importance of the selection criteria by using Fuzzy AHP. On the other hand, it optimizes the orders among the suppliers based on their performance in the sustainability indicators and the given importance of those indicators.

4.5 Conclusion

This chapter provides steps of developing a model for supplier selection and order allocation on the sustainability criteria. In this study, Fuzzy AHP and Fuzzy multi-objective linear programming were used for developing a supplier selection model for a more sustainable supply chain. In this model, weights were calculated using Fuzzy AHP and then fuzzy linear programming was used to determine the optimum solution. An asymmetric approach was proposed to induce practicality in the model because in a real life situation, all the factors cannot have an equal weight. A sensitivity analysis has been performed to know the variability of individual objective with respect to the overall objective. A case study of an Indian

automobile company was used to illustrate the applicability of the supplier selection model when considering sustainability criteria.

Chapter 5
Buyer supplier relationship selection

Preview

This chapter discusses a Fuzzy AHP based model for the buyer supplier relationship selection. This model consists of two stages. In first stage, pair wise comparison has been done to get the priority of benefits, opportunities, cost and risk. In second stage, pair wise comparison has been done among the strategic criteria and sub criteria of BOCR to get the best alternative of buyer supplier relationship. A best alternative of buyer supplier relationship has been selected by using the five different types of BOCR association methods.

5 Introduction

During the last decade, research on sustainability has changed the scenario of buyer-supplier relationship in the supply chain (Nakano & Hirao, 2011). One of the most important criteria in industrial purchasing is the supplier's attitude towards sustainability (Bai & Sarkis, 2010; Carter & Jenning, 2002). The negative impact of supplier activities on the environmental and social sustainability is evident (Shaw, et al., 2012). No product can claim to be sustainable without considering its supply chain (Mahler, 2007). The buyer firm needs to improve sustainability performance across the supply chain. The necessity of incorporating sustainable practices is influenced mainly by the stakeholders' interest (Zhu & Sarkis, 2010). This has changed the buyer-supplier relationship from an arm's length to a collaborative relationship (Gimenez & Tachizawa, 2012). Many firms are developing new relationships with supply chain partners such as joint development, sharing resources and information, knowing and solving supply chain partners' problems and jointly creating sustainability goals (Carters and Rogers, 2008). Relationships with supply chain partners is developed with the intention of providing assistance in terms of technology, resources, information, developing capability, and building capability. The outcomes of the relationship should be improved awareness, know how, technological understanding, marketing and competitive advantage and legal fulfillment.

In relationship marketing literature, managing marketing is based on building relationship with the partner (Grönroos, 1996). Whereas, the most acceptable definition of relationship marketing is "Relationship marketing is to identify and establish, maintain, and

enhance relationships with customers and other stakeholders, at a profit, so that the objectives of all parties involved are met by a mutual exchange and fulfillment of promises" (Grönroos, 1990). The focus of exchange in marketing theory has been replaced by maintaining relationships with the stakeholders (Hunt & Morgan, 1990; Sridharan & Simatupang, 2013). For a sustainable supply chain, it is the duty of both buyers and suppliers to develop relationships with each other to achieve joint sustainability objectives of the supply chain (Daugherty, 2011; Simpson & Power, 2005). In a business-to-business environment, the implementation of relationship marketing is easier than the customer market (Grönroos, 1996). A partnership in the supply chain helps to optimize the use of resources, skills and expertise across supply chain and develop a competitive network (Lambert et al., 1996). However, the buyer firm should always look for an appropriate partner, since developing a relationship requires a considerable investment of time and resources (Min et al., 2005). The allocation of resources for developing relationships with suppliers should be done by looking at the expected return on the relationship. Therefore, the degree of relationship and its nature depends upon the inter-organizational dependency and their capability to achieve a particular objective (Hagedoorn 2002).

In view of this, for developing a sustainable supply chain, the buyer firm should always identify the potential suppliers and jointly allocate resources for developing relationships based on their capability and expected return on relationship (Ronchi et al., 2007). There is need for a comprehensive model for buyer-supplier relationship selection (Lee, 2009). As discussed in relationship literature, collaborating firms always make a cost and benefits analysis. These components need to be included when determining the type of relationship with a particular supply chain partner. Similarly, the expected return on the relationship depends on the opportunity and risk. Hence, the component of opportunity and rick need to be considered. The final model for developing a buyer-supplier relationship should be based on the benefits, opportunity, cost and risk (BOCR).

There is only one model developed by Lee (2009) that considers BOCR in the buyer-supplier relationship. However, this model was developed for an electronics company manufacturing LCDs that does not consider sustainability dimensions. Lee (2009) suggested that more complicated alternatives should be selected in order to know the supplier specific relationship types based on the BOCR. This study endeavors to fill the gaps by considering the sustainability dimensions in the buyer-supplier relationship.

This study considers that any suppler-buyer relationship is based on a benefit and cost analysis and expected return on the relationship in term of opportunities and risks. Most of the previous BOCR analysis has been done with the help of the analytical hierarchy process (AHP) and ANP (Analytical network programming). In this chapter, we have used Fuzzy AHP for developing a buyer-supplier relationship model for a sustainable supply chain. The use of fuzzy with AHP has been advised by many authors in order to remove any vagueness in the responses (Lee, 2009; Chang, 1996).

5.1 Literature review on Buyer-Supplier relationship in sustainable supply chain

Buyer-supplier relationships depend upon inter-organizational dependency. In term of a sustainable supply chain, it has been argued that close working with supply chain partners would result in better performance (Seuring & Muller, 2008). However, it is impractical for a company to develop relationships to the same degree with all the supply chain partners (Hadjikhani & LaPlaca, 2013). Sometimes, developing a long-term relationship does not provide the expected return with respect to the investment (Wilson, 1995). Companies need to optimize their resources among the supply chain partners for developing relationships. The current understanding of relationship marketing literature in the industrial environment clarifies that a relationship is developed with the consideration of a cost and risk analysis. The types of relationships discussed in relationship marketing as well as supply chain literature have been taken into consideration. A literature search has been done to trace the importance of buyer-supplier relationships in a sustainable supply chain. In a current literature search, papers with relationship management and sustainable supply chain components have been analyzed in order to trace the evidences of relationship management in previous work. The literature is also focused on identifying the benefits, cost, risk and opportunities of a buyer-supplier relationship in a sustainable supply chain environment.

The number of criteria in a relationship selection model can be taken on the basis of expert' decision-making and literature support for specific problems (Shaw et al., 2012). In terms of economic sustainability, previous researchers have done enough research. The indicators taken for the economic and operational acceptability of suppliers are as follows: rejection percentage on a quality basis (Walker et al., 2008; Matos & Hall, 2007), percentage of late delivery items (Daugherty, 2011; Zsidisin & Hendrick, 1998) and cost of the sourcing item (Holt & Ghobadian, 2009; Zutshi & Sohal, 2004). Social sustainability indicators discussed in

the literature are as follows: child labor (Muller et al., 2009; Koplin et al., 2007), working conditions (Bommel, 2010; Carter & Rogers 2008), rights of employees (Ni et al., 2010; Ciliberti, 2008; Rocha et al., 2007) and poverty reduction (Ni et al., 2010; Bitzer et al., 2008). Environmental sustainability includes packaging improvements (Tsoulfas & Pappis, 2006; Hall, 2000), energy efficiency (Nakano & Hirao, 2011; Wu & Pagell, 2011), pollution and emission minimization (Florida, 1996; Ciliberti, 2008), waste minimization (Matos & Hall, 2007; Bitzer et al., 2008), reverse logistics (Ni et al., 2010, Carter & Jenning, 2002), green purchasing (Ni et al., 2010; Bitzer et al., 2008), green designing (Bai & Sarkis, 2010; Holt & Ghobadian, 2009;), using renewable energy (Smith, 2007; Zhu et al., 2007) and disposal (Olorunniwo & Li, 2010; Vachon & Klassen, 2006). In this chapter, we have adopted the same strategic criteria for relationship selection which were used for supplier selection in Chapter 5.

5.1.1 Evidences of buyer supplier relationship in sustainable supply chain

Supply chain always been a topic of interest among the scholars of supply chain as well as marketing. There are an adequate number of studies that have shown evidences that a relationship based supply chain is necessary for the adoption of a particular practice across the supply chain; like ISO adoption, new technology and sustainability adoption. In term of a sustainable supply chain, a buyer-supplier relationship tends to discover solutions to the various barriers and facilitate the adoption. Table 5.1 includes the various terms used in the sustainable supply chain literature.

Table 5.1 Evidences of buyer supplier relationships in sustainable supply chain

Coordination	Senge & Prokesch, 2011; Bommel, 2010; Hong et al., 2009; Carter & Rogers 2008; Darnall, 2008; Bitzer et al., 2008; Keatinga et al., 2008; Matos & Hall, 2007; Hall, 2000
Trust	Ageron et al., 2011; Daugherty, 2011; Peters et al., 2011; Bai & Sarkis, 2010; Bitzer et al., 2008; Matos & Hall, 2007; Ellis & Higgins, 2006; Carter & Jenning, 2002; Zsidisin & Hendrick, 1998
Long and strong supply chain relationship	Closs et al., 2011; Luthra et al., 2011; Peters et al., 2011; Bommel, 2010; Pullman et al., 2010, Teuteberg & Wittstruck, 2010; Muller et al., 2009; Asif et al., 2008, Brito et al., 2008; Cai et al., 2008; Hutchins & Sutherland, 2008; Keatinga et al., 2008; Zhu et al., 2008b; Attaran & Attaran, 2007; Markley & Davis, 2007; Linton et al., 2007; Tsoulfas & Pappis, 2006; Vermeulen & Ras, 2006, Handfield et al., 2005; Rao, 2002; Carter & Jenning, 2002; Hall, 2000; Walton et al., 1998; Zsidisin & Hendrick, 1998; Sarkis, 1995

Stakeholder relationship and engagement	Peters et al., 2011; Pullman et al., 2010; Sarkis et al., 2010; Muller et al., 2009; Cramer, 2007; Matos & Hall, 2007; Rocha et al., 2007; Ellis &Higgins, 2006; Zutshi & Sohal, 2004; Carter & Jenning, 2002
Cooperation	Cheung & Rowlinson, 2011; Smerecnik & Anderson, 2011; Buyukozkan & Cifci, 2010; Bommel, 2010; Sharma et al., 2010; Cai et al., 2008; Ciliberti, 2008; Zhu et al., 2008a; Lee, 2008; Vachon & Klassen, 2008; Zhu et al., 2008b; Zhu et al., 2007a; Zhu et al, 2007b, Tsoulfas & Pappis, 2006; Vachon & Klassen, 2006; Vermeulen & Ras, 2006; Handfield et al., 2005; Simpson & Power, 2005; Bowen et al., 2001; Green et al., 1998; Zsidisin & Hendrick, 1998; Elkington, 1994
Supply chain Partners Involvement	Bai & Sarkis, 2010; Holt & Ghobadian, 2009; Hong et al., 2009; Bitzer et al., 2008; Rao & Holt, 2005
Partnership	Ageron et al., 2011; Bommel, 2010; Fortes, 2009; Svensson, 2009; Zhu et al., 2008b; Svensson, 2007; Markley & Davis, 2007; Ellis & Higgins, 2006; Hamprecht et al., 2005; Rao & Holt, 2005; Klassen & Vachon, 2003
Integration with supply chain partners	Kushwaha, 2011; Bommel, 2010; Bai & Sarkis, 2010; Fortes, 2009; Muller et al., 2009; Routroy, 2009; Hong et al., 2009; Ciliberti, 2008; Brito et al., 2008; Walker et al., 2008; Vachon & Klassen, 2008; Rocha et al., 2007; Koplin et al., 2007; Vachon & Klassen, 2006; Rao & Holt, 2005; Handfield et al., 2005; Zhu & Sarkis, 2004; Walton et al., 1998
Collaboration	Kudla & Klaas-Wissing, 2012; Ageron et al., 2011; Cheung & Rowlinson, 2011; Diabata & Govindan, 2011; Peters et al., 2011; Bai & Sarkis, 2010; Buyukozkan & Cifci, 2010; Closs et al., 2010; Ni et al., 2010; Olorunniwo & Li, 2010; Vermeulen & Seuring, 2009; Gold et al., 2009; Lee, 2008; Darnall, 2008; Attaran & Attaran, 2007; Simpson et al., 2007; Koplin et al., 2007; Matos & Hall, 2007; Vachon & Klassen, 2006; Preuss, 2005; Zhu & Sarkis, 2004; Kogg, 2003; Klassen & Vachon, 2003; Zsidisin & Hendrick, 1998
Joint development Programs	Peters et al., 2011;Senge & Prokesch, 2011; Hong et al., 2009; Salam, 2008; Seuring & Muller, 2008; Vachon & Klassen, 2008; Simpson et al., 2007; Rao & Holt, 2005; Zsidisin & Hendrick, 1998; Florida, 1996
Influence- power use and code of conducts	Eltayeb et al., 2011; Michelsen, 2007; Clemens & Douglus, 2006; Hamprecht et al., 2005

Table 5.1 illustrates how previous authors have tried to relate the buyer-supplier relationship with supply chain sustainability. Literature has used many key words for supply chain relationships, like collaboration, coordination, integration, cooperation and many more. However, the exact form of the relationship is not clear with these key words. For example, collaboration is important for product designing, forecasting, planning and increasing sustainability performance (Vermeulen & Seuring, 2009; Attaran & Attaran, 2007).

Collaboration is vital for creating awareness about sustainability across the supply chain (Zhu & Sarkis, 2004). Zsidisin & Hendrick (1998) argued that collaboration with suppliers to provide equipment, material, parts and services is essential for extending environmental sustainability across supply chain. Authors have found various situations in which the word 'collaboration' fits. Hence, a single key word cannot define the nature of a buyer-supplier relationship. It is situational based on the perception of need of the relationship and areas for improvement (Rinehart et al., 2008).

In order to understand the buyer supplier relationship, a detailed analysis needs to be done. The type of relationships depends upon the capability, capacity and commitment of the supplier (Kanda & Deshmukh, 2008). Besides this, some buyer firms do not want to indulge in any relationship and use their buying power to create pressure on the suppliers (Ford, 1980). Channel literature first discussed supply chain relationships that vary from arm's length to vertical integration (Golicic et al., 2003; Contractor & Lorange 1988). Relationships were further categorized by many authors based on the relationship magnitude. Supply chain relationships can be called partnerships, alliances, joint ventures, network organizations, franchises, license agreements, contractual relationships, service agreements, and administered relationships (Golicic et al., 2003). Cannon & Perreautt (1999) found that relationships could be classified based on similar characteristics and traits. The eight types of relationships are basic buying and selling, bare bones, contractual transaction, customer supply, cooperative systems, collaborative, mutually adaptive, and customer is king. Beside this, four relationship types between the buyer and suppliers has been given by Hansen (2006), are transactional, collaboration, co-production and co-creation in terms of exchange. Rinehart et al. (2002) were successful in getting the naming done by practitioners in his research based on certain characteristics and types of relationships. Those relationships were non-strategic transactions, administered relationships, contractual relationships, specialty contract relationships, partnerships, joint ventures, and strategic alliances.

These relationships can be defined by considering the level of investment required by both parties. The process of developing a relationship is the same, but the investment required to get the expected result is different. The effort from each party depends on their capacity and commitment. It is also influenced by the cost benefit of the relationship and opportunities and risk related to it.

The question of developing a relationship with a supplier can be answered by the expected performance of the relationship. For example, if a supplier is the most sustainable among all the suppliers of a particular input material but lacks the capacity, in this case, the buyer firm should work on developing the capacity of that supplier. In another situation, if a supplier is working satisfactorily on some of the sustainability criteria but lacks in one particular area, the buyer firm needs to assistant supplier to improve its performance in that area. A buyer firm should think of providing monetary support in some cases if it improves the sustainability performance of the relationship. Hence, developing a relationship is specific to the capacity, capability and current performance of the supplier (Lee et al., 2010). Experts from the automobile supply chain have finalized following relationships alternatives for the case study.

There are five types of relationship possibilities between buyers and suppliers in a sustainable supply chain of Indian automobile industry.

1. **One time relationship (**Carter & Rogers 2008; Seuring & Muller, 2008, Vachon, 2007**)**
   Relationship depends upon the current transaction only.
2. **Foundation relationship (**Wu & Pagell, 2011; Klassen & Vachon, 2003; Monczka et al., 1998**)**
   A relationship intended to develop basic trust and commitment among supplier-buyer. In terms of sustainability, it is related to the basic support extended to each other for developing a sustainable product.
3. **Problem solving relationship (**Ageron et al., 2011; Bai & Sarkis, 2010; Bitzer et al., 2008; Lee, 2008; Smith, 2007; Vachon, 2007; Elkington, 1994**)**
   This relationship is intended to know and solve supplier's problems. This type of relationship is problem specific and help is provided to the supplier for handling problems of sustainability adoption.
4. **Long term trust based relationship (**Bai & Sarkis, 2010; Lee, 2008; Seuring & Muller, 2008; Walker et al., 2008; Sahay, 2003; Monczka et al., 1998; Zsidisin & Hendrick, 1998**)**
   In this type of relationship, the buyer and supplier enter into long-term business objectives. Trust among the buyer and supplier is very important to attract long-term investments in the relationship.
5. **Mutual development and growth (**Ageron et al., 2011; Wu & Pagell, 2011; Lee, 2008; Markley & Devis, 2007; Moeller, 2006; Klassen & Vachon, 2003**)**

A relationship focused on setting joints goals and developing a program for sustainability adoption. It also concentrates on mutually developing the capacity and capability of each other.

5.1.2 Benefits, cost, risk and opportunities of buyer supplier relationship

Today, sustainability of the supply chain is becoming an obligation for supply chain partners. Companies are adopting sustainability practices due to external pressure, while others see it as an opportunity for growth and the associated benefits. Companies may also be reluctant towards sustainability because of the costs involved in overhauling the process and the perception of low economic returns and performance (Ageron et al., 2011; Nakano & Hirao, 2011; Fortes, 2009; Cai et al., 2008; Keatinga et al., 2008; Simpson & Power, 2005; Bowen et al., 2001). The buyer-supplier relationship always depends on the tradeoff between cost, risk and benefits, opportunities. In the literature on supply chain sustainable, authors have quoted many benefits, cost, risk and opportunities with respect to relationship development for sustainability adoption in the supply chain (Table 5.2).

Table 5.2 BOCR of buyer supplier relationship in sustainable supply chain

Criteria		Sub criteria	Source
Benefits			
Financial	1.1	Reduce Distribution cost	Eltayeb, 2011; Peters et al., 2011; Zhu et al., 2008; Tsoulfas & Pappis, 2006; Ytterhus, 1999; Green et al., 1998
	1.2	Low cost on information	Eltayeb, 2011; Peters et al., 2011; Darnll, et al., 2008; Zhu et al., 2008; Tsoulfas & Pappis, 2006
	1.3	Reduce inventory	Ageron et al., 2011; Closs et al., 2010; Hong et al., 2009; Zhu et al., 2008; Attaran & Attaran, 2007
Operational	2.1	Improve Internal process	Hong et al., 2009; Zhu et al., 2008; Tsoulfas & Pappis, 2006
	2.2	Resource optimization	Hong et al., 2009; Brito et al., 2008; Tsoulfas & Pappis, 2006
	2.3	On time delivery	Eltayeb, 2011; Daugherty, 2011; Brito et al., 2008; Zhu et al., 2008
Sustainability adoption	3.1	Improved quality on sustainability standards	Ageron et al., 2011; Eltayeba et al., 2011; Bitzer et al., 2008; Zhu & Sarkis, 2008; Ytterhus, 1999
	3.2	Reduced pressure from various agencies	Ageron et al., 2011; Zhu & Sarkis, 2010; Muller et al., 2009; Cai et al., 2008; Matos & Hall, 2007
	3.3	Sustainable supply chain	Nakano & Hirao, 2011; Seuring & Muller, 2008; Smith, 2007; Zutshi & Sohal, 2004; Klassen & Vachon, 2003
Opportunities			
Marketing advantage	4.1	Improve corporate Image/ Reputation	Muller et al., 2009; Matos & Hall, 2007; Rocha et al., 2007; Simpson et al., 2007; Vermeulen & Ras, 2006
	4.2	Premium Pricing	Ageron et al., 2011; Eltayeba et al., 2011; Ytterhus, 1999
	4.3	Product Differentiation	Kogg, 2003
	4.4	New Market	Holt & Ghobadian, 2009; Bitzer et al., 2008; Markley & Devis, 2007; Clemens & Douglus, 2006
Technical	5.1	Sharing technology and	Muller et al., 2009; Hong et al., 2009; Koplin et al., 2007;

capabilities		knowledge	Rocha et al., 2007; Vachon, 2007; Kogg, 2003; Rao, 2002
	5.2	Educating each other's employee	Seuring & Muller, 2008; Ciliberti, 2008; Lee, 2008; Zhu et al., 2007; Clemens & Douglus, 2006; Ytterhus, 1999
	5.3	Developing technical standards	Bai & Sarkis, 2010; Zhu et al, 2007; Rao & Holt, 2005; Klassen & Vachon, 2003;
Mutual growth	6.1	Capacity building and development	Ageron et al., 2011; Wu & Pagell, 2011; Lee, 2008; Markley & Davis, 2007; Klassen & Vachon, 2003
	6.2	Sharing resources and information	Wu & Pagell, 2011; Nakano & Hirao, 2011; Bommel, 2010; Smith, 2007; Lee, 2008; Klassen & Vachon, 2003
	6.3	Jointly setting goals	Olorunniwo & Li, 2010; Vachon & Klassen, 2008; Matos & Hall, 2007
Cost			
Cost of relationship	7.1	Financial investment for developing relationship	Ageron et al., 2011; Muller et al., 2009; Cai et al., 2008; Linton et al., 2007; Bowen et al., 2001
	7.2	Time required to develop relationship	Peters et al., 2011; Bitzer et al., 2008; Handfield, 2005; Carter & Jenning, 2002; Zsidisin & Hendrick, 1998;
	7.3	Responsibility sharing	Ageron et al., 2011; Daugherty, 2011; Ni et al., 2010; Cai et al., 2008; Rocha et al., 2007; Zutshi & Sohal, 2004
Impact of relationship	8.1	Perception of relationship success	Ageron et al., 2011; Nakano & Hirao, 2011; Fortes, 2009; Cai et al., 2008; Simpson & Power, 2005; Bowen et al., 2001
	8.2	No improvement in sustainability performance	Ageron et al., 2011; Fortes, 2009; Cai et al., 2008; Keatinga et al., 2008; Simpson & Power, 2005; Bowen et al., 2001
	8.3	Poor partner commitment towards sustainability	Ageron et al, 2011; Diabata & Govindan, 2011; Lee, 2008; Vachon, 2007; Rao & Holt, 2005; Zutshi & Sohal, 2004
Cost of adoption	9.1	Technological changes	Wu & Pagell, 2011; Bitzer et al., 2008; Lee, 2008; Zhu & Sarkis, 2004; Klassen & Vachon, 2003
	9.2	Process change	Olorunniwo & Li, 2010; Cai et al., 2008; Attaran & Attaran, 2007; Rocha et al., 2007
	9.3	Infrastructure development	Markley & Devis, 2007; Simpson & Power, 2005; Bowen et al., 2001
Risk			
Management	10.1	Lack of trust	Diabata & Govindan, 2011; Senge, 2011; Bitzer et al., 2008; Rao and Holt, 2005
	10.2	Problem in sharing risk	Olorunniwo & Li, 2010, Simpson & Power, 2005; Hall, 2000
	10.3	Lack of integration	Asif et al, 2008; Seuring & Muller, 2008; Vachon, 2007
Market	11.1	Dependency on few suppliers	Matos & Hall, 2007; Rocha et al., 2007; Handfield, 2005
	11.2	Bargaining power of supplier	Diabata & Govindan, 2011; Senge, 2011; Bitzer et al., 2008; Rao & Holt, 2005
	11.3	Competition in future	Diabata & Govindan, 2011; Senge, 2011; Bitzer et al., 2008; Rao & Holt, 2005
Investment	12.1	Huge investment required for developing relationship	Ageron et al., 2011; Cai et al., 2008; Muller et al., 2009; Linton et al., 2007; Bowen et al., 2001
	12.2	Unavailability of required technology with partners	Bai & Sarkis, 2010; Bitzer et al., 2008; Lee, 2008; Vermeulen & Ras, 2006; Zutshi & Sohal, 2004; Hall, 2000
	12.3	Breaking partnership in between	Diabata & Govindan, 2011; Rao & Holt, 2005

5.2 Introduction to methodologies

5.2.1 AHP

Satty introduced AHP in 1971. AHP enables researchers to solve multi-criteria decision-making problems in a six step process. (Lee et al. 2006; Satty 1990) As given by Satty:

- Defining the problem and clearly stating the objective and outcomes.
- Break problem in to hieratical structure with decision elements (Criteria and alternatives)
- Form comparison matrices by the pair wise comparison among decision variables.
- Calculate the weight of the decision variables.
- Check the consistency of the response to ensure the consistency of the judgments made by decision makers.
- Aggregate the relative weights and obtain final rating of the alternatives.

5.2.2 Fuzzy AHP

Fuzzy set theory helps to analyze the vagueness and fuzziness of uncertain environments (Zadeh, 1965). This can be managed by developing healthy models for decision-making (Baykasoglu, & Gocken, 2012; Dereli et al., 2007; Yu, 2002). In order to avoid being misled by the decision-making model, it should be comprised of some degree of fuzziness. In this case, the fuzzy set theory does its role. Most of the time, decision-making models provide uncertain answers instead of a precise value. It makes the quantification of a qualitative value very difficult (Lee, et al., 2005). In AHP, the crisp value is taken for the pair wise comparison but it is not appropriate for making real life decisions where responses are supposed to be uncertain (Shaw et al., 2012). To solve this problem, decision models should incorporate a fuzzy theory to deal with uncertainty (Lee, 2009; Yu, 2002). A selection of alternatives in fuzzy AHP is used by the fuzzy set theory in a conventional AHP.

Fuzzy AHP is often used in research for decision-making with various proposed methods for calculating fuzziness (Lee, 2009; Lee et al., 2008; Chen, 1996; Chang, 1996;). There are advantages and disadvantages for each method. Considering the simplicity of calculations and advantages of one method over another, Chang (1996) used the extent analysis method for Fuzzy AHP. This approach deals with the uncertainty of decision making and is more robust in nature (Chan & Kumar, 2007). It uses triangular fuzzy numbers for a pair wise comparison to calculate the priority of a different decision variable and an extent analysis to

calculate the synthetic value from the pair wise comparison. Various steps included in this methodology have been discussed in the section 4.2.1 of Chapter 4.

5.2.3 BOCR addition methods

In order to deal with the benefits, opportunities cost and risk; a pair wise comparison has been done to know which option is more beneficial and more opportunistic in nature. The same approach has been done for cost and risk by asking which option is more costly and more risky in nature. The weights calculated from the pair wise comparison can be added as proposed by Satty (2003):

(1) Additive:

$$Relative\ priority\ for\ alternatives = \mathrm{bB} + \mathrm{oO} + \mathrm{c(1/C)} + \mathrm{r(1/R)}$$

(2) Probabilistic additive:

$$Relative\ priority\ for\ alternatives = bB + oO + c(1-C)normalized + r(1-R)normalized$$

(3) Subtractive:

$$Relative\ priority\ for\ alternatives = \mathrm{bB} + \mathrm{oO} - \mathrm{cC} - \mathrm{rR}$$

(4) Multiplicative priority powers:

$$Relative\ priority\ for\ alternatives = Bb\ Oo\ [(1/C)normalized]c\ \ [(1/R)\ normalized]r$$

(5) Multiplicative:

$$\text{Relative priority for alternatives} = \mathrm{BO/CR}$$

Where B, O, C and R represents the synthesized results and b, o, c and r are normalized weights of B, O, C and R, respectively.

5.2.4 Methodology and algorithm

A systematic fuzzy AHP model for evaluating the forms of buyer–supplier relationship is proposed in this section. The steps are summarized as follows:

Step 1: Identify the experts and clearly state the problem to them. Collaboration is not always a good option, and there are various types of relationships based on the degree of collaboration and expected outcomes of the relationship.

Step 2: Decompose the problem hierarchically. Develop two hierarchies based on the literature and expert opinions.

Step 3: A nine-point scale questionnaire is developed for pair wise comparison by the experts (Table 5.3). Experts are included from the supply chain and operation management department of the company (Lee, 2009).

Table 5.3 Nine point scale (Lee, 2009)

Fuzzy Number	Membership Function
$\tilde{1}$	(1,1,2)
$\tilde{x}$	(x-1, x, x+1) for x= 2,3,4,5,6,7,8
$\tilde{9}$	(8,9,9)
$1/\check{1}$	$(2^{-1}, 1^{-1}, 1^{-1})$
$1/\check{x}$	$((x+1)^{-1}, x^{-1}, (x-1)^{-1})$ for x= 2,3,4,5,6,7,8
$1/\check{9}$	$(9^{-1}, 8^{-1}, 8^{-1})$

Step 4: Combine experts' opinions on the importance weight for each strategic criterion. For a number of S experts, the synthetic set representing the relative importance level between strategic criteria p and q can be generated by geometric average as (Lee, 2009):

$$h^{-} = \left(\prod_{t=1}^{s} l_t\right)^{\frac{1}{s}}, \qquad \forall t = 1, 2 \ldots s.$$

$$h = \left(\prod_{t=1}^{s} m_t\right)^{\frac{1}{s}}, \qquad \forall t = 1, 2 \ldots s.$$

$$h^{+} = \left(\prod_{t=1}^{s} n_t\right)^{\frac{1}{s}}, \qquad \forall t = 1, 2 \ldots s.$$

and (l_t, m_t, u_t) is the lower, middle and upper limit of fuzzy response from expert *t*.

Step 4: Calculate the relative weights, b, o, c and r, for the four merits B, O, C and R (stage 1).

Step 6: Fuzzy extent analysis method developed by Chang (1996) is used to obtaining the crisp relative priority of criteria.

Step 7: Stage 2 calculations. Calculate the fuzzy ranking of alternatives under each merit (B, O, C and R) by following Step 6.

Step 8: Obtain the performances of each alternative under each qualitative criterion by following Step 6.

Step 9: Identify the ranking of each alternative under benefits, opportunities, cost and risk.

Step 10: Synthesize and establish the fuzzy ranking of alternatives under each merit (B, O, C and R) by following the five combination ways as discussed in Section 3.3.

5.3 Application of the model on Indian automobile supply chain

The effectiveness of the model is discussed by a case study on a multinational automobile company (ABC), at the corporate office based in Noida (India). The company has four manufacturing units, one research centre and five sales offices across India. The company is mainly domestic demand oriented and partially export oriented. The company produces electrical, thermal, electronic, as well as power train products for both two wheelers and four wheelers. The company procures products from various suppliers in both semi-finished and finished forms. This study has been done for a plastic mold parts supplier. In this case, the company is sourcing material from four different suppliers.

The ABC Company has decided to improve its sustainability performance and wants to convey this to its suppliers. ABC has decided to develop a relationship with its supplier based on the company performance of several strategic sustainability criteria. These criteria have been selected by experts and the type of relationship that can be made with the plastic mold parts supplier are: one time relationship, foundation relationship, problem solving relationship, long term relationship and joint development.

Due to increasing sustainability practices across the industry, the ABC Company is looking to incorporate sustainability related criteria in the procurement processes. The company found that having excellent relationship management makes a supplier more sustainable and loyal. The relationship between the two parties depends on the capability and capacity of the individual suppliers. Management has invited experts from the marketing, production, quality, and research departments for the buyer-supplier relationship selection. There were total six experts invited.

5.3.1 Two stage model

The following two-stage model has been developed to solve the relationship selection problem. This case study has been done with respect to the particular supplier. In the first stage, the benefits, cost, opportunity, and risk has been compared with respect to the sustainability criteria finalized for the relationship selection. In the second stage, all the relationship

alternatives have been compared with respect to the benefits, opportunity, cost, and risk of the relationship.

5.3.1.1 Stage 1

Calculate the weight of benefits by comparing the sustainability indicators and demand of the product. In our case, eight criteria have been considered for deciding the buyer-supplier relationship. This includes energy use, emission, waste, employee and society, cost of sourcing, quality of input product, on time delivery and product demand. Figure 5.1 illustrate the comparison hierarchy of stage 1 (Comparison tables are attached in Appendix 1).

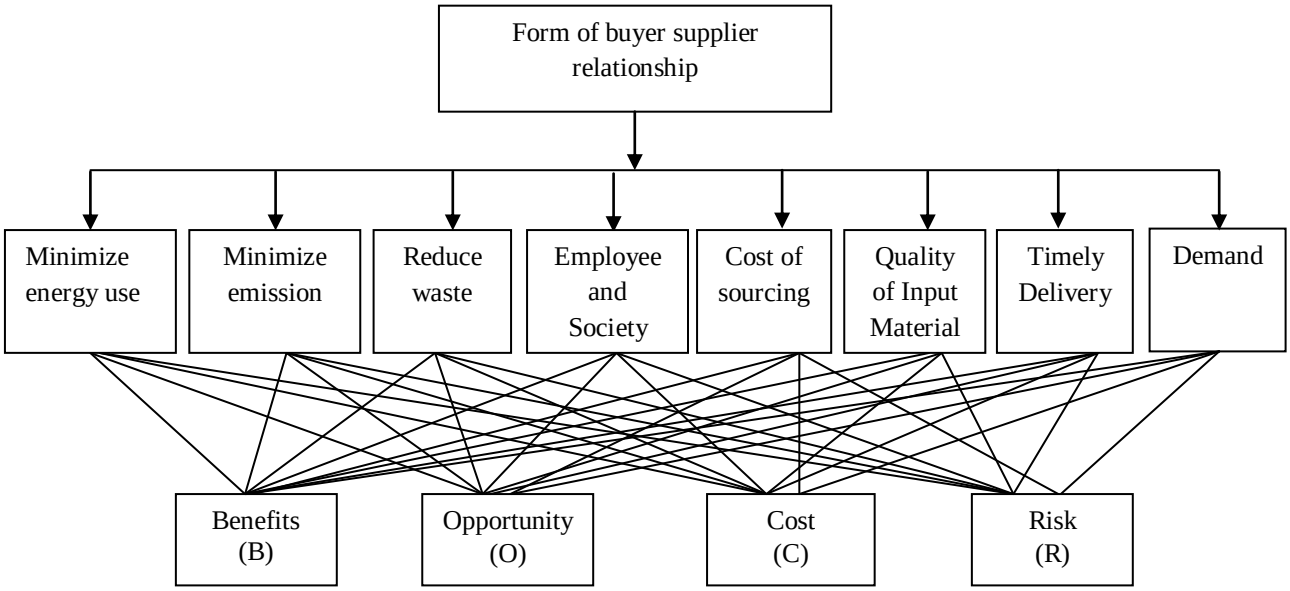

Figure 5.1 The control hierarchy (Stage 1)

5.3.1.2 Stage 2

All the relationship alternatives are compared with respect to the benefits, cost, risk, and opportunity of the buyer supplier relationship. Figure 5.2 illustrate a comparison hierarchy for selecting the best form of buyer supplier relationship with respect to the benefits, opportunities, cost, and risk of the relationship. The criteria for the model are benefits, opportunity, cost and risk. Each criterion has several sub-criteria (Table 5.2). There are five buyer-supplier relationship alternatives: one time relationship, foundation relationship, problem-solving relationship, long-term trust based relationship and mutual development and growth. A pair

wise comparison has been done for each level of the model in order to prioritize the final alternatives.

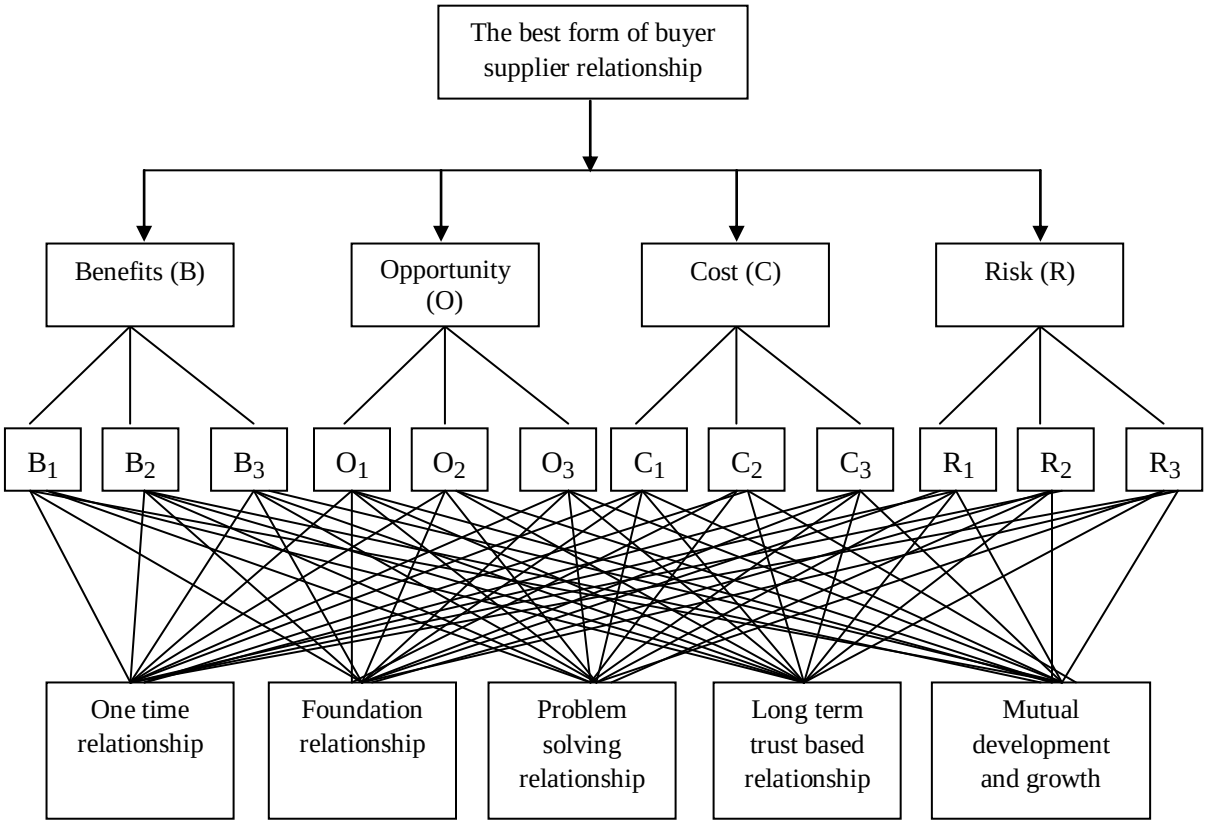

Figure 5.2 The control hierarchy (Stage 2)

5.3.2 Calculation of a Fuzzy AHP matrix (Chang, 1996)

The sustainability criteria have been compared to the relationship selection. Experts were asked to compare the criteria to determine the final weight for deciding the best form of the buyer-supplier relationship. The response from the experts was added using Lee's (2009) formula discussed in the computation procedure. The final cumulative response of the experts is shown in Table 5.4.

A response matrix has been calculated using Chang's fuzzy extended method (1996). Similar steps were used for the calculation of all possible metrics in Stage 1 and Stage 2 of our model.

Table 5.4 Comparison of selection criteria

	Ordering Cost	Rejection on Quality	Late Delivery	Social welfare	Emission	Energy use per product	Demand	Waste Generation
Ordering Cost	1.00,1.00,1.00	1.51,1.82,2.94	0.48,0.66,0.93	1.59,2.08,3.17	1.59,2.08,2.83	1.62,1.91,3.05	1.35,1.82,2.62	1.59,2.08,3.17
Rejection on Quality	0.34,0.55,0.66	1.00,1.00,1.00	1.00,1.44,2.00	1.59,2.08,3.17	1.59,2.08,3.17	1.51,1.82,2.94	2.14,2.85,3.96	1.26,1.44,2.24
Late Delivery	1.07,1.52,2.08	0.50,0.69,1.00	1.00,1.00,1.00	1.41,1.73,2.52	1.51,2.18,2.94	1.91,2.62,3.70	1.51,2.04,3.14	1.59,2.08,3.17
Social welfare	0.31,0.48,0.63	0.31,0.48,0.63	0.40,0.58,0.71	1.00,1.00,1.00	1.00,1.12,2.14	0.46,0.56,0.87	0.41,0.45,0.78	0.92,1.07,1.73
Emission	0.35,0.48,0.63	0.31,0.48,0.63	0.34,0.46,0.66	0.47,0.89,1.00	1.00,1.00,1.00	1.26,1.44,2.52	1.00,1.00,1.41	1.41,1.73,2.83
Energy use / product	0.33,0.52,0.62	0.34,0.55,0.66	0.27,0.38,0.52	1.15,1.78,2.15	0.40,0.69,0.79	1.00,1.00,1.00	1.12,1.20,1.59	1.26,1.44,2.52
Demand	0.31,0.48,0.63	0.45,0.69,0.79	0.31,0.48,0.63	0.58,0.93,1.09	0.35,0.58,0.71	0.40,0.69,0.79	1.00,1.00,1.00	0.89,0.89,1.78
Waste generation / product	0.38,0.55,0.74	0.25,0.35,0.47	0.32,0.49,0.66	1.29,2.24,2.42	0.71,1.00,1.00	0.63,0.83,0.89	0.56,1.12,1.12	1.00,1.00,1.00

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j} = (1,1,1) + (1.51,1.82,2.94) + \cdots + (1,1,1)$$

$$= (57.94, 74.71, 103.15)$$

$$\left(\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right)^{-1} = \left(\frac{1}{103.15}, \frac{1}{74.71}, \frac{1}{57.94}\right) = (0.0097, 0.0134, 0.0173)$$

$$\sum_{j=1}^{m} M_{g1}^{j} = (1,1,1) + (1.51, 1.82, 2.94) + \cdots + (1.59,2.08,3.17)$$

$$= (10.72,\ 13.44,\ 19.71)$$

$$\sum_{j=1}^{m} M_{g2}^{j} = (10.43,13.27,19.15), \sum_{j=1}^{m} M_{g3}^{j} = (10.51,13.87,19.55), \sum_{j=1}^{m} M_{g4}^{j} = (4.82,5.74,8.48)$$

$$\sum_{j=1}^{m} M_{g5}^{j} = (6.15,7.48,10.68), \sum_{j=1}^{m} M_{g6}^{j} = (5.87,7.57,9.86), \sum_{j=1}^{m} M_{g7}^{j} = (4.30,5.757.43),$$

$$\sum_{j=1}^{m} M_{g8}^{j} = (5.14,7.59,8.30)$$

$$F_1 = \sum_{j=1}^{m} M_{gi}^{j} \otimes \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = (10.72, 13.44, 19.71) \otimes (0.0097, 0.0134, 0.0173)$$

$$= (0.10,\ 0.18,\ 0.34)$$

$F_2 = (10.43,13.27,19.15) \otimes (0.0097, 0.0134, 0.0173) = (0.10, 0.18, 0.33)$

$F_3 = (10.51,13.87,19.55) \otimes (0.0097, 0.0134, 0.0173) = (0.10, 0.19, 0.34)$

$F_4 = (4.82,5.74,8.48) \otimes (0.0097, 0.0134, 0.0173) = (0.05, 0.08, 0.15)$

$F_5 = (6.15,7.48,10.68) \otimes (0.0097, 0.0134, 0.0173) = (0.06, 0.10, 0.18)$

$F_6 = (5.87,7.57,9.86) \otimes (0.0097, 0.0134, 0.0173) = (0.06, 0.10, 0.17)$

$F_7 = (4.30,5.757.43) \otimes (0.0097, 0.0134, 0.0173) = (0.04, 0.08, 0.13)$

$F_8 = (5.14,7.59,8.30) \otimes (0.0097, 0.0134, 0.0173) = (0.05, 0.10, 0.14)$

V ($F_1 \geq F_2$) = 1, V ($F_1 \geq F_3$) = 1, V ($F_1 \geq F_4$) = 1, V ($F_1 \geq F_5$) = 1,
V ($F_1 \geq F_6$) = 1, V ($F_1 \geq F_7$) = 1, V ($F_1 \geq F_8$) = 1

Similarly,

V ($F_2 \geq F_1 F_3 F_4 F_5 F_6 F_7 F_8$) = (1, 1, 1, 1, 1, 1, 1)

V ($F_3 \geq F_1 F_2 F_4 F_5 F_6 F_7 F_8$) = (1, 1, 1, 1, 1, 1, 1)

V ($F_4 \geq F_1 F_2 F_3 F_5 F_6 F_7 F_8$) = (0.375, 0.444, 0.444, 1, 1, 1, 0.857)

V ($F_5 \geq F_1 F_2 F_3 F_4 F_6 F_7 F_8$) = (0.143, 0.25, 0.25, 0.80, 1, 0.833, 0.667)

V ($F_6 \geq F_1 F_2 F_3 F_4 F_5 F_7 F_8$) = (0.286, 0.375, 0.375, 1, 1, 1, 0.833)

V ($F_7 \geq F_1 F_2 F_3 F_4 F_5 F_6 F_8$) = (0.143, 0.25, 0.25, 0.80, 1, 0.833, 0.667)

V ($F_8 \geq F_1 F_2 F_3 F_4 F_5 F_6 F_7$) = (0.429, 0.50, 0.50, 1, 1, 1, 1)

The weight vectors are calculated as follows:

d (f_1) = Min V ($F_1 \geq F_2 F_3 F_4 F_5 F_6 F_7 F_8$) = Min (1, 1, 1, 1, 1, 1, 1) = 1

d (f_2) = Min V ($F_2 \geq F_1 F_3 F_4 F_5 F_6 F_7 F_8$) = Min (1, 1, 1, 1, 1, 1, 1) = 1

d (f_3) = Min V ($F_3 \geq F_1 F_2 F_4 F_5 F_6 F_7 F_8$) = Min (1, 1, 1, 1, 1, 1, 1) = 1

d (f_4) = Min V ($F_4 \geq F_1 F_2 F_3 F_5 F_6 F_7 F_8$) = Min (0.375, 0.444, 0.444, 1, 1, 1, 0.857) = 0.375

d (f_5) = Min V ($F_5 \geq F_1 F_2 F_3 F_4 F_6 F_7 F_8$) = Min (0.143, 0.25, 0.25, 0.80, 1, 0.833, 0.667) = 0.143

d (f_6) = Min V ($F_6 \geq F_1 F_2 F_3 F_4 F_5 F_7 F_8$) = Min (0.286, 0.375, 0.375, 1, 1, 1, 0.833) = 0.286

d (f_7) = Min V ($F_7 \geq F_1 F_2 F_3 F_4 F_5 F_6 F_8$) = Min (0.143, 0.25, 0.25, 0.80, 1, 0.833, 0.667) = 0.143

d (f_8) = Min V ($F_8 \geq F_1 F_2 F_3 F_4 F_5 F_6 F_7$) = Min (0.429, 0.50, 0.50, 1, 1, 1, 1) = 0.429

W' = (d (f_1) d (f_2) d (f_3) d (f_4) d (f_5) d (f_6) d (f_7) d (f_8))^T

= (1,1,1, 0.375, 0.143, 0.286, 0.143, 0.429) ^{T}

= (0.229, 0.229, 0.229, 0.086, 0.033, 0.065, 0.033, 0.98)

The normalized priorities of sustainability criteria for relationship selection are 0.229, 0.229, 0.229, 0.086, 0.033, 0.065, 0.033, and 0.98 (Figure 5.2). The final priorities of the benefits, cost, opportunities and risk can be calculated by following the same procedure. The final priority weights for the stage 1 of the model are shown in Table 5.5. The final normalized weights have been calculated by multiplying the weights of sustainability criteria and BOCR weight of the control criteria.

For example, the weight of benefits are calculate by: 0.229*0.415+0.229*0.401+0.229*0.374+0.033*0.543+0.065*0.396+0.033*0.364+0.098*0.524 = 0.426

The weights of opportunity, cost and risk are 0.260, 0.226 and 0.088 respectively.

Table 5.5 BOCR rating

	Ordering Cost	Rejection on Quality	Late Delivery	Social welfare	Emission	Energy	Demand	Waste	Normalized weight
	0.229	0.229	0.229	0.086	0.033	0.065	0.033	0.098	
Benefits	0.415	0.401	0.374	0.554	0.543	0.396	0.364	0.524	0.426
Opportunities	0.333	0.209	0.291	0.197	0.215	0.244	0.297	0.200	0.260
Cost	0.149	0.289	0.200	0.212	0.229	0.349	0.191	0.257	0.226
Risk	0.103	0.101	0.135	0.037	0.013	0.010	0.148	0.019	0.088

These priorities are obtained by comparing the BOCR with respect to the strategic criteria. The strategic criteria were selected from the literature and expert opinion (Figure 5.3). The maximum weight has been obtained by benefits which is 0.426. Similarly, opportunities and cost of the relationship development has got 0.260 and 0.226 respectively. Risk has been found on least priority during the selection of best form of buyer supplier relationship in sustainable supply chain. These weights will be used in stage two for the selection of buyer supplier relationship alternative.

In stage 2, the relative weight of the criteria and sub-criteria are listed in Table 5.6. The most important control criterion under the benefit category is financial benefits, which have a priority of 0.411. It means a firm keen on developing a relationship with the supplier for

developing a more sustainable supply chain should look for the financial benefits. Going in to the sub-criteria under benefits, reducing distribution costs is preferred, having a priority of 0.2198. Other major benefits in the sub-criteria are low cost on information (0.1465), improve internal process (0.1278) and reduced pressure from the external agencies (0.1277). The improvement of quality on sustainability standards also make a significant contribution in benefits sub-criteria (0.1192). Under the opportunity merit, improved corporate image (0.1698) under marketing advantage and sharing technology and knowledge (0.1516) under technical capabilities are the most important criteria. This implies the buyer-supplier relationship in a sustainable supply chain are developed for improving the buyer's and supplier's image and companies look for sharing technology and knowledge about increasing sustainable practices. Under the cost merit, all the control costs of a relationship (0.352), impact of relationship (0.343) and the cost of adoption (0.304) have nearly equal priority. This is because each type of relationship has a different cost of developing the relationship. The type of relationship is also dependent upon the type of adoption the supplier needs in terms of sustainability and impact of the relationship in developing sustainability performance. Under the opportunity merit, the most important sub-criteria are financial investment for the relationship (0.1598), cost of infrastructure development (0.1373), time required for developing a relationship (0.1299) and perception of the relationship success (0.1209). Under risk merit, management of the relationship is the most important control criteria having priority of 0.815. All the important sub-criteria that come under the relationship management control criteria are lack of trust (0.2485), lack of integration (0.2685) and problem in sharing loss (0.2980). It means that firm worries most about the capability of managing relationship.

Table 5.6 Relative priorities of control criteria and sub criteria

Merits	Control Criteria	Sub Criteria	Normalized priority	Integrated priority
Benefits (0.426)	Financial (0.411)	Reduce Distribution cost	0.516	0.2198
		Low cost on information	0.344	0.1465
		Reduce inventory cost	0.140	0.0596
	Operational (0.326)	Improve Internal process	0.392	0.1278
		Resource optimization	0.301	0.0981
		On time delivery	0.307	0.1001
	Sustainability adoption (0.263)	Improved quality on sustainability standards	0.453	0.1192
		Reduced pressure from various agencies	0.485	0.1277
		Sustainable supply chain	0.061	0.0161
Opportunities (0.260)	Marketing advantage (0.454)	Improve corporate Image/ Reputation	0.374	0.1698
		Premium Pricing	0.291	0.1321
		Product Differentiation	0.200	0.0908
		New Market	0.135	0.0613
	Technical capabilities (0.369)	Sharing technology and knowledge	0.411	0.1516
		Educating each other's employee	0.326	0.1202
		Developing technical standards	0.263	0.0972
	Mutual growth (0.177)	Capacity building and development	0.600	0.1063
		Sharing resources and information	0.257	0.0457
		Jointly setting goals	0.141	0.0250
Cost (0.226)	Cost of relationship (0.352)	Financial investment for relationship	0.454	0.1598
		Time required to develop relationship	0.369	0.1299
		Responsibility sharing	0.177	0.0623
	Impact of relationship (0.343)	Perception of relationship success	0.352	0.1209
		No improvement in sustainability performance	0.343	0.1178
		Poor partner commitment	0.304	0.1043
	Cost of adoption (0.304)	Technological changes	0.244	0.0742
		Process change	0.304	0.0925
		Infrastructure development	0.452	0.1373
Risk (0.088)	Management (0.815)	Lack of trust	0.305	0.2485
		Problem in sharing risk	0.329	0.2685
		Lack of integration	0.366	0.2980
	Market (0.162)	Dependency on few suppliers	0.815	0.1320
		Bargaining power of supplier	0.163	0.0264
		competition in future	0.022	0.0036
	Investment (0.022)	Huge investment for relationship	0.233	0.0051
		Unavailability of required technology with partners	0.145	0.0032
		Breaking partnership in between	0.623	0.0137

Table 5.7 Priorities of alternatives under four merits

	Merits			
	Benefits (0.426)		Opportunities (0.260)	
Alternatives	Relative	Normalized	Relative	Normalized
One time relationship	0.150	0.048	0.151	0.050
Foundation relationship	0.059	0.019	0.090	0.030
Problem solving relationship	0.958	0.306	0.800	0.266
Long term relationship	1.000	0.319	0.973	0.323
Joint development	0.968	0.309	1.000	0.332

	Merits							
	Cost (0.226)				Risk (0.088)			
Alternatives	Relative	Normalized	Reciprocal	Normalized	Relative	Normalized	Reciprocal	Normalized
One time relationship	0.073	0.032	31.10	0.272	0.035	0.013	75.28	0.747
Foundation relationship	0.032	0.014	71.45	0.626	0.173	0.066	15.12	0.150
Problem solving relationship	0.351	0.156	06.41	0.056	0.560	0.214	04.67	0.046
Long term relationship	0.800	0.355	02.81	0.024	0.852	0.325	03.07	0.030
Joint development	1.000	0.443	02.25	0.019	1.000	0.382	02.62	0.026

Table 5.8 Final synthesis of priorities of alternatives

	Synthesis methods									
	Additive		Probabilistic additive		Subtractive		Multiplicative priority powers		Multiplicative	
Alternatives	Priority	Rank	Priority	Rank	Priority	Rank	Priority	Rank	Priority	Rank
One time relationship	0.094985	V	0.3391992	IV	0.024971	IV	0.043697	IV	0.000991	V
Foundation relationship	0.157577	IV	0.3209759	V	0.006748	V	0.041111	V	0.002649	IV
Problem solving relationship	0.205222	III	0.4593121	I	0.145084	I	0.170002	I	0.111408	I
Long term relationship	0.234654	II	0.4251118	II	0.110884	II	0.162888	II	0.094357	II
Joint development	0.235069	I	0.3980857	III	0.083857	III	0.158281	III	0.088181	III

Table 5.9 Sensitivity analysis

Merit	Benefits (0.426)				Opportunities (0.260)			
Change in merit with synthesis method	b decreases		b increases		o decreases		o increases	
	b best alternatives		b best alternatives		o best alternatives		o best alternatives	
Additive	No Change	MDG	0.467	LTR, MDG	0.213	LTR, MDG	No Change	MDG
Probabilistic additive	No Change	PSR	No Change	PSR	No Change	PSR	0.858	LTR, PSR
Subtractive	No Change	PSR	No Change	PSR	No Change	PSR	0.858	LTR, PSR
Multiplicative priority powers	No Change	PSR	No Change	PSR	No Change	PSR	0.479	LTR, PSR
Multiplicative	No Change	PSR	No Change	PSR	No Change	PSR	No Change	PSR
Merit	Cost (0.226)				Risk (0.088)			
Change in merit with synthesis method	c decreases		c increases		r decreases		r increases	
	c best alternatives		c best alternatives		r best alternatives		r best alternatives	
Additive	No Change	MDG	0.354	LTR (0.311), FR	No Change	PSR	No Change	MDG
Probabilistic additive	0.053	LTR, PSR	No Change	PSR	No Change	PSR	0.688	FR
Subtractive	No Change	PSR	No Change	PSR	No Change	PSR	No Change	PSR
Multiplicative priority powers	0.173	LTR, PSR	0.815	FR	No Change	PSR	0.151	MDG
Multiplicative	No Change	PSR	No Change	PSR	No Change	PSR	No Change	PSR

The relative importance of relationship alternatives is shown in Table 5.7. Under benefits merit, long-term relationship and joint development performed well with a priority of 0.319 and 0.309, respectively. Problem solving relationship is also at 0.306. In opportunity merit, joint development is the best option with a priority of 0.332. Long-term relationship is at 0.323. However, under the cost merit, foundation relationship becomes the best with a weight of 0.626 and one-time relationship is in second place with a weight of 0.272. Under the merit of risk, one-time relationship have a high priority (0.747) followed by the foundation relationship (0.150).

The final alternative priority is calculated by using five different combination methods shown in Table 5.8. Under all the combination methods, problem solving relationship ranks first, except in the additive method while joint development scores first in the additive method and ranks third in remaining methods. Long-term relationship scores second under all methods of combination. Under the additive method, long-term relationship ranks II and joint development ranks I with the score of 0.235069 and 0.234653 (insignificant difference of only 0.000415). Similarly, problem solving relationship ranks III, foundation relationship ranks IV and one-time relationship ranks V with the scores of 0.205222, 0.157577 and 0.094985. Under the probabilistic additive method and the subtractive and multiplicative priority powers method, the ranking of all the alternatives is the same. Problem solving relationship is at rank I, followed by long-term relationship and joint development for rank II and III. One-time relationship stands at rank IV in all the synthesis methods of combining priorities. In the multiplicative synthesis method, one-time relationship ranks V and foundation relationship is at rank IV with priorities (0.000991) and (0.002649), respectively.

The reason for the good performance of alternative “problem solving relationship” is the moderate performance of it on all the merits. While, other relationship types rank second and third are more beneficial and have more opportunity, but have more risk and cost.

A sensitivity analysis has been performed to check the change in the priority level of alternatives. The sensitivity analysis was done by changing the value of one merit while keeping the others constant. Table 5.9 shows the change in the priority level of the alternatives with the change in the priorities of benefits, opportunity, cost and risk. The sensitivity analysis was performed by changing the value of one strategic factor and keeping others’ value constant. When b decreases from 0.426, mutual development and growth remain the most preferred alternative in the additive method. Figure 5.3 shows the sensitivity analysis in the additive method with respect to the change in the value of b. In all

the other methods of combination, the problem solving relationship is the most preferred. Similarly, when opportunity is decreased to 0.213, long-term relationship is the most preferred.

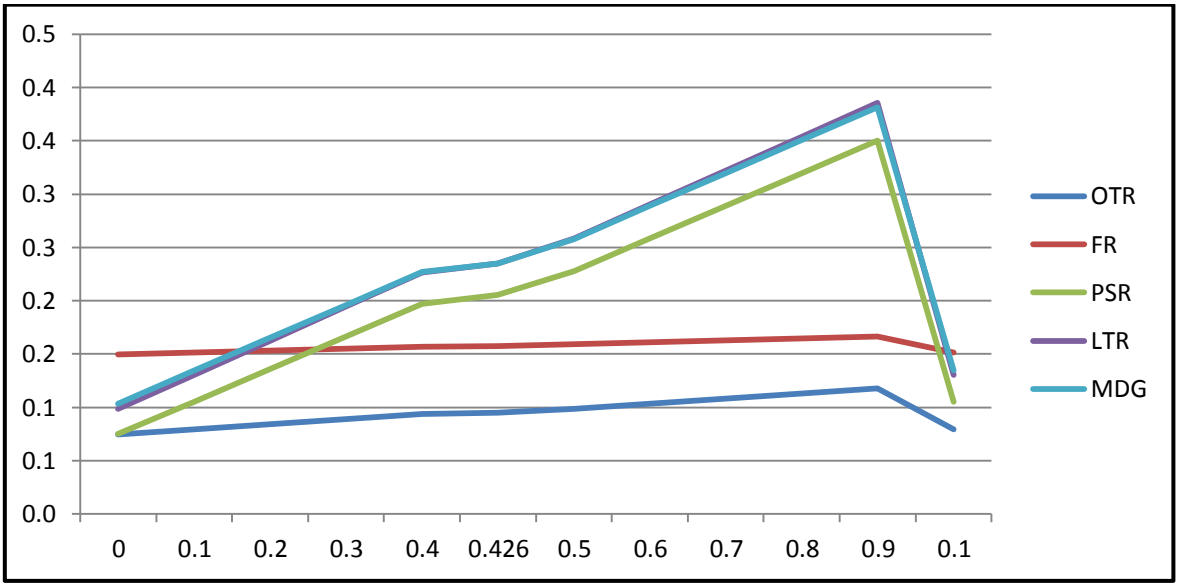

Figure 5.3 Sensitivity analyses with respect to the change in value of b (additive method)

A special case is seen with the cost factor. When cost priority is increased by more than 0.226, the most preferred alternatives at 0.311 are LTR and MDG and when it is increases further, after 0.354 the foundation relationship is the most suitable alternative in terms of cost. Similarly, all the variances can be seen in Table 5.9. In this study, the problem-solving relationship has been preferred, since it is focused on a specific problem related to sustainability adoption. It has been found moderate on all the merits. It has been found moderate on the benefits and opportunity; it also has moderate values on risk and cost compared to the other alternatives.

5.4 Managerial implications

In this paper, a fuzzy AHP model is applied to evaluate the forms of buyer-supplier relationships for developing a more sustainable supply chain. Contrary to other available supplier selection models, this model considers the cost, opportunity and risk related with developing a relationship with a particular supplier. This model can propose an appropriate relationship type in a supply chain. Fuzzy theory has been applied to handle the ambiguity and vagueness in decision making by the experts.

This model can help managers to decide the form of the buyer-supplier relationship in the supply chain. This model also provides information on the most profitable

relationship alternative with respect to changes in the priority of benefits, opportunity, cost and risk. This model also considers sustainability indicators for deciding the best form of the buyer-supplier relationship (Stage 1). Managers have the freedom to include customized sustainability indicators based on the industry and specific problems under consideration. This model can also be used to review current buyer-supplier relationships. A sensitivity analysis equips managers with the knowledge to decide relationship alternatives with the changing priorities of BOCR.

5.5 Conclusion

In this chapter a buyer supplier relationship selection model has been developed considering the benefits, opportunities, cost and risk of a relationship type. Two stage Fuzzy AHP model has been developed considering the literature and experts; opinion. Five types of relationships have been compared based on the benefits, opportunities, cost, and risk of developing a relationship for developing sustainable supply chain.

Chapter 6
Research methodology for hypotheses testing

Preview

This chapter is a base for achieving objective five of the present research. It explains the quantitative research procedure used to validate the proposed model. A brief discussion of the scale development process has been provided. Subsequent parts of the chapter discuss each step of the research methodology including research design, data collection methods, scaling techniques, sampling design, questionnaire design, data collection procedure and the data analysis procedure applied in each phase of the scale development process.

6 Introduction

The role of the buyer-supplier relationship for developing a sustainable supply chain has been affirmed by many authors (Hsu et al., 2013). The buyer-supplier relationship helps in dealing with the various barriers to sustainability adoption and provides an opportunity for mutual development (Carters & Rogers, 2008). In addition, pressure from multiple agencies compels supply chain partners to work in collaboration to improve the sustainability performance of the supply chain (Ashby et al., 2012; Gold et al., 2009).

The concept of a sustainable supply chain depends on the relationships among the supply chain partners. This relationship is specific to each supplier and their capacity, capability and commitment towards sustainability adoption (Daugherty, 2011; Bommel, 2010). The commitment of the supply chain partners firms to adopt sustainability is mainly due to external pressure from various agencies. Some companies, however, see sustainability as an opportunity for creating a marketing and competitive advantage (Clemens & Douglus, 2006).

In chapter 3, it has been discussed that besides external pressure, support and benefits, relationship strategies are required for developing a sustainable supply chain. Therefore, for developing a proper mechanism to develop a sustainable supply chain, certain questions need to be answered. These questions are:

1) How is top management commitment of supply chain partners affected by external pressure, support and expected benefits of sustainability adoption?

2) How does top management commitment affect the buyer-supplier relationship (supplier selection, supplier development, and supplier's performance review)?

3) How do buyer-supplier relationships (supplier selection, supplier development, and supplier's performance review) affect the sustainability (social, economic, and environmental) performance of the supply chain?

To develop a mechanism for a sustainable supply chain, a research instrument needs to be developed. To develop, test, and validate this research instrument, the Indian automobile industry has been considered. In the existing body of literature, there is a lack of empirical investigation on sustainable supply chain development mechanisms (Carters & Rogers, 2008; Seuring & Muller, 2008). Chapters 6 and 7 try to fill this major gap. Chapter 6 provides the research methodology adopted for developing the research instrument, while chapter 7 discusses the entire research instrument development procedure.

6.1 Proposed research model

A tentative research model has been proposed to achieve Objective 5 discussed in the second chapter. A rigorous literature survey helped to develop the conceptual relationships between the variables under study (Figure 6.1). These conceptual relations are used as a base for further empirical testing. Variables under consideration for developing a model for "sustainability adoption through relationship marketing" are discussed in the literature review in the third chapter. A final conceptual model has been presented in the same chapter and is used for understanding the relationship between relationship management activities and the sustainability performance of the supply chain and the impact of various enablers on the continuation of sustainability practices in the Indian automobile sector. The proposed model comprises many items under the following constructs.

- External pressure and support (13)
- Top management commitment (6)
- Benefits of sustainability (21)
- Buyer supplier relationship strategy containing three categories: Supplier selection (5), supplier development (18) and performance review (7)
- Sustainability indicators containing the three dimensions of sustainability, economical sustainability (5), environmental sustainability (12) and social sustainability (19)

A well-accepted scale development procedure has been adopted to test the reliability and validity of the proposed model.

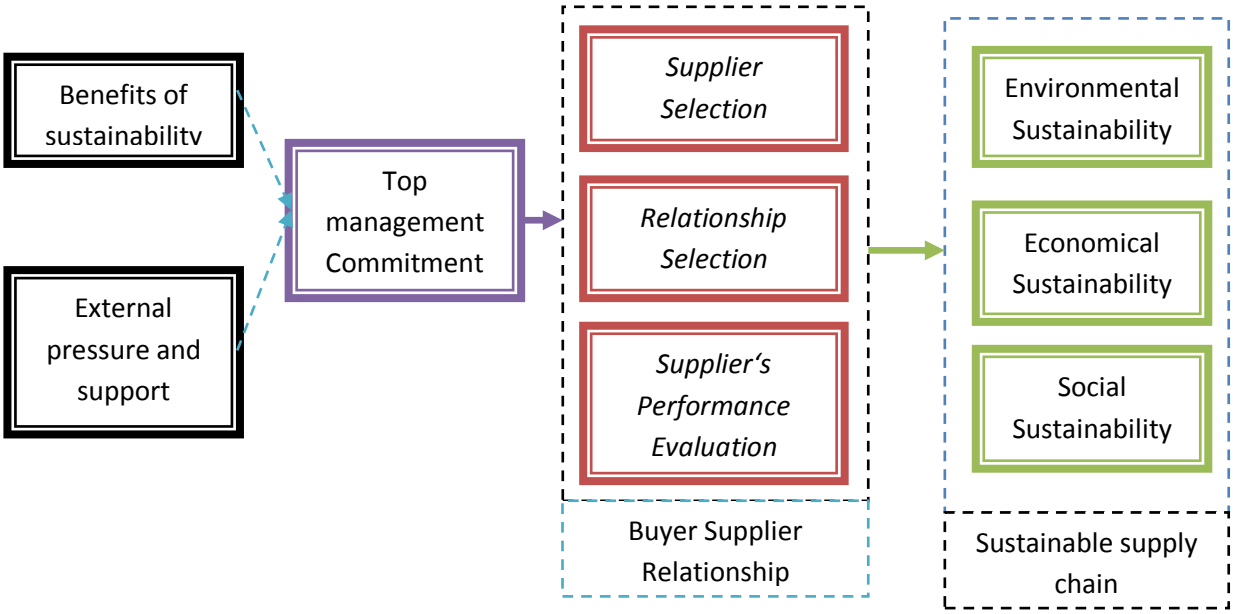

Figure 6.1 Conceptual model for sustainability adoption through buyer supplier relationship

6.2 Research instrument (questionnaire) procedure

Churchill (1979) has proposed the most accepted scale development procedure. Researchers use this method with the augmentation proposed by Peter, (1981); Anderson and Gerbing (1982); Bentler and Bonnet (1980); Bagozzi (1980), and Nunnally and Bernstein (1994). The scale development procedure is comprised of two phases, the item generation and selection phase and the scale refinement phase (Figure 6.2).

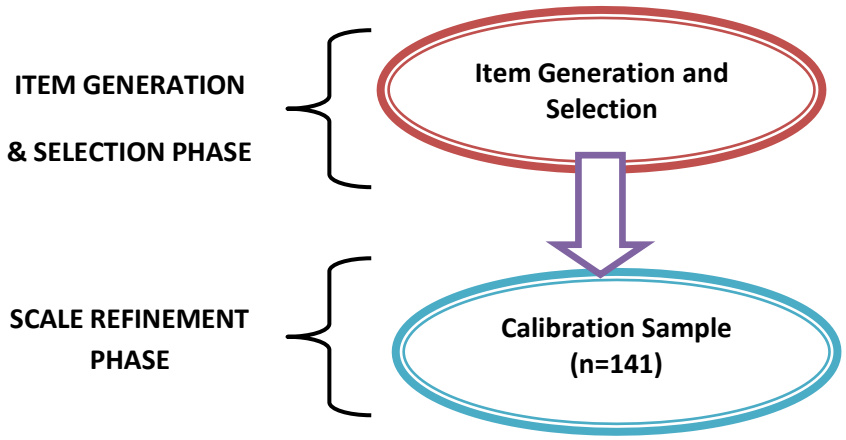

Figure 6.2 Scale Development procedure

6.2.1 Item Generation & selection phase (Qualitative Inquiry Stage)

In this stage, new items and constructs were developed and selected. The steps to develop these items and constructs are:

- Content analysis and categorization

- Generation of the initial pool of items
- Assess content and face validity through experts' judgments

6.2.2 Scale refinement phase

The steps followed in this stage are:

- Item analysis
- Consistency and reliability assessment

6.2.2.1 Purification stage

The remaining consistent and reliable items were further purified on a representative sample of respondents. The steps adopted for the scale purification are:

- Confirmatory factor analysis
- Unidimensionality and reliability assessment
- Convergent and discriminate validity assessment

Therefore, the scale has been developed based on these phases for the present study. A detailed description of each phase is discussed in Chapter 7. The subsequent sections of this chapter highlight the research methodology adopted for the development of the scale.

6.3 Research methodology

The objectives of the research can be achieved by a proper research methodology. Research methodology plays a vital role in guiding the researchers to attain the desired research objectives (Tsang & Antony, 2001; Gill & Johnson, 2002). Malhotra & Dash (2009) proposed the steps used in the present research.

The Steps include the research design adopted, the data collection method employed, the scaling techniques used, the questionnaire design, the sample design, the data collection procedure and the data analysis procedure. All these steps are discussed in subsequent sections of this chapter.

6.3.1 Research design

Research design works as an outline of a study. *"A research design is the logical sequence that connects the empirical data to the study's initial research questions and ultimately its conclusions" (Yin, 1994).* Three categories of research design have been suggested by Malhotra & Dash (2009) for marketing studies that are exploratory, descriptive, and causal. The objective of the present research requires an exploratory and descriptive research design. In this study, the design was to provide a possible influence of

the buyer-supplier relationship on the sustainability adoption intention of the supplier, not necessary a causal relationship. However, this research provides very important insights into the influence of buyer-supplier relationship dynamics and sustainability performance of supply chain

To achieve the research objectives of the present research, all three types of research designs have been applied. First, the exploratory research design (Parker et al., 2002) has been used to assist the researcher in exploring and identifying the factors, dimensions and consequences of customer experiences (see Chapter 2). Based on the data derived from the exploratory research design, the researcher was able to design a model (see Figure 6.1) for empirically testing a mechanism for developing a sustainable supply chain. Second, this research is also cross sectional descriptive in nature. In this kind of research, data collection has been done. Using cross sectional descriptive research is necessary for the development of a research instrument. Data has been collected from the decided sample and details of the sample are provided in a later part of this chapter. A questionnaire survey has been done for this study from various managerial level employees in the Indian automobile industry.

This research also used causal research design. In a causal research design, the relationship between two or more variables is established. In the present study, sustainability adoption triggers (external pressure & support and benefits of sustainability adoption) are independent variables that affect the top management's commitment to adopt sustainability. Further, top management commitment affects the buyer-supplier relationship, which results in better sustainability performance of the supply chain. To identify the relationship between these constructs, a causal research design was developed.

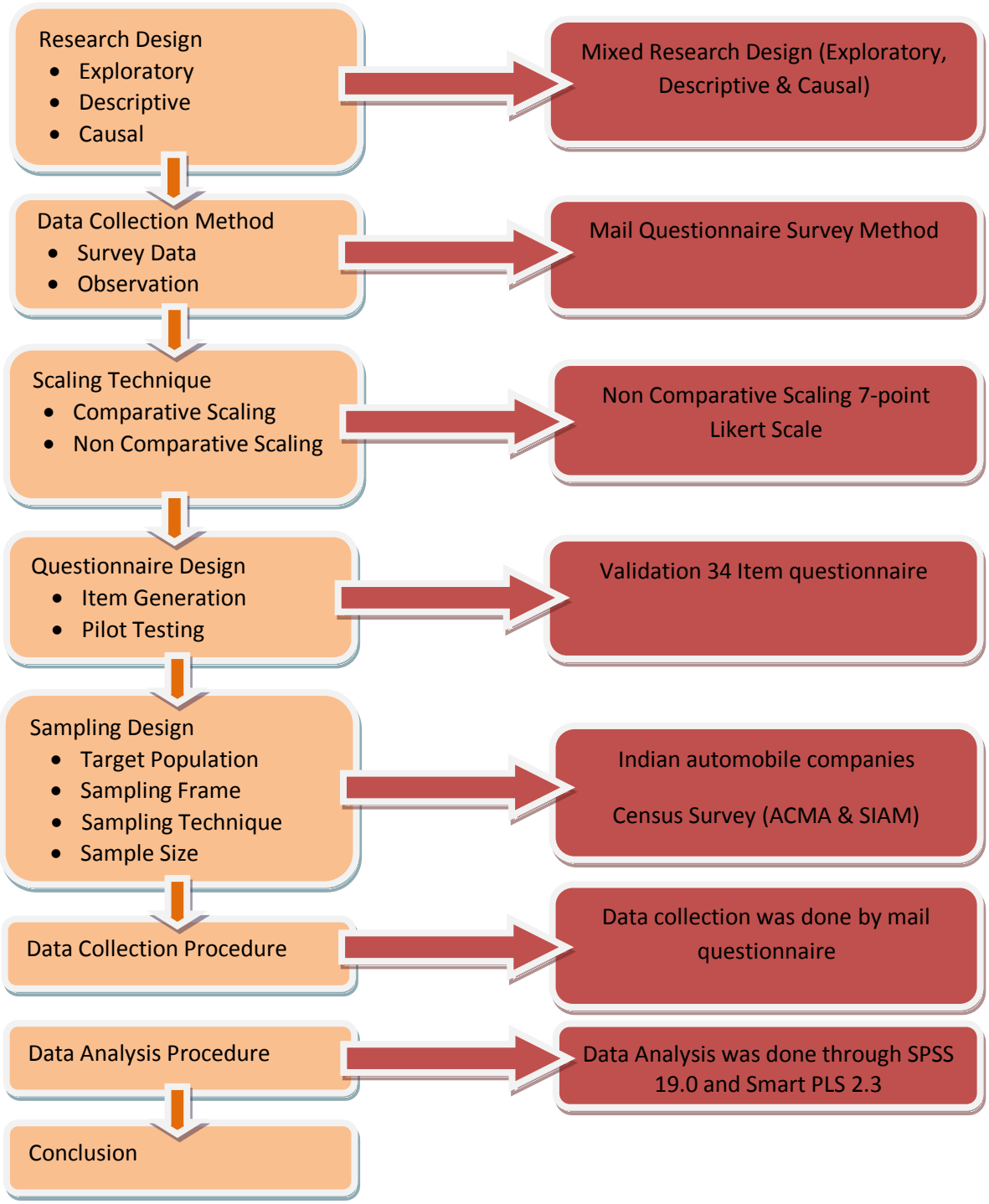

Figure 6.3 Flow chart of research methodology

In brief, a mixed approach has been used by combining exploratory, descriptive and causal research designs in the present study. A mixed approach provides a better, more holistic and structured solution to the research problem under consideration. The mixed approach has been suggested by Amartunga et al. (2001) to get better results, since these three research designs are complementary to each other. Table 6.1 has information of the research methodology used in a previous study.

Table 6.1 Review of past research

Authors	Approach	Type of Respondents	Sampling Type	Usable Sample Size	Universe	Scale Used	Technique Applied
Lin, 2009	Questionnaire	Managers	Census	162	Electronics	Likert scale	Factor analysis
Holt & Ghobadian, 2009	Questionnaire	Managers	Census	60	CIPS Listed companies		Principal component analysis
Zhu et al., 2008a	Questionnaire	Managers	Convenience sampling	341	Chinese manufacturer	Likert scale	Factor analysis
Rao, 2002	Questionnaire	Managers	Census	52	ISO certified	Likert scale	SEM
Zhu et al., 2008b	Questionnaire	Managers	Random sampling	314	Multi Industry	Likert scale	Multiple regression
Carter & Jenning, 2002	Questionnaire	Managers		201	Consumer product manufacturer		SEM
Sarkis, et al., 2010	Questionnaire	Managers	Census	157	Automobile Spain	Likert	SEM
Pullman, et al., 2010	Questionnaire	Managers	Census	152	Wine Industry USA	Likert	Regression
Klassen & Vachon, 2003	Questionnaire	Managers	Census	202	ISO certified Canada	Likert	Regression
Clemens & Douglus, 2006	Questionnaire	Managers	Census	107	SMS and ISRI USA	Likert	Regression
Darnall, et al., 2008	Questionnaire	Managers	Census	489	Companies reporting to EPA	Likert	Factor analysis

6.3.2 Data collection methods

Most of the previous empirical research on sustainable supply chain used the questionnaire survey method to collect data. Some of the researchers used the data from the various agencies (Hong et al., 2009). However, in developing countries it is difficult to get these types of agencies (Mishra & Suar, 2010). In another method of data collection, researchers have used a published document for the content analysis (Closs, 2010; Michelsen, 2007). Yet it is very rare in developing countries to get this type of disclosure from companies on their sustainability standards (Mishra & Suar, 2010).

The third approach researchers' use for data collection is a questionnaire (Holt & Ghobadian, 2009; Lee, 2008; Seuring & Muller, 2008; Lin, 2007; Rao & Holt, 2005; Klassen & Vachon, 2003). There are many advantages of using a questionnaire survey. First, respondents are aware of the problem under consideration and they are able to give a suitable response. Second, response bias is reduced since researchers promise to keep the anonymity of the respondent. Besides, using a questionnaire survey is inexpensive, accurate, covers wide range and data can be collected quickly (Cresswell, 2003; Zikmund, 2000). In addition, previous researchers have proposed data collection through an online survey since it is better for internal consistency and predictive validity (Sethuraman et. al, 2005). However, there are some disadvantages of using the questionnaire survey method like the unavailability of internet among the population of interest. In the present study, data has been collected from middle and top management level employees where data collection is not a problem. Data has been collected by a research instrument developed by following a well-accepted scale development procedure proposed by Churchill (1979). The following steps were adopted for the collection of data from the respondents:

1. A questionnaire was sent along with a cover letter by e-mail. The cover letter introduced the researcher, explained the purpose and significance of the study. A verification letter signed by author was also attached for the authenticity of the researcher (Appendix 2).
2. The cover letter was addressed to the name and position of key people who are responsible for the sustainability, if any, or the supply chain manager or to the middle level manager involved in the operations (Appendix 3).
3. After one month, a reminder (Appendix 4) was sent to the respondents who did not fill their response.

3. The same process was adopted once again with the help of a second reminder letter to get the more responses (Appendix 5).
4. Finally, in some cases an appointment was made for a personal meeting at different places in order to cover the entire population under consideration.

6.3.3 Scaling techniques

"*Scaling involves creating a continuum upon which measured objects are located*" (Malhotra & Dash, 2009). There are two scaling categories: comparative scales and non-comparative scales. In the present study, a 7-point Likert scale questionnaire was used to collect the data.

The reasons for using the Likert scale includes: easiness in construction and administration of the research instrument and suitability for personal, e-mail and telephonic data collection (Malhotra & Dash, 2009). In this study, data was collected through an e-mail survey; and the Likert scale is best suited to meet the purpose of the research. Many sustainable supply chain studies have used the Likert scale (Ageron et al., 2011; Smerecnik & Anderson, 2011; Zhu & Sarkis, 2010; Zsidisin & Hendrick, 1998).

6.3.4 Questionnaire design

The initial pool of the items for the questionnaire development has been taken from the literature. A total of 106 items have been found on the mechanisms of developing a sustainable supply chain. Those 106 items are:

- External pressure and support (13)
- Top management commitment (6)
- Benefits of sustainability (21)
- Buyer-supplier relationship strategies containing three categories: supplier selection (5), supplier development (18) and performance review (7)
- Sustainability indicators containing three dimensions of sustainability economical sustainability (5), environmental sustainability (12) and social sustainability (19)

The initial screening of the items reduced the items to 81 from 106. In the next step, experts were invited (Professors/Managers) to examine the group of items. Experts deleted 18 items, reducing the number of items to 57. After to this, following a similar approach as Lin and Hsieh (2011), experts were called to rank the items in one of three categories, "not

representative", "somewhat representative" or "clearly representative". *"Only items rated clearly and somewhat representative by at least 80 percent of the judges were retained"* (Lin & Hsieh, 2011). Only specific to the automobile induatry, this exercise resulted in the deletion 23 items that left 34 items remaining. These items were again reviewed by another group of five experts and no additional items were deleted by these experts.

6.3.5 Sampling design

The selection of appropriate samples is necessary to achieve the objective of research. Sampling techniques are broadly divided into two categories: probability sampling and non-probability sampling. Sample selection includes five stages, defining the target population, determination of the sampling frame, selection of the sampling technique suitable for the particular study, an estimation of the sample size and execution of the sample process (Malhotra & Dash, 2009).

The main concern during the sample selection is whether the sample should be industry specific or not. There are arguments that the sample should be taken from a wide range of industries. However, literature and expert opinion reveals that each industry faces specific challenges. Hence, the sample should be industry specific, which gives more applicability to the research findings for that specific industry (Diabata & Govindan, 2011). Another concern regarding the selection of sample is related to the kind of respondents needed for the research. The accomplishment of research depends on the selection of appropriate respondents. In the present study, respondents have been selected from midlevel management and top management employee of the Indian automobile companies. In order to get an inference of the company's initiatives towards sustainability of the supply chain, only one response has been taken from one company. The adoption of sustainability practices into companies operations and policies and extending to supply chain is very strategic in nature, hence only midlevel management and top management level employees have been selected as the respondents. These respondents were expected to be involved in the supply chain operation of the company.

6.3.6 Target population

The target population is defined in terms of elements, sampling units, extent and time (Malhotra & Dash, 2009). The target population for the present study is described below:

Elements - Managers;

Sampling units - Automobile companies;
Time - February 2013 to September 2013;
Extent - India.

6.3.6.1 Elements - managers

Primary data was collected by a questionnaire survey for the present study. The elements of the study are managers of automobile companies in India. Since the adoption and extension of sustainability practices requires strategic decision making, only midlevel and top level management employees were targeted for the responses. The second reason for the selection of midlevel and top level employees was that strategic decision makers could provide the appropriate information regarding the applicability of developing a sustainable supply chain through buyer-supplier relationships.

6.3.6.2 Sampling units - why automobile companies?

The automobile industry was selected as sampling unit of the study for a variety of reasons. These are stated as follows:

There are a number of studies available on the automobile industry across the globe regarding a sustainable supply chain (Olorunniwo & Li, 2010; Sarkis et al., 2010; Koplin et al., 2007; Zhu et al., 2007). However, all of these studies belong to developed countries and is in a very nascent stage in developing countries. This was the main reason for the selection of automobile companies in addition to the attractiveness of the Indian automobile industry (Section 2.2). Indian automobile companies are assumed to adopt more sustainable practices since there is an increase in the export of finished units and component parts from India. Like other manufacturing companies, the automobile industry is one of the main consumers of natural resources and impacts the environment, since automobile production involves steel, rubber and plastic processing. According to Sarkis (2001), '*The natural environment and the manufacturing are becoming inextricably linked*' (p.666). These reasons make it imperative to know the possible mechanisms for developing a sustainable supply chain in the automobile industry.

6.3.7 Sampling frame

The sampling frame represents the elements of the target population. It consists of guidelines to mark the target population (Malhotra & Dash, 2009; Huang et al., 2002). In this

study, automobile companies are the target sector. The list of automobile companies has been retrieved from the directory of the Automobile Component Manufacturing Association of India (ACMA, 2013) and the Society of Indian Automobile Manufacturers (SIAM, 2013). In total, 691 automotive component manufacturing companies and 47 finished products manufacturers have been identified. The total sample size for the present study is 738. Previous studies have used data from industry specific associations for developing a sampling frame (Olorunniwo & Li, 2010; Clemens & Douglus, 2006; Klassen & Vachon, 2003).

6.3.8 Sampling method

For the present study, a census survey method was used (Eltayeb, et al., 2011; Sarkis et al., 2010). The target population consists of Indian automotive component suppliers and finished product manufacturers, which are equal to 738 units. The list of identified companies has been provided by the ACMA and the finished product manufacturers are provided by SIAM.

6.3.9 Sample Size

Green (1991) provided that a desirable sample size (n) should be:

$$n > 50 + 8V$$

Where, 'V' is the number of independent variables for testing the multiple regression.

Although, Hair et al. (1998) suggested that the sample size could have an effect on the generalizability of the results. The desirable ratio should be in the range of 15 to 20 for each independent variable. However, a lower ratio like 5:1 could also be considered (Hair et al., 1998). Besides, there is a difference in the suggestions provided by many authors based on the statistical test used in the research. Tabachnick & Fidell (2001) suggested the minimum sample size should be 300 for the factor analysis. Nunnally (1978) suggested that the number of cases should have a ratio of 1:10 to ensure factor reliability. The minimum requirement for developing a structural equation model is a sample size of 150 (Hair et al., 2006). On the guidelines of various studies in the area of sustainable supply chains, the survey questionnaire was sent to all the companies (Olorunniwo & Li, 2010; Das Gupta, 2007; Clemens & Douglus, 2006).

6.4 Data Collection procedure

This study was based on primary data. Primary data was collected from a questionnaire sent by e-mail. Collecting data by an email questionnaire has been used by many researchers in the area of sustainable supply chains (Lee, 2008; Clemens & Douglus, 2005; Rao & Holt, 2005; Rao, 2002; Carter & Jenning, 2001). Only one response has been taken from one automobile company treating it as a single unit of analysis. It was assumed that all automobile companies included in sample are ready to adopt and extend sustainability practices in supply chain operations.

The questionnaire was sent to the middle and top level managers of 738 companies. The instrument was e-mailed in February 2013. The e-mail included a cover letter (Appendix 2 & 3) that explained the objective of the study and a questionnaire (Appendix 6). One month after the first email, a reminder cover letter (See Appendix 3) along with the instrument was sent. One more follow up e-mail was sent in the first week of May 2013 with another reminder cover letter (See Appendix 4). Other methods like telephone, personal contact, and personal visits after telephonic appointments were also used to improve the response rate. A total 157 instruments were returned resulting in a 21.27% response rate. This response rate is well-accepted in literature (Klassen & Vachon, 2003; Baske et al., 2008; Lin, 2007). In first lot, 2.84% (21) and in the second lot 4.20% (31) responses were received. In the third lot 6.23% (46) responses were received. In the final lot, the response rate increased considerably to 7.99% (59). This was due to various follow up actions like telephone calls and personal visits.

Table 6.2 Responses received during data collection

Industry Category/ Responses		**Total**
First Wave	Delivered	738
	Received	21
Second Wave	Delivered	717
(First reminder)	Received	31
Third Wave	Delivered	686
(Second reminder)	Received	46
Final	Delivered	640
(Follow up)	Received	59
Total	Delivered	738
	Received	**157**

After downloading and numbering the all questionnaires in the sequence of receipt, the questionnaires were deleted from the system to maintain the anonymity of the respondents Email address. From the 157 responses, the numbers of usable responses were 141 (19.10%).

6.5 Data analysis procedure

The data analysis was conducted by using the partial least square (Wold, 1985) technique. This technique puts minimum criteria on the measurement scale and sample size (Chin et al., 2003) not like AMOS and LISERAL. The basic objective of the CB-SEM is to minimize the variation between sample covariance and what the theoretical model forecasts. The main problem with this approach is that it needs a large sample size (Kline, 2005).

The minimum size of sample should be 10 times the number of items. At the other end, SEM efficiently works in the case of reflective models (Chin & Newsted, 1995; Cho, & Park, 2001; Mahdavi et al., 2008). "An underlying assumption for SEM analysis is that the items or indicators used to measure an LV are reflective in nature" (Chin 1998b).

PLS is an effective method for a small sample size compared to the number of variables. In addition, it handles missing values. One of the most important features of the PLS is the normalization of data is not a necessary condition to run the PLS technique (Sosik et. al., 2009). This technique has been applied in different areas of management and related subjects like marketing, human resource management, consumer psychology, and CSR (Sosik et. al., 2009; Sarstedt, 2008; Pavlou & Fygenson 2006; Hulland, 1999; Fornell et. al, 1990). This technique has been used prominently where either the lower numbers of responses were expected or a large sample collection was not possible. Therefore, the PLS is a useful technique for the present study.

As a rule of thumb, the minimum sample size required for the PLS is 100 (Chin, 1998a; Barclay et al., 1995). In the present study, the number of latent variables is 9 and 34 indicators are related to these latent variables. The sample size is determined by 10 times the number independent latent variables (Chin, 1998a; Barclay et al., 1995). In the present study, the number of latent variables is nine. Therefore, the minimum sample size for the present study is 90.

In the present study, data is collected from 141 (usable) Automobile firms, which is higher than the required sample size. Various reliability and validity tests were conducted to analyze and validate both the measurement and structural models.

6.6 Conclusion

This chapter starts with the proposed research model for developing a sustainable supply chain. To validate this model, a framework of research instrument development procedure is presented. The later section of the chapter deals with the various steps involved in the research methodology to achieve the fifth objective of the study. These steps include the research design, data collection methods, scaling techniques, questionnaire design, sampling design and data analysis procedure. A detailed description of the data analysis process is given in the subsequent chapter of the thesis.

Chapter 7
Analysis and results

Preview

The objective of this chapter is to develop a model showing the mechanism for developing a sustainable supply chain. In this study, a well-accepted scale development procedure has been used. The outcome of the study gives a comprehensive preview for developing a sustainable supply chain. In addition, this study will help managers formulate strategies for developing a sustainable supply chain.

7 Introduction

In last five years, many attempts have been made to develop a mechanism for developing a sustainable supply chain. Ashby (2012), Bommel (2010), Gold et al. (2009), Carter & Rogers (2008), and Attaran & Attaran (2007) are some of the studies which were conceptual in nature. Lin (2007) tried to discover the green supply chain management practices. Klassen & Vachon (2003) focused their research on the impact of collaborative activities and its impact on extending plant level environmental activities to supply chain. In order to gain insight of the mechanisms for developing a sustainable supply chain, Lee (2008) used a hieratical linear regression analysis to know the various factors that facilitate green adoption in the supply chain.

In the growing body of literature, most of the work on sustainable supply chains is conceptual in nature and based on case studies and literature reviews. The majority of the empirical studies are solely on environmental practices. However, there are some studies on social sustainability as well. Hutchins & Sutherland (2008) did a conceptual study to find the factors for measuring social sustainability in the supply chain. Ciliberti et al. (2008) did an empirical investigation to understand the various social sustainability practices. Similar works on social sustainability belong to Ni et al. (2010), Muller et al. (2009), Baske et al. (2008), Cramer (2007), and Carter & Jenning (2002).

The above reviewed studies raised the need to develop a comprehensive model developing sustainable supply chain. First, most of the studies on sustainable supply chains are conceptual in nature. Therefore, an empirical investigation of a conceptual framework is necessary. Second, the empirical studies available in the literature are directed towards a single

dimension of sustainability. According to the triple bottom line concept, it is necessary to balance all three dimensions of sustainability. Therefore, it is necessary to empirically validate the conceptual model of a sustainable supply chain. A proper evaluation is possible only by considering all three dimensions in a single model. The third reason was the lack of availability of such a scale in the Indian context, since none of the above-mentioned studies was carried out in India.

Therefore, to fulfill the gap mentioned in Chapter 2, it was necessary to develop a proper mechanism for developing a sustainable supply chain. This study attempts to analyze a conceptual model for developing a sustainable supply chain. This chapter covers the fifth objective that was stated in chapter 1 of the present thesis. The proposed research model shown in Chapter 6 was used to achieve this objective. In this model, nine constructs were used. They are external pressure & support, benefits of sustainability adoption, top management commitment, buyer-supplier relationships (supplier selection, supplier development, suppliers; performance review), and sustainable supply chain (economical, social and environmental). The detail of these constructs and the literature evidence of all these factors have been discussed in chapter 2. The scale development process is discussed in the succeeding sections of this chapter.

7.1 Assessment of a non-respondent bias

To assess the non-response bias in the data collection through an e-mail survey, statistical difference tests between the earliest and latest responses was applied (Kureshi et al., 2010; Rahman & Siddiqui, 2006; Krause & Scannel, 2002; Armstrong & Overton, 1977). The responses received in the first lot (21) were compared with the last 21 responses (Armstrong & Overton, 1977). An ANOVA F-test has been used to compare any differences with respect to the response time. Table 7.1 shows the ANOVA non-respondent test and results indicate no significant difference in the two groups.

The SPSS 19.0 has been used in this study to calculate the F values of each item and their significance level. Table 7.1 reveals the difference in responses according to the time period is not significant. Hence, it has been assumed that there is no non-respondent biasness in the present study.

Table 7.1 Non-response bias Test

Manifest variable		Sum of Squares	df	Mean Square	F	Sig.
EXT1	Between Groups	3.4286	1.0000	3.4286	1.8557	0.1807
	Within Groups	73.9048	40.0000	1.8476		
	Total	77.3333	41.0000			
EXT2	Between Groups	0.5952	1.0000	0.5952	0.4596	0.5017
	Within Groups	51.8095	40.0000	1.2952		
	Total	52.4048	41.0000			
EXT3	Between Groups	1.1667	1.0000	1.1667	0.8492	0.3623
	Within Groups	54.9524	40.0000	1.3738		
	Total	56.1190	41.0000			
EXT4	Between Groups	1.1667	1.0000	1.1667	0.8448	0.3635
	Within Groups	55.2381	40.0000	1.3810		
	Total	56.4048	41.0000			
BENF1	Between Groups	1.1667	1.0000	1.1667	0.4730	0.4956
	Within Groups	98.6667	40.0000	2.4667		
	Total	99.8333	41.0000			
BENF2	Between Groups	1.5238	1.0000	1.5238	1.2598	0.2684
	Within Groups	48.3810	40.0000	1.2095		
	Total	49.9048	41.0000			
BENF3	Between Groups	0.0238	1.0000	0.0238	0.0173	0.8959
	Within Groups	54.9524	40.0000	1.3738		
	Total	54.9762	41.0000			
BENF4	Between Groups	0.0952	1.0000	0.0952	0.0802	0.7785
	Within Groups	47.5238	40.0000	1.1881		
	Total	47.6190	41.0000			
TC1	Between Groups	1.5238	1.0000	1.5238	0.9756	0.3292
	Within Groups	62.4762	40.0000	1.5619		
	Total	64.0000	41.0000			
TC2	Between Groups	0.5952	1.0000	0.5952	0.3439	0.5609
	Within Groups	69.2381	40.0000	1.7310		
	Total	69.8333	41.0000			
TC3	Between Groups	0.0952	1.0000	0.0952	0.0708	0.7915
	Within Groups	53.8095	40.0000	1.3452		
	Total	53.9048	41.0000			
TC4	Between Groups	0.3810	1.0000	0.3810	0.2174	0.6436
	Within Groups	70.0952	40.0000	1.7524		
	Total	70.4762	41.0000			
TC5	Between Groups	0.0238	1.0000	0.0238	0.0127	0.9109
	Within Groups	75.0476	40.0000	1.8762		
	Total	75.0714	41.0000			

PR1	Between Groups	2.8810	1.0000	2.8810	1.2100	0.2779
	Within Groups	95.2381	40.0000	2.3810		
	Total	98.1190	41.0000			
PR2	Between Groups	0.0952	1.0000	0.0952	0.0445	0.8339
	Within Groups	85.5238	40.0000	2.1381		
	Total	85.6190	41.0000			
PR3	Between Groups	0.0238	1.0000	0.0238	0.0076	0.9311
	Within Groups	125.8095	40.0000	3.1452		
	Total	125.8333	41.0000			
SS1	Between Groups	2.3810	1.0000	2.3810	1.0438	0.3131
	Within Groups	91.2381	40.0000	2.2810		
	Total	93.6190	41.0000			
SS2	Between Groups	2.3810	1.0000	2.3810	1.3587	0.2507
	Within Groups	70.0952	40.0000	1.7524		
	Total	72.4762	41.0000			
SS3	Between Groups	0.8571	1.0000	0.8571	0.4380	0.5119
	Within Groups	78.2857	40.0000	1.9571		
	Total	79.1429	41.0000			
SD1	Between Groups	1.9286	1.0000	1.9286	0.8862	0.3522
	Within Groups	87.0476	40.0000	2.1762		
	Total	88.9762	41.0000			
SD2	Between Groups	4.6667	1.0000	4.6667	2.3195	0.1356
	Within Groups	80.4762	40.0000	2.0119		
	Total	85.1429	41.0000			
SD3	Between Groups	2.3810	1.0000	2.3810	1.0953	0.3016
	Within Groups	86.9524	40.0000	2.1738		
	Total	89.3333	41.0000			
SD4	Between Groups	1.9286	1.0000	1.9286	0.8232	0.3697
	Within Groups	93.7143	40.0000	2.3429		
	Total	95.6429	41.0000			
SD5	Between Groups	0.2143	1.0000	0.2143	0.1370	0.7132
	Within Groups	62.5714	40.0000	1.5643		
	Total	62.7857	41.0000			
ECS1	Between Groups	2.8810	1.0000	2.8810	1.5593	0.2190
	Within Groups	73.9048	40.0000	1.8476		
	Total	76.7857	41.0000			
ECS2	Between Groups	1.5238	1.0000	1.5238	0.7425	0.3940
	Within Groups	82.0952	40.0000	2.0524		
	Total	83.6190	41.0000			
ECS3	Between Groups	0.3810	1.0000	0.3810	0.1856	0.6689
	Within Groups	82.0952	40.0000	2.0524		
	Total	82.4762	41.0000			

SSC1	Between Groups	0.2143	1.0000	0.2143	0.2004	0.6568
	Within Groups	42.7619	40.0000	1.0690		
	Total	42.9762	41.0000			
SSC2	Between Groups	0.0238	1.0000	0.0238	0.0149	0.9036
	Within Groups	64.0952	40.0000	1.6024		
	Total	64.1190	41.0000			
SSC3	Between Groups	0.0952	1.0000	0.0952	0.0739	0.7871
	Within Groups	51.5238	40.0000	1.2881		
	Total	51.6190	41.0000			
EVS1	Between Groups	0.0952	1.0000	0.0952	0.0683	0.7952
	Within Groups	55.8095	40.0000	1.3952		
	Total	55.9048	41.0000			
EVS2	Between Groups	0.0238	1.0000	0.0238	0.0184	0.8928
	Within Groups	51.8095	40.0000	1.2952		
	Total	51.8333	41.0000			
EVS3	Between Groups	1.9286	1.0000	1.9286	0.8795	0.3540
	Within Groups	87.7143	40.0000	2.1929		
	Total	89.6429	41.0000			
EVS4	Between Groups	0.0000	1.0000	0.0000	0.0000	1.0000
	Within Groups	69.6190	40.0000	1.7405		
	Total	69.6190	41.0000			

7.2 Common method bias

Common method bias is a problem for social and psychological research. There are mix responses from researchers on common method bias. Podsakoff et al. (2003) suggested that management studies should address this issue when considering self report methodologies. Studies suffering from this error may represent a false correlation among the constructs.

We have found that no single factor is responsible for the majority of the variance of the all indicators. In addition, if the intercorrelation among the manifest variable is more less than 0.9 than the data is assumed to be not having the common method biasness.

Podsakoff et al. (2003) and Williams et al. (2003) have proposed adding a common factor in the model that includes all the principal constructs' indicators. We have added one construct in our PLS model whose indicators are the indicators of the entire principal construct. The substantive factor loading of the indicators on the method factor and principal factor has been compared in the Table 7.2. In our study average variance explained by the method factor is only 0.036 while by the principal construct is 0.68 which is nearly 1:19. Hence our study has been assumed of not having common method biasness.

Table 7.2 Common method biasness

	Substantive factor loading R_1	R_1 square	Method factor loading R_2	R_2 square
Benefits -> Benf1	0.3988	0.1590	0.4585	0.2102
Benefits -> Benf2	0.8457	0.7152	-0.0166	0.0002
Benefits -> Benf3	0.9368	0.9678	-0.2602	0.0677
Benefits -> Benf4	0.9137	0.8348	-0.1960	0.0384
Economical -> ECS1	0.9045	0.8181	-0.1362	0.0185
Economical -> ECS2	0.9637	0.9287	-0.1574	0.0247
Economical -> ECS3	0.5290	0.2798	0.2973	0.0883
Environment -> EVS1	0.9207	0.8476	-0.1317	0.0173
Environment -> EVS2	0.9514	0.9753	-0.2963	0.0877
Environment -> EVS3	0.5773	0.3332	0.1966	0.0386
Environment -> EVS4	0.5637	0.3177	0.2339	0.0547
External -> EXT1	0.7737	0.5986	0.0455	0.0020
External -> EXT2	0.9250	0.8556	-0.1732	0.0299
External -> EXT3	0.7421	0.5507	0.1018	0.0103
External -> EXT4	0.7396	0.5470	0.0179	0.0003
Performance -> PR1	0.6957	0.4840	0.2147	0.0460
Performance -> PR2	0.8240	0.6789	0.0263	0.0006
Performance -> PR3	0.9632	0.9277	-0.2832	0.0802
Development -> SD1	0.7173	0.5145	0.0375	0.0014
Development -> SD2	0.8744	0.7645	-0.1221	0.0149
Development -> SD3	0.6309	0.3980	0.2086	0.0435
Development -> SD4	0.7520	0.5655	-0.0024	5.76E-06
Development -> SD5	0.9266	0.8585	-0.1348	0.0181
Selection -> SS1	0.9617	0.9806	-0.201	0.0404
Selection -> SS2	0.9195	0.8454	-0.0431	0.0018
Selection -> SS3	0.4961	0.2461	0.2677	0.0716
Social -> SSC1	0.9412	0.8858	-0.1552	0.0240
Social -> SSC2	0.6028	0.3633	0.2389	0.0570
Social -> SSC3	0.8503	0.7230	-0.0905	0.0081
TC -> TC1	0.7076	0.5007	0.1168	0.0136
TC -> TC2	0.9362	0.8764	-0.1526	0.0232
TC -> TC3	0.9845	0.9692	-0.2268	0.0514
TC -> TC4	0.7394	0.5467	0.0538	0.0028
TC -> TC5	0.6309	0.3980	0.1905	0.0362
	0.7894	**0.6856**	**-0.0021**	**0.03604**

7.3 Demographic profile of the respondents

Demographic data provides information about the characteristics of the respondents and sufficient information to make a clear picture of the respondents, which is necessary for generalizations about the respondents. The first section of the data collection instrument is dedicated to the demographic data of the respondents and companies, which includes certain questions related to various characteristics of the respondents and the company.

7.3.1 Individual job function

This study was based on developing a sustainable supply chain. Looking at the degree of decision-making required, it is assumed that middle level and top level management employees hold the information related to each construct used in this study. The position held by the respondents who participated in the survey on behalf of 141 Automobile companies, more than 68.79% (97) respondents held a position at middle level management (Figure 7.1). This predicts that the responses received provide the desired information to some extent. Only 7.80% (11) belong to top level management (President, VP, Executive Director). Senior managers contribute 13.47% (19) responses, which explain their non-availability or lack of interest in giving responses related to sustainability issues by senior managers. Sit et al. (2009) also support this finding. Some responses have been received from multi level resources that accounts for 9.92% (14).

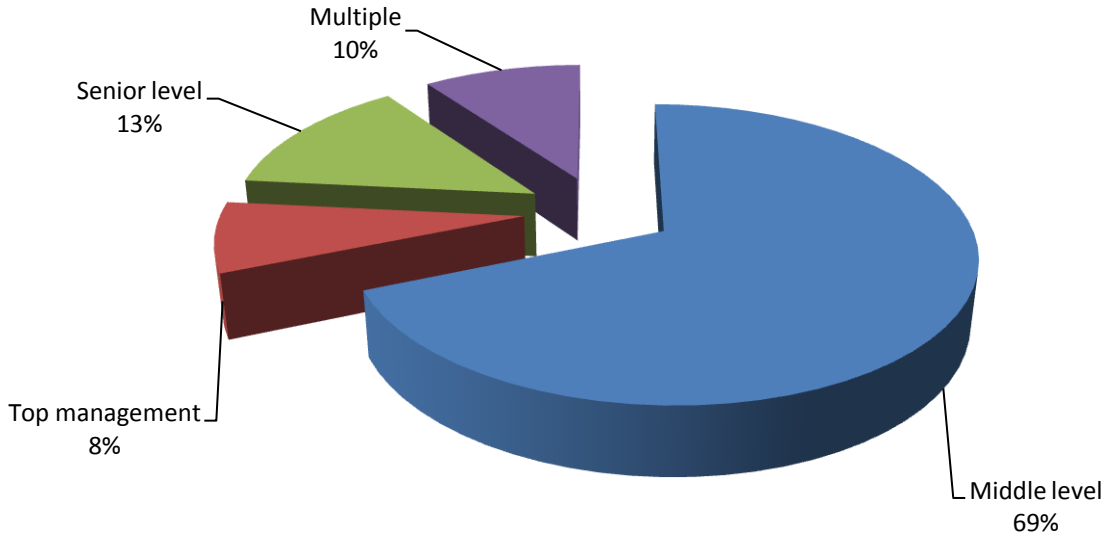

Figure 7.1 Job positions of respondents

7.3.2 Experience of respondents

64.53% (More than half) of the respondents were found to have an experience of 5 to 10 years while 9.21% percent had more than 10 years of experience (Figure 7.2). Only 9.92% respondents were found under the category of multiple source response while 16.31% had less than 5 year of experience in the automobile industry.

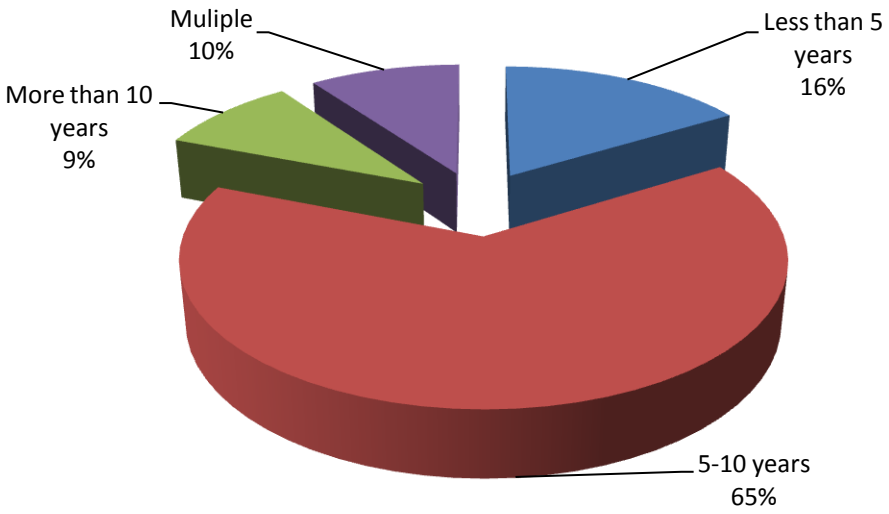

Figure 7.2 Years of experience

7.4 Descriptive statistics of the items used

This section deals with the descriptive statistics of the data collected for the study. Table 7.3 presents the consolidated results regarding the items used in this study on a 7-point Likert scale.

Table 7.3 Descriptive statistics

Item	1	2	3	4	5	6	7	Mean	SD
EXT1	2	2	0	9	25	69	34	5.81	1.11
EXT2	1	4	3	6	33	69	25	5.65	1.13
EXT3	2	0	0	9	18	51	61	6.47	1.04
EXT4	1	0	0	9	12	55	64	6.20	0.99
BENF1	4	1	0	1	15	33	87	6.33	1.22
BENF2	0	1	2	8	21	64	45	5.99	0.97
BENF3	0	1	0	12	20	60	48	6.00	0.97
BENF4	1	1	3	10	17	52	57	5.84	1.10
TC1	1	2	4	3	15	55	61	6.11	1.13

TC2	1	0	3	11	23	56	47	5.91	1.09
TC3	1	1	2	6	22	65	44	5.96	1.03
TC4	1	1	4	6	20	64	45	5.94	1.09
TC5	1	2	2	7	14	58	57	6.07	1.11
PR1	2	3	0	2	10	35	89	6.00	1.21
PR2	1	2	2	2	12	46	76	5.90	1.27
PR3	4	2	2	9	33	59	32	6.16	1.20
SS1	2	1	3	10	29	61	35	6.38	1.15
SS2	1	3	2	6	26	49	54	6.29	1.07
SS3	1	4	2	6	27	70	31	5.99	1.03
SD1	1	2	1	4	5	33	95	5.74	1.16
SD2	1	3	0	2	12	52	71	5.95	1.18
SD3	4	0	1	6	19	57	54	5.75	1.13
SD4	1	6	1	9	13	62	49	5.79	1.11
SD5	4	0	1	3	16	50	67	6.16	1.03
ECS1	1	2	1	1	21	69	46	6.23	1.03
ECS2	1	2	4	6	19	58	51	6.05	0.99
ECS3	4	1	2	5	26	58	45	6.30	1.07
SSC1	1	0	1	11	17	60	51	5.99	0.99
SSC2	4	0	2	2	20	61	52	5.94	1.05
SSC3	0	5	3	4	23	53	53	5.74	0.98
EVS1	0	5	3	4	23	53	53	6.21	0.95
EVS2	1	1	0	9	23	59	48	6.01	1.00
EVS3	2	1	0	4	13	43	78	5.96	1.16
EVS4	1	0	2	9	12	51	66	6.17	1.04

7.5 Research instrument development

In this study, a well-accepted scale development process proposed by Churchill (1979) has been adopted. This process was further modified by various studies like Bentler & Bonnet (1980) and Turker (2009). As discussed in the chapter 6, the stages of the scale development are provided in the next section.

7.5.1 Item generation and selection

To generate the seven-item construct for developing sustainable supply chain, an extensive literature review has been done. A total of 106 items have been found under these seven constructs.

- External pressure and support (13)
- Top management commitment (6)

- Benefits of sustainability (21)
- Buyer-supplier relationship strategy containing three categories:
    - Supplier selection (5),
    - Supplier development (18)
    - Performance review (7)
- Sustainability indicators containing the three dimensions of sustainability, Economical sustainability (5), Environmental sustainability (12) and Social sustainability (19)

An initial screening reduced the number of items to 75. In next step, experts were invited (Professors/Managers) to examine the group of items. Experts deleted 18 items, reducing the number of items to 57. After to this, following a similar approach as Lin and Hsieh (2011), experts were called to rank the items in one of three categories, "not representative", "somewhat representative" or "clearly representative". *"Only items rated clearly and somewhat representative by at least 80 percent of the judges were retained"* (Lin & Hsieh, 2011). Specific to automobile industry, this exercise resulted in the deletion 23 items that left 34 items remaining. These items were again reviewed by another group of five experts and no additional items were deleted by these experts.

7.5.2 Unidimensionality check of the blocks

First, we made a unidimensionality check of the block before running the path analysis. Many tests are required when manifest variables are connected to latent variables in a reflective way (Tenenhaus et al., 2005).

Table 7.4 Unidimensionality check of the blocks

Latent Variable	No. of indicators	Cronbach's-α	Dillon-Goldstein's-α	First eigenvalue	Second eigenvalue
Benefits	4	0.8070	0.8720	2.537	0.572
Development	5	0.8371	0.8847	3.031	0.573
Economical	4	0.7189	0.8419	1.922	0.609
Environmental	3	0.7837	0.8545	2.394	0.714
External	4	0.8038	0.8717	2.521	0.641
Performance	3	0.8058	0.8850	2.163	0.496
Selection	3	0.7783	0.8722	2.103	0.695
Social	3	0.7115	0.8273	1.847	0.633
Top Management	5	0.8563	0.8962	3.177	0.708

These tests included a principal component analysis of the block, Cronbach's-α and Dillon-Goldstein's-α. If in a blocks first Eigen value is more than one and the other Eigen values are less than one, then the block can be termed unidimensional (Churchill, 1979).

Similarly, if the values of Cronbach's-α and Dillon-Goldstein's-α are greater than 0.7 then the block is considered unidimensional (Tenenhaus et al., 2005). In some case Cronbach's-α value more than 0.6 is also acceptable for the construct having less than five items (Petrick & Backman, 2002). The results of these tests are given in Table 7.4. This table shows that values of Cronbach's-α and Dillon-Goldstein's-α are greater than 0.7 for each blocks. The first Eigen value is greater than 1 and the second Eigen value is less than 1. Hence, the unidimensionality of the block is acceptable.

7.6 Measurement model and results

In this stage, various constructs used in the questionnaire were validated by applying the partial least square technique. The questionnaire, refined from an earlier stage containing 34 items, was sent to managers working in the Indian automobile industry. Respondents were asked to assess the items on a 7-point Likert scale (1 – Highly disagree and 7- Highly agree). The respondents were contacted through an e-mail survey followed by telephonic calls and personal visits to the companies. The mail contained a cover letter indicating the purpose of the study. The total number of responses was 141. The sample size was sufficient for the execution of the PLS technique as suggested in the literature (Chin & Newstead, 1995).

7.6.1 Internal consistency

Internal consistency was evaluated by calculating the internal composite reliability (ICR) and Cronbach's alpha of the scale (Barcley et. al, 1995). The measurement model in this study represents the relationships between the latent variables and the indicators of each block. The results of outer model are given in Table 7.5. The reliability of each manifest variable (item) has been checked by measuring the loading of the manifest variable on the latent variable (block). Similar to many previous studies, a loading of more than 0.7 is acceptable for reliability. In our case, the entire manifest variables have a loading of more than 0.7 to their respective latent variable. However, some of the studies have reported that loading more than 0.5 is acceptable (Tenenhaus et al., 2005; Chin, 1998; Barclay et al., 1995). The results in Table 7.4 depicts that values of Cronbach's alpha and composite reliability (CR) are more than 0.7.

Similarly, the loading value of each manifest variable with respect to latent variables is more than 0.7. The values of composite reliability and Cronbach's alpha should be more than 0.7.

Table 7.5 Outer model results

Latent Variable	Manifest variable	Outer weight	Loading	Communality	AVE	CR	Cronbach's Alpha
Benefits	BEN1	0.3931	0.8200	0.7770	0.6305	0.8720	0.8071
	BEN2	0.3118	0.8200	0.8330			
	BEN3	0.2413	0.7820	0.8240			
	BEN4	0.3099	0.7530	0.7490			
External	EXT1	0.2918	0.7990	0.8150	0.6297	0.8717	0.8039
	EXT2	0.3049	0.7720	0.7790			
	EXT3	0.3302	0.8300	0.8280			
	EXT4	0.3333	0.7720	0.7510			
Top Management Commitment	TC1	0.2723	0.8010	0.7970	0.6335	0.8962	0.8564
	TC2	0.2342	0.8050	0.8240			
	TC3	0.2036	0.7870	0.8180			
	TC4	0.2528	0.7880	0.7770			
	TC5	0.2927	0.7980	0.7690			
Selection	SS1	0.3723	0.8800	0.9150	0.6955	0.8721	0.7784
	SS2	0.4040	0.8660	0.8990			
	SS3	0.4299	0.7500	0.6760			
Performance	PR1	0.4377	0.8930	0.8830	0.7200	0.8850	0.8059
	PR2	0.4018	0.8520	0.8430			
	PR3	0.3342	0.7980	0.8200			
Development	SD1	0.2499	0.7500	0.7490	0.6058	0.8847	0.8371
	SD2	0.2285	0.7630	0.7760			
	SD3	0.2901	0.8140	0.8030			
	SD4	0.2458	0.7500	0.7490			
	SD5	0.2679	0.8120	0.8130			
Economical	ECS1	0.3950	0.7810	0.7950	0.6397	0.8419	0.7189
	ECS2	0.4046	0.8210	0.8370			
	ECS3	0.4507	0.7980	0.7690			
Social	SSC1	0.4093	0.7990	0.8130	0.6332	0.8381	0.7115
	SSC2	0.4599	0.8180	0.7890			
	SSC3	0.4046	0.7690	0.7510			
Environmental	EVS1	0.3009	0.7810	0.8020	0.6037	0.8590	0.7837
	EVS2	0.2695	0.7630	0.7970			
	EVS3	0.3796	0.7830	0.7290			
	EVS4	0.3443	0.7810	0.7630			

7.6.2 Convergent validity

Convergent validity refers to the extent of which measures of constructs that theoretically should be related are in fact related. It can be evaluated by using the average variance extracted measure (AVE). AVE is the average value of the squared loadings of each item on a construct. It gives an idea of how well a theoretical latent construct explains the variance of a set of items that are supposed to measure that particular construct. In a simple way, AVE is used to quantify the amount of variance captured by the items of a construct versus the amount of variance caused by the measurement error. If the value of AVE is 0.5 or more than 0.5, it is acceptable to justify the convergent validity of the measurement model. The cut-off value of 0.5 signifies that at least half of the measurement variance is due to that particular construct. Table 7.5 shows the AVE value of the various constructs of the measurement model. It signifies the convergent validity of the measurement model.

The formulae applied to calculate the Average Variance Extracted (AVEs) and Composite Reliability (CR) are (Fornell & Larcker, 1981):

$$AVE = \frac{\sum_{i=1}^{n} \lambda_i^2}{\sum_{i=1}^{n} \lambda_i^2 + \sum_{i=1}^{n} Var(\epsilon_i)}$$

$$CR = \frac{(\sum_{i=1}^{n} \lambda_i)^2}{(\sum_{i=1}^{n} \lambda_i)^2 + \sum_{i=1}^{n} Var(\epsilon_i)}$$

where, λ= Standardized factor loading

$Var\ (\epsilon)$= Error variance for a construct

In our case, the value of AVE is more than 0.5; hence, constructs used in the present study have convergent validity.

7.6.3 Discriminant validity

Next, the discriminant validity of the each construct has been calculated. Discriminant validity indicates how much each construct is different from the other constructs. In the PLS, there is one method to know the discriminant validity. A construct should share more variance with its measures than it shares with the other constructs' measures (Hulland, 1999). It can be estimated by comparing the square root of AVE with the correlation among the latent variables to ensure that the square root of AVE is more than the correlation among the latent variables

(Chin, 1998). All constructs were more strongly correlated with its measures than other constructs as shown in Table 7.6.

Table 7.6 Correlation between latent variables

Construct	BENF	SD	ECS	EVS	EXT	PR	SS	SSC	TC
BENF	**0.7941**								
SD	0.6053	**0.7783**							
ECS	0.7008	0.7052	**0.7998**						
EVS	0.7205	0.7353	0.7689	**0.7770**					
EXT	0.7586	0.6222	0.5853	0.6306	**0.7936**				
PR	0.7542	0.7208	0.7612	0.7257	0.7792	**0.8486**			
SS	0.6179	0.7335	0.7165	0.7297	0.6009	0.6814	**0.8340**		
SSC	0.6344	0.6605	0.6349	0.6801	0.6813	0.7252	0.5928	**0.7957**	
TC	0.6206	0.5673	0.5458	0.571	0.7183	0.657	0.518	0.6284	**0.7959**

The above analysis shows that the criteria of the measurement model are reliable and valid. In the next section, we analyzed the structural model, which represents the relationships between the hypothesized constructs in the conceptual model.

7.7 Structural model

In the PLS analysis, there are two criteria for evaluating the model. One is the coefficient of determination R^2 and other is the significance level (Chin, 1998). Falk & Miller (1992) mentioned that the value of R^2 should be greater than 0.1. The results of structural models are provided in Figure 7.3, 7.4.

In our model, we have taken three output variables, which are the social, economic and environmental sustianability of a supply chain. All these three constructs have R^2 value of 0.568, 0.665 and 0.660. This indicates an increase of 56.8% in social sustianability, 66.50% in economical sustianability and 66% inenvironmental sustianability criteia has been explained by the proposed constructs. The reason behind the good value of R^2 is that most of the items in the questionnaire are included with the consultation of Indian automobile experts and designed only for the automobile industry supply chain. Further, the R^2 value of other constructs, top management, selection, performance and development are 0.529, 0.268, 0.432 and 0.322, repectively.

Table 7.7 R^2 and adjusted R^2 values of latent variables

Latent Variable	R^2	Adjusted R^2
Top Management	0.529	0.522
Selection	0.268	0.262
Performance	0.432	0.427
Development	0.322	0.317
Economical	0.665	0.657
Social	0.568	0.561
Environemntal	0.660	0.653

Table 7.7 lists the R^2 and adjusted R^2 values of all the endogeneous latent variables. An adjusted R^2 provides more accurate information about the degree by which a latent variable is presented by its predictors.

7.7.1 Goodness of fit

In the PLS the goodness of fit of the model is used for understanding its applicability for the prediction. The goodness of fit of the model can be expressed mathematically by

$$GoF = \sqrt[2]{\overline{Comunality} * \overline{R^2}}$$

Where, $\overline{Comunality}$ = weighted average of different communality (= AVE in PLS) and $\overline{R^2}$ = Average R^2 of all endogenous constructs.

The value of the GoF varies from 0 to 1, where a greater value indicates better predictive ability. In our case, the value of GoF is 0.56, which provides a substantial model fit.

7.7.2 Hypothesis testing

The basic objective of a path analysis is to provide a statistical tool to test and confirm the structural model to assess the hypotheses that represents the link among the variables of interests (Kline, 2005). This is an important tool to assess the linkage among the variables because the main goal of path analysis is to make an approximation of the degree of association among the variables to investigate the causal relationships (Wong et al., 2009; Asher, 1983). The path analysis measures the relative importance of different direct and indirect causal paths leading to the dependent variables. Figure 7.3 and 7.4 represents the path analysis of our study.

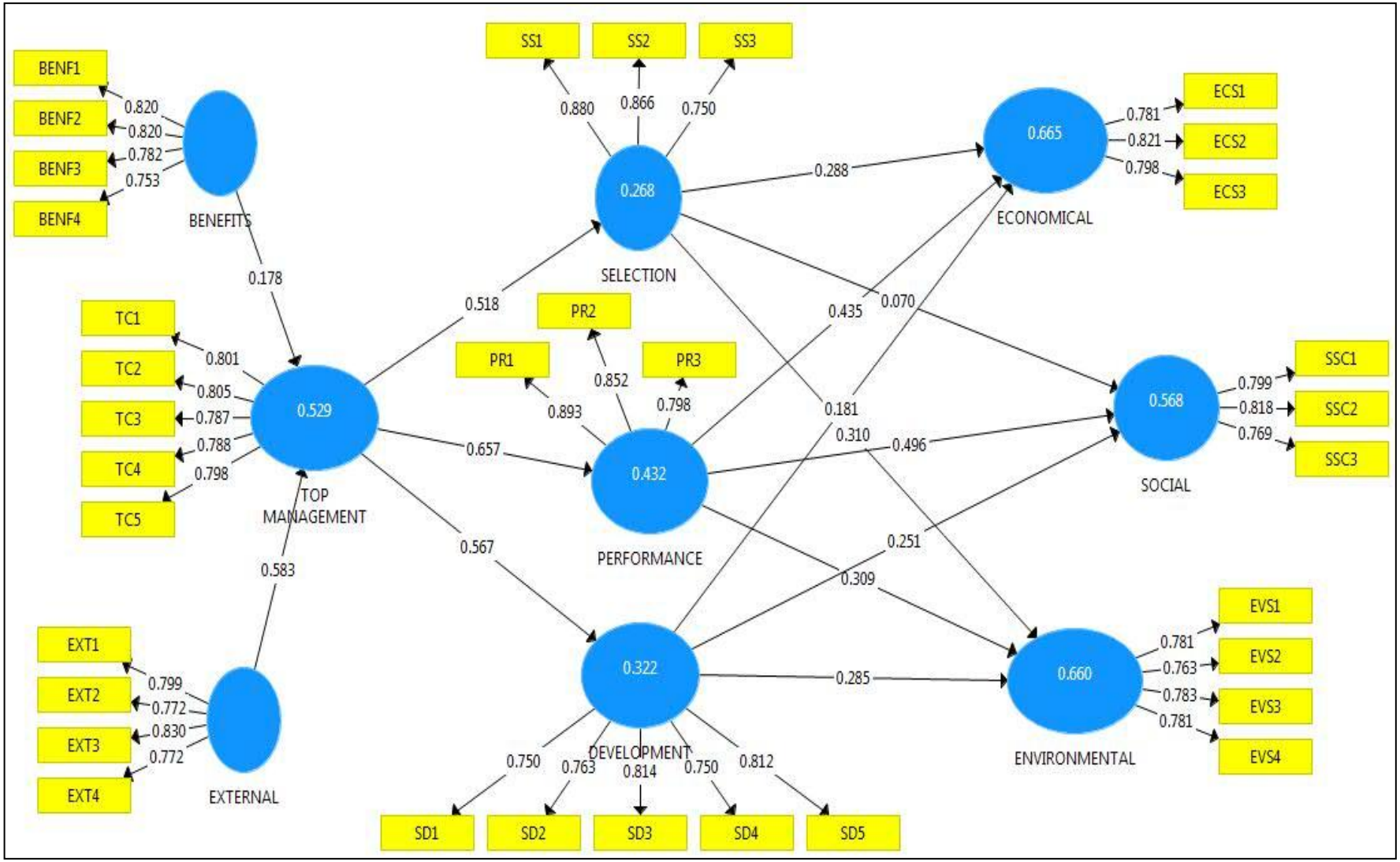

Figure 7.3 Results of structural model

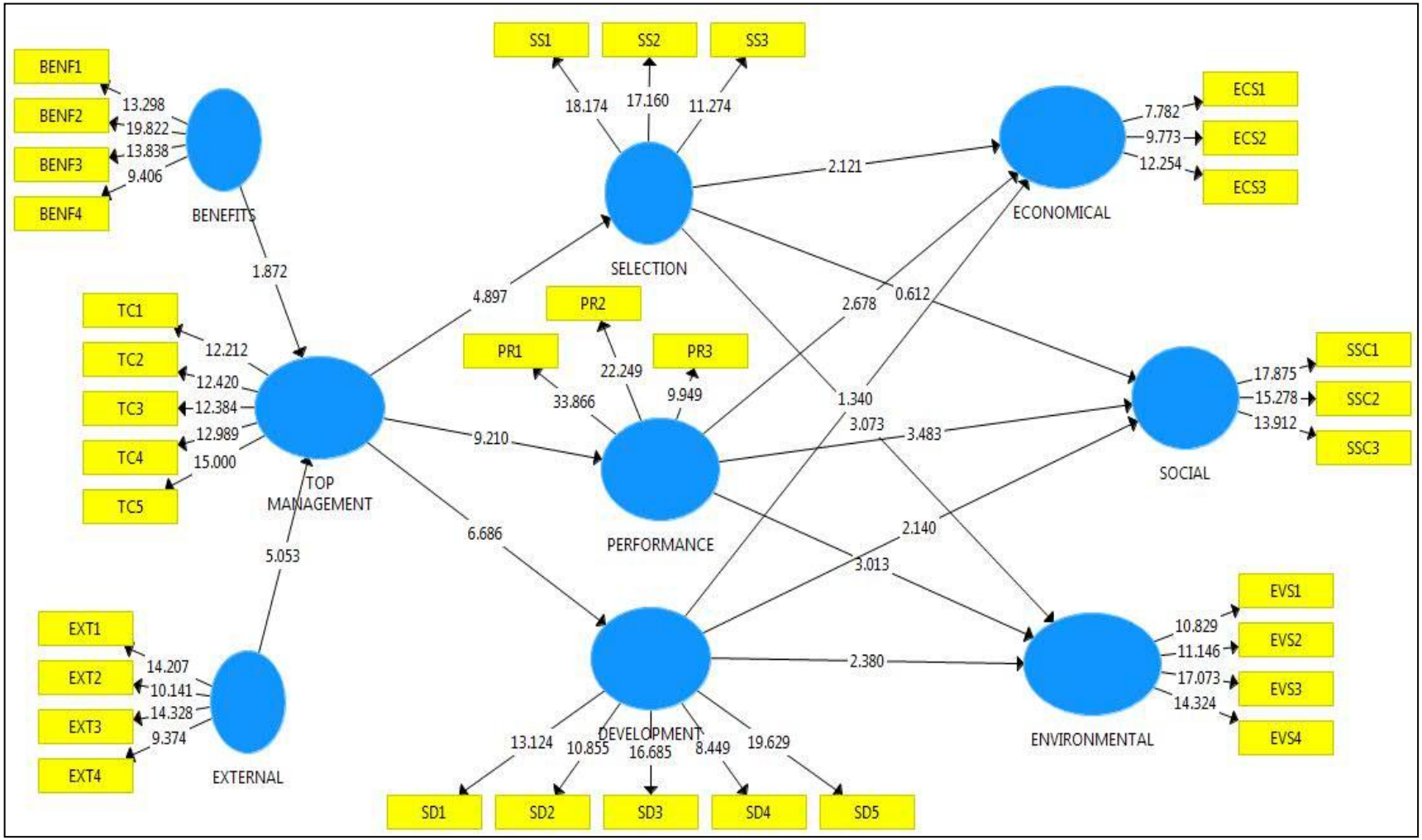

Figure 7.4 Hypotheses testing (T-statistics value)

Table 7.8 Path coefficients, T statistics and related hypotheses decision

Hypothesis	Path	Path cofficient	T Statistics	P Value	Decision
H_1	Benefits - Top Management	0.1782	2.2759	0.0244	Supported
H_2	External - Top Management	0.5831	6.3475	0.0001	Supported
H_{3a}	Top Management - Selection	0.5180	5.7748	0.0001	Supported
H_{3b}	Top Management - Performance	0.6570	11.5876	0.0001	Supported
H_{3c}	Top Management - Development	0.5673	7.5143	0.0001	Supported
H_{4a}	Selection - Environmental	0.3100	3.5282	0.0006	Supported
H_{5a}	Performance - Environmental	0.3088	3.6757	0.0003	Supported
H_{6a}	Development - Environmental	0.2853	3.0851	0.0024	Supported
H_{4b}	Selection – Social	0.0704	0.7958	0.4275	Unsupported
H_{5b}	Performance - Social	0.4961	4.2111	0.0001	Supported
H_{6b}	Development – Social	0.2513	2.5378	0.0122	Supported
H_{4c}	Selection – Economical	0.2876	2.4438	0.0158	Supported
H_{5c}	Performance - Economical	0.4350	3.2329	0.0015	Supported
H_{6c}	Development - Economical	0.1807	1.5373	0.1265	Unsupported

The structural model is tested by examining the path cofficient and their significance level in the PLS. The PLS bootstrapping technique was used to obtain the value of the T statistics with 200 cases and 500 random samplings. The results obtained from PLS bootstrapping are shown in Table 7.8. In our case we have 14 hypothesis. The number of hypothesis has been increased because we have divided the buyer-supplier relationships into three categories: Supplier selection, Supplier performance review and Supplier development. Similarly we have divided the sustaianbility of the supply chain into three categories: economical, social and environmental as proposed by Elkington (1994).

In our case 12 hypothesis have been accepted while two hypothesis H_{4b} and H_{6c} are rejected. These two hypothesis are:

- H_{4b}: Supplier selection activities have a positive impact on the social sustianability of the supply chain.
- H_{6c}: Supplier development has a positive impact on the economical sustianability of the supply chain.

Both of these hypothesis have been rejected in this study. It is difficult to measure the social sustianability indicators' performance on the unit of the produced product. But social sustianability has been found to have a positively affected by supplier development and

performance review. In the second case, reason for this rejection may be the cost incurred in the adoption of sustianability practices and developing relationships that may affect the economical sustainability of the supply chain in shorter time period (Seuring & Muler, 2008).

7.8 Results and managerial implications

The main objective of the present study was to develop a mechanism model for a sustainable supply chain by adopting empirical validation. The model presented in Figure 7.3 provides a clearer picture in terms of explaining the various activities involved in developing a sustainable supply chain. We have divided the buyer-supplier relationships into three different activities: supplier selection, supplier performance and supplier development. These three buyer activities of the supplier relationship have been checked against the three dimensions of sustainability: economical, social and environmental. The intention behind breaking buyer-supplier relationships and sustainability into further categories was to determine the specific impact of a particular activity on a specific sustainability dimension. In our case, the results are in line with previous studies. Previous authors have found that the buyer-supplier relationship will have a positive impact on environmental sustainability (Lin, 2007; Zutshi & Sohal, 2004). All the activities under the buyer-supplier relationship are positively affecting the environmental dimension of the sustainability. In terms of social sustainability, Hamprecht et al. (2005) found that an evaluation of supplier performance can increase the social sustainability of the supply chain. They have also mentioned that for motivating suppliers, certain monetary benefits can be transferred. Our study also found the same results that supplier development activities affect the economical sustainability and a performance review increases the social sustainability of the supply chain.

The present study has worked as an extension of the belief that buyer-supplier relationships have a positive impact on supply chain sustainability. In addition, various expected benefits of sustainability adoption and external influences positively affect the top management's commitment towards sustainability adoption and extension across the supply chain. Our study has taken a broad approach in investigating the impact of buyer-supplier relationships on sustainability outcomes of the supply chain. The buyer-supplier relationship has been divided into three parts to check the influence on the three dimension of sustainability. All measures were evaluated on the perception of 141 managers working in the sample companies.

The present study has enough evidence to support the claims that the buyer-supplier relationship can increase the sustainability performance of the supply chain. This study has made an important contribution by developing a path analysis model of a sustainable supply chain by considering the predictors of top management commitment, the buyer-supplier relationship and sustainability outcomes. However, present study focused on the Indian automobile industry, yet the results of the study reveal that how buyer-supplier relationship activities contribute to various dimensions of a sustainable supply chain.

In addition, the present study examined the role of expected benefits and external influence on the top management's commitment of the supply chain partners to incorporate and extend sustainability practices across the supply chain. Consistent with previous studies, our results shows there is a positive impact of the buyer-supplier relationship on sustainability outcomes.

Another important contribution of the present study shows that PLS path modeling can be used to evaluate a hierarchical model containing a multi-order construct. Since PLS is believed to be suitable for understanding complex relationships (Fornell & Bookstein, 1982), the application of PLS path modeling in this context has made it possible to widen the theoretical contribution of the present study. For evaluating higher order latent variables, a repeated indicator approach has been used in the present study (Wold, 1985). The result of the study presents adequate parameters to confirm the measurements and structural model. The successful application of PLS in this context reflects Wold's view (1985, p. 589), "*PLS comes to the fore in larger models, when the importance shifts from individual variables and parameters to packages of variables and aggregate parameters*."

Earlier studies have not broadly evaluated buyer-supplier relationships and a sustainable supply chain empirically. Thus, this study offers a better in depth understanding of buyer-supplier relationship activities and economical, social and environmental sustainability in context of emerging economies.

It is also believed that the present study has extended the theoretical contribution considerably by employing a research model in a new setting, which is the BSR-SSC model in the context of developing countries. According to Whetten (1989), "*the common element in advancing theory development by applying it in new settings….that is, new applications should improve the tool, not merely reaffirm its utility*.

Although this study focuses on a theoretical re-conceptualization and validation, the findings of this study have implications for manufacturing practitioners in general. For managers, this study presents empirical evidence to support buyer-supplier relationship development initiatives in developing countries in the context of the manufacturing sector. The empirical evidence of a positive relationship between buyer-supplier relationship activities and sustainability performance will help in addressing the concern for the return on investment in adopting sustainability practices.

7.9 Conclusion

In this chapter, a model has been developed that envelops the sustainability issue of the supply chain. To serve this purpose, a psychometric scale development process has been followed. Various reliability and validity tests have been conducted for the refinement and validation of the scale. In addition to this, hypothesis testing was also performed by using Smart PLS software. Finally, discussions and implications of the study have been discussed.

Chapter 8
Research summary, implications, limitations, and future scope

Preview

This chapter provides an overview of the research work conducted in the present study by discussing major research outcomes and key results. The implications of results from different methodologies are also provided. These implications of this study will ensure its use by both practitioners and academicians. Next to this, the limitations of the present study are also provided. Finally directions for future research are also suggested.

8 Introduction

Focal firms are always at the point of scruitny of many agencies, if there are any unsustainable practices at any stage of supply chain (Mahler, 2007). Demand from these agencies has influenced whole supply chain to work together. Companies are now coming closer to develop each other's capability and capacity to improve the sustainability performance of supply chain.

It becomes necessary to develop a mechanism for the sustainability adoption across supply chain. Although, there are some conceptual papers available in the literature dealing with the mechanism for developing sustainable supply chain. There is no empirical investigation on these models to check their validity. It is very necessary to the countries like India to focus on sustainable supply chain wheree industries are now becoming more of export oriented. In order to meet the global standards, every industry should have more sustainable supply chain.

In literature review, it has been found that there is need of knowing the interrelationships among and classification of the various enablers of the sustainable supply chain. Besides, supplier selection has been discussed many times for developing sustainable supply chain. But there is lack of such studies which consider sustainability criteria for the supplier selection and order allocation among them. Similarly, if one company wants to extend sustainability practices across supply chain, it has to develop relationship with the suppliers. But relationship selection should be based on the supplier capability, capacity, and commitment towards sustainability. Consideration of benefits, opportunities, cost, and risk of developing relationship with particular supplier should be done for relation selection.

This study works as a path for both researchers and practitioners working in this field of study. This study will help in decision making by classifying the enablers of sustainable supply chain, developing model for supplier selection and order allocation on sustainability criteria, developing model for relationship selection for improving the sustainability of supply chain considering BOCR.

The present study contributes significantly to the empirical literature of corporate sustainability in following ways:

First, no study has identified and classified the enablers of sustainable supply chain. This study has tried to find out the interrelationship among the enablers of sustainable supply chain. This study has also classified the enablers based n their driving and dependence power.

Second, majority of the studies has used very few sustainability criteria in suppler selection and order allocation. Shaw et al., (2012) used only emission, late delivery, rejection, and cost of the product in to consideration while developing supplier selection model. This study provides clearer picture by taking 7 sustainability criteria for supplier selection and order allocation among them. Those criteria are: waste minimization, emission, energy use minimization, social welfare, rejection, late delivery, and cost of the product.

Third, relationship selection studies were mostly pointed towards the cost and performance of the study. Lee (2009) has developed model for relationship selection for LCD manufacturing suppliers. No study till now has discussed relationship selection for sustainable supply chain considering BOCR.

Fourth, the majority of studies are conceptual in nature those dealing with the mechanism of developing sustainable supply chain. Some of the empirical studies are there but they are environment or social sustainability oriented. Very few studies have been accomplished considering the sustainability in supply chain and buyer supplier relationship. In the present study, all the three dimensions, as suggested by Elkington (1994) are used for the assessment of corporate sustainability performance. In earlier studies, in those the primary data was collected to serve the measurement objective were focused on a single dimension of the sustainable development.

8.1 Outline of the present research

Increased concern towards the environmental degradation and social responsibility of a business has put tremendous pressure on the focal firms to extend sustainability practices across supply chain. Most of the burden on the society and environment is due to the suppliers' operations. This issue is motivating firm to strictly monitor the sustainability performance of the supplier. In this context, buyer supplier relationship is emerging as an important strategy to address the issue. Moreover, buyer supplier relationship has been found positively affecting the sustainability performance of the supply chain.

Based on the gaps identified from the literature review (Chapter 2) of which a part is reproduced here, it is very clear that there is enough scope of work for further study in this field.

- Number of paper on sustainable supply chain has been increased. There are more than fifty journals which are covering the research on the sustainable supply chain. Most of the papers are published in the Journal of Cleaner Production, Supply Chain Management: an International Journal, Journal of Operation and Production Management, European Journal of Operation Research, Journal of Physical Distribution and Logistics, Industrial Marketing Management, Journal of Business and Industrial Marketing, Journal of Strategic Marketing, and Journal of Relationship Marketing. Some of the papers were from very wide spectrum of the journals including: Journal of Wine Research, Biological Science, Employee Responsibility and Rights Journals, Corporate Governance and Corporate Environmental Strategy.
- There are many literature reviews available on the sustainable supply chain. Seuring and Muller (2008) presented a literature review that conceptualizes the framework of a sustainable supply chain and a model to develop a sustainable supply chain. Carter & Roger (2008) also proposed a sustainable supply chain framework. The main focus of the paper was on balancing economic, environmental, and social sustainability. Gimenez and Tachizawa (2012) have presented recent literature on sustainable supply chains. In this paper, the authors attempt to find the impact of a governance mechanism for developing a sustainable supply chain and to find the enablers of this governance mechanism. All these papers have focused on validating the conceptual frameworks.
- Sustainable supply chain research is very new to the Indian firms. Only one study by Kushwaha (2010) is available on sustainable development through green supply chain

management. That research neglected the social sustainability of the supply chain in India.

- In literature review, it has been found that there is need of knowing the interrelationships among and classification of the various enablers of the sustainable supply chain. A well established Interpretive structural modelling (ISM) and Fuzzy MICMAC has been used to fill these gaps (Chapter 3).
- In literature there was no study strictly focused upon the supplier selection and order allocation in sustainable supply chain. One study by Shaw et al. (2012) has tried to develop the supplier selection and order allocation model for the low carbon emission supply chain. But this paper has also neglected the social sustainability as well as some dimension of environmental sustainability including waste minimization and minimizing energy use. Additional studies need to be done to address the sustainability more comprehensively in supplier selection and order allocation. A hybrid methodology comprising Fuzzy AHP and Fuzzy multi-objective linear programming has been used to fill this gap (Chapter 4).
- There is only one study on the buyer supplier relationship selection in the literature which considered benefits, opportunity, cost, and risk of developing a relationship. This study was done by Lee, (2009) but lacks the incorporation of sustainability criteria in relationship selection. A model has been developed using Fuzzy AHP as suggested by Lee (2009) considering the sustainability criteria to select the best form of relationship (Chapter 5).
- One of the most important gaps identified from the literature is that none of the study has empirically tested the model of the sustainable supply chain development mechanism. Hence a model has been developed to fulfill this gap (Chapter 7).

8.2 Significant research contribution and key findings

The main purpose of this study was to provide insights to develop a sustainable supply chain using buyer supplier relationships. In the present study both qualitative and quantitative models were developed with the help of practitioners and decision makers of the Indian automobile industry. These models will also help researcher working in this field of study. These

models are an attempt to fulfill the gaps in the available literature and to achieve the objective of the present study.

The main input and key findings of the present study are as follows:

- In this study a review and taxonomical classification of the available literature was presented. Different factors of sustainable supply chain and Buyer-Supplier relationship were derived from a further perusal of the present study. In the literature review enablers, buyer supplier relationship strategy, benefits, benefits, opportunities, cost and risk of developing relationship and indicators of sustainable supply chain has been tabulated. Major gaps have been identified in this chapter. A conceptual model has been developed based on the literature for developing sustainable supply chain using buyer supplier relationship.
- After the identification of enablers of sustainable supply chain in the context of Indian automobile industry a qualitative model has been developed to depict the interrelationship among the enabler and their classification. The ISM and Fuzzy MICMAC methodology has been used for this purpose. A pair wise comparison is done to obtain a Structural Self-Interaction Matrix (SSIM) that is checked for transitivity. Pair wise comparison has been done with the help of experts from Indian automobile industry and academia. SSIM is used to develop a Reachability Matrix (RM) and is partitioned into different levels. After this, a conical matrix is developed from the reachability matrix by rearranging the variables according to the different levels. Based on the above steps, a directed graph (digraph) is drawn and transitivity links are removed. The digraph is converted into an ISM model by replacing the nodes of the elements with statements. The ISM model is checked for conceptual inconsistency and necessary modifications are incorporated. Fuzzy MICMAC is used to classify these enablers on the basis of driving and dependence power. Fuzzy scale is used to know the indirect relationship among the enablers. Fuzzy matrix is established and values are plotted on the MICMAC graph. *Awareness, pressure from various agencies, demand from customers, support from various agencies, top management commitment, resource sharing, information sharing and monitoring and auditing supply chain partners* were having low dependence power and high driving power. Hence, these eight enablers were found suitable for creating a favorable environment for sustainability adoption in supply chain. Three enabler *long*

term relationship, trust and commitment and knowing and solving supply chain partner problem were having moderate driving and dependence power and found suitable for implementing the sustainability practices across supply chain. Remaining four variables, *joint development, cost reduction, capability and capacity development and marketing and competitive advantage* were high on dependence power and low on driving power. Hence these enablers are suitable for the developing a sustainability culture across supply chain. There were no anonymous (unrelated) enablers found in this study.

- A supplier selection and order allocation model has been developed using Fuzzy AHP and Fuzzy Multi-objective linear programming. Experts were invited from industry for the pair wise comparison of the selection criteria. Those selected criteria were *waste minimization, energy use minimization, emission minimization, social welfare, late delivery, rejection on quality, cost of the unit product and demand from the buyer firm*. Weights have been assigned to these selection criteria. Demand has been used as fuzzy constraints in this study. These weights have been used to formulate the seven fuzzy objectives. A final objective of maximizing the sustainability performance has been developed. Lingo (version 13) has been used to calculate the order allocation among the four suppliers under consideration. In this study two approaches have been compared, these two approaches are: symmetric and asymmetric. A sensitivity analysis has been done to show the changes in the objective function with respect to the main objective function.
- After developing model for supplier selection for sustainable supply chain. A qualitative model has been developed for the relationship selection in sustainable supply chain. Fuzzy AHP has been used for this purpose. A two stage model has been developed after reviewing the literature and taking experts opinion. This model was based on the premise of selecting buyer supplier relationship considering the benefits, cost, opportunity and risk. Following benefits have been considered in developing this model: *financial benefit, operation benefits and sustainability adoption*. Opportunities include *marketing advantage, technological capabilities and mutual growth*. In term of cost, three types of cost have been considered which are *cost of relationship, cost of adoption, and impact of relationship*. Risk considered were *management of relationship, market dependency and investment*. In first stage of the model, pair wise comparison has been done to know the

weights of benefits, opportunities, cost and risk on the sustainability criteria to select a best form of relationship. In second stage of the model, pair wise comparison has been done to know the weights of relationship alternatives: *one time relationship, foundation relationship, problem solving relationship, long term relationship and mutual development and growth*. The final selection of the alternatives has been done by using five different methods of association of BOCR. A sensitivity analysis has been performed to understand the change in relationship alternative selection with respect to the change in the weight of benefits, opportunity, cost and risk.

- In the first stage, items related to the factors were extracted from the available literature. For this purpose different techniques were used such as content analysis, production of the primary pool of items and evaluation of content and face validity through expert judgment. This initial refinement process was followed by the purification stage. In this stage reliability, CFA, unidimensionality, convergent and discriminant validity assessment were conducted. This scale has been developed for checking the hypotheses. The internal consistency and reliability has been checked by different tests.
- It was hypothesized that expected benefits of sustainability adoption positively affects the top management commitment towards incorporation and extension of sustainability practices across supply chain (H_1). Based on the empirical evidence and results, this hypothesis is supported. The positive impact of expected benefits of sustainability adoption on top management reveals that top management commitment can be increased by creating awareness about the expected benefits of the sustainability adoption. Product differentiation, new market opportunities, premium pricing, positive reputation, and competitive advantage may be some of the reasons for this positive relationship.
- The second hypothesis formulated was that there is a positive impact of external pressure and support on the top management commitment towards incorporation of sustainability practices (H_2). The result of present study supports this hypothesis. There is positive impact of the external influence on the top management for incorporating and extending sustainability practices across supply chain. This result reveals that external pressure from various agencies including focal firm can have positive impact and can help in extension of sustainability practices across supply chain.

- Three hypotheses were formulated as there is positive impact of top management commitment on the sustainability specific buyer supplier relationship. These hypotheses are also fully supported by empirical results. More the commitment among the top management of supply chain partner more is the chances to develop a buyer supplier relationship. Incorporation of the practices like supplier selection on sustainability standards, supplier development and performance review are the activities followed by companies committed towards the sustainability adoption.
- In the last, nine hypotheses were formulated to check the relationship between buyer supplier relationship and sustainability performance of the supply chain. It was formulated as there is positive impact of buyer supplier relationship on the sustainability performance of the supply chain. Seven out of nine hypotheses were supported by empirical results. Positive impact of supplier selection activities on economical sustainability and positive impact of supplier section activities on social sustainability were rejected in our empirical validation of conceptual model.

8.3 Implications of the present study

The outcomes of the present research add to the existing body of literature on sustainable supply chain. The results of the study provide a path for the both academicians and practitioners for the developing sustainable supply chain in the long run as well its impact on developing buyer supplier relationship. The main probable implications of the present research are:

8.3.1 Implication for academicians

The main implications for the academicians are:

- A bibliographic record provided in the literature review of the present research may work as a guideline for future research in this field of study. Many items identified under the categories of enablers of sustainable supply chain, BOCR of buyer supplier relationships, relationship management strategies, sources of external influence, barriers of sustainable supply chain, and indicators of sustainability in supply chain can be used by researchers/academicians for their research work.
- The categorization and interrelationships among enablers' of sustainable supply chain can help academicians to do further research.

- Supplier selection and order allocation model for sustainable supply chain can be used for further investigation by considering more industry specific criteria.
- Relationship selection considering the benefits, opportunities, cost, and risk of developing a relationship can be customized for specific industry by using same or other methodology.
- The conceptual model of present study to development of sustainable supply chain may be helpful for a further study in other industry or comparing the two countries/industries.

8.3.2 Implications for practitioners

The important managerial implications of the present study are summarized below:

- The outcome of the present study presents the practical implications of the identified corporate sustainability measurement factors. Their application in the Indian manufacturing sector provides a guideline for the managers and decision makers of these companies to improve their corporate sustainability performance.
- Managers can have a better understanding of enablers at each stage of adoption with the ISM model and MICMAC categorization. The focal firm's ability to induce changes in the supply chain depends upon the willingness of supply chain partners to support and accept the change. The focal companies should identify and target the managers of supply chain partners in order to develop the intention to adopt sustainability. The focal firm can use following approaches to develop future relationships with supply chain partners: supplier selection on the environmental, social, and economical criterion and monitoring and auditing supply chain partners based on sustainability standards.
- From a managerial perspective, supplier selection is important for managing the sustainability of the final product. Rather than ranking suppliers on sustainability standards, companies can now allocate the ordering units among them. The existing literature on supplier selection has focused on various multi criteria decision-making techniques for supplier selection. However, these techniques lack the ability to allocate the order among suppliers in order to maximize the sustainability performance of available suppliers and their resources. This study will help managers to use the sustainability criteria in sustainability adoption.

The proposed supplier selection and order allocation method can be used in a way that particularly suits the need of the supply chain, by weighing and comparing the different selection criteria. Rather than using a symmetric approach, managers should apply an asymmetric approach when dealing with the importance of the criteria in real life problems. This approach includes the managers' decisions and implementation in real time situations. On the one hand, our approach deals with the importance of the selection criteria by using Fuzzy AHP. On the other hand, it optimizes the orders among the suppliers based on their performance in the sustainability indicators and the given importance of those indicators. This model is very helpful in mitigating the sustainability challenges across the supply chain. It also illustrates the importance of performance on individual selection criteria for order allocation. These models can also be integrated in SRM (Supplier relationship management) package of SAP or any other ERP modules.

- The model presented in Figure 7.3 provides clearer picture in term of explaining the various activities involved in developing sustainable supply chain. Managers can use this study to evaluate the role of specific latent variable in developing a sustainable supply chain. Although this study focuses on theoretical re-conceptualization and validation, the findings of this study have implication for manufacturing practitioners in general. For managers, this study presents empirical evidence to support the buyer supplier relationship development initiatives in developing countries in context of the manufacturing sector. The empirical evidence of a positive relationship between buyer supplier relationship activities and sustainability performance will help in addressing the concern for the return on investment in adopting sustainability practices.

8.4 Limitations of the study

Every study has its own limitation due to various factors. This limitation may be time, sample, availability of data, techniques applied etc. The same is the case with the present study. These limitations may provide various useful inputs that can be addressed in future studies. The limitations of the present study are as follows:

In ISM-MICMAC methodology, the responses were taken from the experts of Indian automotive industry that may biasness. More rigorous model can be developed by collecting the data on large sample and validating it using other statistical techniques.

In Fuzzy AHP, fuzzy has been incorporated to remove any vagueness in the responses of the experts. Again, data has been collected from the experts; there are chances of biasness in this study. Though there is no limitation in the AHP for taking experts' opinion, still the weights of criteria can be calculated by using lage sample and other statistical techniques.

The questionnaire developed in the study is a generalized scale for the entire Indian automobile industry. There may be variation in the importance of various factors from industry to industry. This study is conducted only in the Indian scenario. Thus, the result may be different in the case of another country. This study is concentrated upon the all the companies listed in our population sample. A case study based research can be developed concentrating single firm and its suppliers for validating our results.

Our sample size is sufficient for using PLS method, but there are some other assumption also related to the selection of sample size. Sample size should be in the ration of 0:5 to 1:10 (items: responses). In this study, there were 34 itmes and our sample size was 141, but It could be somewhere between 170 (1:5) to 340 (1:10). We proposed to do this study on a larger sample size.

The sample size was limited to Automobile industry, which potentially limits its application for other industries. Our study did not control for potential industry effects that could influence the relationships between variables.

One more issue that is worth mentioning here is that the measures of each construct used in the present research are based on the manager's perceptions, which to some extant may be subjective. Although a perceptual measurement of firm performance is a well adopted technique in literature, results of the present study can be further validated by using objective data. In addition, statistics can confirm an association but do not present any proof of causality. Thus, other interpretations of results and data analysis might be used.

In the present study, data for both dependent and independent variable was collected through the same self reported questionnaire, so the data may have suffered from measurement bias. This study is based on the data collected from a single country; therefore, it is necessary to validate the results before generalizing the study to other countries. The effect of situational

factors which have an impact on the sustainability performance has not been considered in the present study.

8.5 Scope for future research

The research carried out in the present study is widespread and may be of high use to academicians, practitioners, managers, decision makers and scholars. Every study has its own limitation in terms of the different issues as mentioned in an earlier section. These limitations raise the need to extend this work in further studies. The study presents many opportunities that could be explored in future studies. The possible and important scope for future research is presented as below:

- The model outlined in Figure 3.5 represents the final interaction among enablers associated with sustainability. Much of the analysis and discussion is centered on the interactions among sustainability enablers. Sharing resources and information that will allow partners to change their perception towards sustainability need further investigation.

  In most of the models, the investigation of the interactions among variables reached a successful conclusion. The models, however, did not take into account efforts that were introduced and failed. Further models can investigate these using real life situations and in confirm it with a longitudinal study.

  Previous research argued that the lack of money, education, technology, and expertise obstructed the sustainability process in the supply chain. Further research could be carried out to identify how the problems of money, technology, and lack of other required expertise are solved by these variables.

  The data used to develop the ISM model and Fuzzy MICMAC graph was taken from fifteen experts from Indian automobile companies. A suitable model with a bigger sample can be carried out with the use of structural equation modelling.

  Assuming that the enablers depicted in the model are satisfactory and by further incorporating various recommendations, a rigorous model could be made to determine the relationships among the enablers with their weights.
- It would be useful to compare fuzzy AHP and fuzzy multi objective linear programming approach with other existing statistical approaches. Further research could evaluate the

environmental and social criteria, assuming that all the suppliers have the same ordering cost, rejection, and late delivery. This would give a more accurate picture of the optimization of the orders based on social and environmental factors. New methods of quantifying the social sustainability criteria can be included to get clearer picture.

- Relationship selection model can be used to understand relationship performance based on the criteria and sub-criteria in the supply chain. This model can be modified with respect to other industries based on their specific needs. A more comprehensive model can be developed if multiple suppliers need to be selected. This model can be used once a supplier is selected and the relationship needs to be determined. A combination model can be developed that can handle relationship selection and supplier selection simultaneously.
- The interrelationship issues among the three dimensions of corporate sustainability i.e. environment, social and economic need to be addressed in future studies.
- With the AHP, the group aggregation techniques such as the Weighted Arithmetic Mean Method (WAMM) or the Geometric Mean Method (GMM) proposed by Ramanathan and Ganesh (1994) can be applied to verify the results of the present study.
- Various literature reviews and classification schemes like, bibliometric analysis, and Meta analysis can also be applied to get more in depth understanding.
- A case study can be developed specific to a focal company to check the improvement in sustainability performance using the finding of this study.
- This study can be extended to all other industries by considering industry specific criteria in supplier selection, relationship selection, and impact of buyer supplier relationship on sustainability performance for generalizing the findings (Foerstl et al., 2015; Dries, et al., 2014).
- Other integrated techniques like Fuzzy ANP, Fuzzy Axiomatic Design (FAD), Quality Function Deployment (QFD), Fuzzy QFD, and TOPSIS could be used for validating our results (Rezaei, 2015; Baykasoğlu, & Gölcük, 2015; Subulan et al., 2014).
- The role of buyer supplier relationships in dealing with the various barriers of sustainability adoption can be checked in future work (Touboulic & Walker, 2015; Kordestani et al., 2015).

- Same study using customer relationship management can be extended to develop sustainable consumers in service sector (Rudawska, 2011; Dasgupta, 2011).
- A longitudinal study need to done to verify the various expected benefits of sustainability adoption.
- New industries can be targeted for developing industry specific models for sustainable supply chain based on supply chain relationships (Chkanikova, 2015; Brandenburg et al., 2014; Rudawska, 2010).
- This study is focused upon the relationship marketing with the channel partner (Supplier). Future work can be done by considering other strategies of holistics marketing concept. A combined holistic marketing strategy can be formulated in the future work (Kähkönen et al., 2015).

8.6 Conclusion

This chapter provides a consolidate picture of the entire study. It also provides the research contribution, implications for the practitioners and academician, key findings, limitations of the present study followed by avenues for the future research. It is expected that this study on developing sustainable supply chain will work as a tool for attracting the interest of various researchers in this field of study, especially in developing countries. This study touched on various issue of developing sustainable supply chain that may be useful in developing a strategy and will be helpful in policy formulation to improve efforts towards the goal of sustainable development.

References

1. Agarwal, A., Shankar, R., & Tiwari, M. (2006). Modeling agility of supply chain. *Industrial Marketing Management*, 36, 443-457.
2. Ageron, B., Gunasekaran, A. & Spalanzani, A. (2012). Sustainable supply management: An empirical study. *International Journal of Production Economics*, 140(1), 168-182.
3. Amaratunga, D., Baldry, D., & Sarshar, M. (2001). Process improvement through performance measurement: the balanced scorecard methodology. *Work Study*, 50(5), 79-189.
4. Amid, A., Ghodsypour, S. H., & O'Brien, C. (2006). Fuzzy multi-objective linear model for supplier selection in a supply chain. *International Journal of Production Economics*, 104(2), 394–407.
5. Anderson, J. C. & Gerbing, D. W. (1988). Structural equation modeling in practices: a review and recommendation two-step approach. *Psychological Bulletin*, 103(3), 411-423.
6. Ansett, S. (2007). Mind the gap: a journey to sustainable supply chains. *Employee Responsibilities and Rights Journal*, *19*(4), 295-303.
7. Armstrong, S. & Overton, T. S. (1977). Estimating non-response bias in mail surveys. *Journal of Marketing Research*, 14, 396-402.
8. Ashby, A., Leat, M., & Hudson-Smith, M. (2012). Making connections: a review of supply chain management and sustainability literature. *Supply Chain Management: An International Journal*, *17*(5), 497-516.
9. Asher, H. (1983), *Casual modeling (2nd ed.)*, Sage, Beverly Hills, CA.
10. Asif, M., Bruijn, E. J. D., Fisscher, O. A. M., & Steenhuis, H. (2008). Achieving Sustainability Three Dimensionally. IEEE, conference publication for Management of Innovation and Technology. *ICMIT 2008. 4th IEEE International Conference*, 423-428.
11. Asslander, M. S., & Roloff, J. (2010). Endangering social and economic sustainability: supplier management in the automobile industry. *International Journal of Sustainable Strategic Management*, 2(3), 256-273.
12. Attaran, M. & Attaran, S. (2007). Collaborative supply chain management the most promising practice for building efficient and sustainable supply chains. *Business Process Management Journal*, 13(3), 390-404.

13. Awasthi, A., Chauhan, S. S., & Goyal, S. K. (2010). A fuzzy multi criteria approach for evaluating environmental performance of suppliers. *International Journal of Production Economics*, 126(2), 370–378.
14. Azapagic, A. & Perdan, S. (2000). Indicators of sustainable development for industry: a general framework. *Process Safety and Environmental Protection*, *78*(4), 243-261.
15. Azapagic, A. (2004). Developing a framework for sustainable development indicators for the mining and minerals industry. *Journal of Cleaner Production, 12*(6), 639-662.
16. Bagheri, A. & Hjorth, P. (2007). Planning for sustainable development: a paradigm shift towards a process-based approach. *Sustainable Development*, 15(2), 83-96.
17. Bagozzi, R. P. & Yi, Y. (1991). Multitrait-multimethod matrices in consumer research. *Journal of Consumer Research*, 426-439.
18. Bagozzi, R. P., Youjae, Y., & Lyne, W. P. (1991). Assessing construct validity in organizational research. *Administrative Science Quarterly*, 36(3), 421-458.
19. Bagozzi, R.P. (1980), *Causal models in marketing*, Wiley, New York.
20. Bahl, S., Wali, O. P., & Kumaraguru, P. (2011, June). Information security practices followed in the Indian software services industry: an exploratory study. In IEEE *Cybersecurity Summit (WCS), 2011 Second Worldwide*, pp. 1-7.
21. Bai, C. & Sarkis, J. (2010). Green supplier development: analytical evaluation using rough set theory. *Journal of Cleaner Production*, 18(12), 1200-1210.
22. Baker, S. (2007). Sustainable development as symbolic commitment: declaratory politics and the seductive appeal of ecological modernisation in the European Union. *Environmental Politics*, *16*(2), 297-317.
23. Barclay, D., Higgins, C., & Thompson, R. (1995). The partial least squares (PLS) approach to causal modelling: personal computer adoption and use as an illustration. *Technology Studies*, 2(2), 285-309.
24. Baykasoglu, A., & Gocken, T. (2012). A direct solution approach to fuzzy mathematical programs with fuzzy decision variables. *Expert Systems with Applications*, *39*(2), 1972-1978.
25. Baykasoglu, A., & Gölcük, İ. (2015). Development of a novel multiple-attribute decision making model via fuzzy cognitive maps and hierarchical fuzzy TOPSIS. *Information Sciences*. 301, 75-98.

26. Bellman, R. E., & Zadeh, L. A. (1970). Decision making in a fuzzy environment. *Management Science*, 17(4), 141–164.
27. Bentler, P. M. & Bonnet, D. G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin*, 88(3), 588-606.
28. Beske, P., Koplin, J., & Seuring, S. (2008). The use of environmental and social standards by German first-tier suppliers of the Volkswagen AG. *Corporate Social Responsibility and Environmental Management*, 15(2), 63-75.
29. Biggemann, S. (2012). The essential role of information sharing in relationship development. *Journal of Business & Industrial Marketing, 27*(7), 521-526.
30. Blowfield, M. E, (2005). Going global: how to identify and manage societal expectations in supply chains. *Corporate Governance*, 5(3), 119-128.
31. Boender, C. G. E., DeGraan, J. G., & Lootsma, F. A. (1989). Multiple-criteria decision analysis with fuzzy pairwise comparisons. Fuzzy Sets and Systems, 29(2), 133–143.
32. Bommel, W. V. (2010). A conceptual framework for analyzing sustainability strategies in industrial supply networks from an innovation perspective. *Journal of Cleaner Production*, 19(8), 895-904.
33. Bowen, F. E., Cousins, P. D., Lamming, R. C., & Faruk, A. C. (2001). The role of supply management capabilities in green supply. *Production and Operations Management*, 10(2), 174-189.
34. Bozbura, F. T., Beskese, A., & Kahraman, C. (2007). Prioritization of human capital measurement indicators using fuzzy AHP. *Expert Systems with Applications*, 32(4), 1110–1112.
35. Brandenburg, M., Govindan, K., Sarkis, J., & Seuring, S. (2014). Quantitative models for sustainable supply chain management: Developments and directions. *European Journal of Operational Research*, 233(2), 299-312.
36. Brindley, C. & Oxborrow, L. (2014). Aligning the sustainable supply chain to green marketing needs: A case study. *Industrial Marketing Management*, 43(1), 45-55.
37. Brito, M. P. D., Carbone, V. & Blanquart, C. (2008). Towards a sustainable fashion retail supply chain in Europe: Organization and performance. *International Journal of Production Economics*, 114(2), 534-555.

38. Buckley, J. J. (1985). Fuzzy hierarchical analysis. *Fuzzy Sets and Systems*, 17(3), 233–247.

39. Buyukozkan, G. & Cifci, G. (2010). Analysis of the Sustainable Supply Chain structure with incomplete preferences. *Proceeding of the World Congress on Engineering*, WCE, June 30-July 2, 2010, London, UK

40. Cai, S., Souza, R. D., Goh, M., Li, W., Lu, Q., & Sundarakani, B. (2008). The adoption of Green Supply Strategy: An institutional perspective. *Proceedings of the 2008 IEEE ICMIT*, 1044-1049.

41. Cannon, J. P. & Perreault W. D. Jr. (1999). Buyer–seller relationships in business markets. *Journal of Marketing Research*, 36 (4) 439-460.

42. Carbone, V. & Moatti, V. (2011). Towards greener supply chains: an institutional perspective. *International Journal of Logistics Research and Applications*, 14(3), 179-197.

43. Carter, C. R. & Jenning, M. M. (2002). Social responsibility and supply chain relationships. *Transportation Research Part E: Logistics and Transportation Review*, 38(1), 37–52.

44. Carter, C. R. & Rogers, D. S. (2008). A framework of sustainable supply chain management: moving towards new theory. *International Journal of Physical Distribution and Logistics Management*, 38(5), 360-387.

45. Chan, F. T. S. & Kumar, N. (2007). Global supplier development considering risk factors using fuzzy extended AHP based approach. *Omega*, 35(4), 417–431.

46. Chang W. L., Ik-Whan G. K., & Dennis S. (2007). Relationship between supply chain performance and degree of linkage among supplier, internal integration, and customer. *Supply Chain Management: An International Journal*, 12(6), 444 – 452.

47. Chang, D. Y. (1996). Applications of the extent analysis method on fuzzy AHP. *European Journal of Operational Research,* 95(3), 649-655.

48. Chen, S. M. (1996). Evaluating weapon systems using fuzzy arithmetic operations. *Fuzzy Sets and Systems*, 77(3), 265-276.

49. Cheng, C. H. (1999). Evaluating weapon systems using ranking fuzzy numbers. *Fuzzy Sets and Systems*, 107(1), 25-35.

50. Cheung, Y. K. F. & Rowlinson, S. (2011). Supply chain sustainability: a relationship management approach. *International Journal of Managing Projects in Business*, 4(3), 480-497.

51. Chin, W. W. & Newsted, P. R. (1999). Structural equation modeling analysis with small samples using partial least squares. Hoyle, R. (Ed.), in *Statistical 'Strategies for Small Sample Research*, Sage, Thousand Oaks, CA, pp. 307-341.

52. Chin, W. W. (1998a). Issues and opinion on structural equation modelling. *MIS Quarterly*, 22(1), 7-16.

53. Chin, W. W. (1998b). The partial least squares approach to structural equation modelling. in Marcoulides G. A. (Ed.) *Modern Methods for Business Research*, Lawrence Erlbaum.

54. Chin, W. W., Marcolin, B., & Newsted, P. R. (2003). A partial least squares latent variable modeling approach for measuring interaction effects: results from a monte carlo simulation study and an electronic-mail emotion/adoption study. *Inform. Systems Res.*, 14(2), 189-217.

55. Chkanikova, O. (2015). Sustainable Purchasing in Food Retailing: Interorganizational Relationship Management to Green Product Supply. *Business Strategy and the Environment*. DOI: 10.1002/bse.1877

56. Cho, N. & Park, S. (2001). Development of electronic commerce user-consumer satisfaction index (ECUSI) for Internet shopping. *Industrial Management & Data Systems*, 101(8), 400-406.

57. Churchill, G. A. (1979). A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research*, 16(1), 64-73.

58. Cilibereti, F., Pontrandolfoa, P., & Scozzi, B. (2008). logistics social responsibility: standard adoption and practices in Italian Companies. *International Journal of Production Economics*, 113(1), 88-106.

59. Clemens, B. & Douglus, T. J. (2006). Does coercion drive firm to adopt 'voluntary' green initiatives? Relationship among coercion, superior firm resources and voluntary green initiatives. *Journal of Business Research*, 59(4), 483-491.

60. Closs, D. J., Speier, C., & Meacham, N. (2010). Sustainability to support end-to-end value chains: the role of supply chain management. *Journal of Academy of Marketing Science*, 39, 101-116.

61. Coakes, E. (2006). Storing and sharing knowledge: Supporting the management of knowledge made explicit in transnational organisations. *Learning Organization, The,* 13(6), 579-593.

62. Contractor, F. J. & Lorange, P. (2002). The growth of alliances in the knowledge-based economy. *International Business Review*, 11(4), 485-502.

63. Cote, R. P., Lopez, J., Sunny M., Genevie`ve M. P., & Ramsey W. (2008). Influences, practices, and opportunities for environmental supply chain management in Nova Scotia SMEs. *Journal of Cleaner Production*, 16(15), 1561-1570.

64. Cramer, J. M. (2007). Organising corporate social responsibility in international product chains. *Journal of Cleaner Production*, 16(3), 395–400.

65. Creswell, J. W. (2003). *Research design: qualitative, quantitative and mixed methods, Sage Publishing*.

66. Curkovic, S. & Sroufe, R. (2010). Using ISO 14001 to promote a sustainable supply chain strategy. *Business Strategy and the Environment*, 20(2), 71-93.

67. Darnall, N., Jolley, G. J., & Horvath, A. (2008). Environmental management system and green supply chain management: complements for sustainability. *Business Strategy and the Environment*, 17(1), 30-45.

68. Dasgupta, D. & Sharma, A. (2009). Customer loyalty and approach of service providers: An empirical study of mobile airtime service industry in India. *Services Marketing Quarterly*, 30(4), 342-364.

69. Dasgupta, D. (2007). Senior citizens as shoppers: An exploratory study into the psychographics. *Published in Proceedings of Academy for Global Business Advancement World Congress held in Penang, Malaysia* on May 21-25, 2007 organised by Texas Univ, A&M, USA and Penang Univ, Malaysia.

70. Dasgupta, D. (2011). *Tourism Marketing*, Dorling Kindersley (India) Pvt. Ltd., Licensee of Pearson South Asia, New Delhi.

71. Daugherty, P. J. (2011). Review of logistics and supply chain relationship literature and suggested research agenda. *International Journal of Physical Distribution and Logistics Management*, 41(1), 16-31.

72. Dereli, T., Baykasoglu, A., & Daş, G. S. (2007). Fuzzy quality-team formation for value added auditing: A case study. *Journal of Engineering and Technology Management*, *24*(4), 366-394.

73. Diabata, A. & Govindan, K. (2011). An analysis of the drivers affecting the implementation of green supply chain management. *Resources, Conservation and Recycling*, 55(6), 659-667.

74. Dixon, J. A. & Fallon, L. A. (1989). The concept of sustainability: origins, extensions, and usefulness for policy. *Society & Natural Resources*, *2*(1), 73-84.

75. Dowling, G. R. & Uncles, M. (1997). Do customer loyalty programs really work?. *Research Brief*, 1.

76. Dries, L., Gorton, M., Urutyan, V., & White, J. (2014). Supply chain relationships, supplier support programmes and stimulating investment: evidence from the Armenian dairy sector. *Supply Chain Management: An International Journal*, 19(1), 8-8.

77. Duperrin, J. C. & Godet, M. (1973). Methode de hierarchisation des elements d'un systeme. *Rapport Economique du CEA*, Paris, 45-51.

78. Dwyer, F. R., Schurr, P. H., & Oh, S. (1987). Developing buyer-seller relationships. *The Journal of Marketing*, 11-27.

79. Elkington, J. (1994). Towards the Sustainable Corporation: Win-Win-Win Business Strategies for Sustainable Development. *California Management Review*, 36(winter), 90-100.

80. Ellis, N. & Higgins, M. (2006). Recatechizing codes of practice in supply chain relationships: discourse, identity and otherness. *Journal of Strategic Management*, 14(4), 387-410.

81. Eltayeb, T. K., Zailani, S., & Ramayah, T. (2011). Green supply chain initiatives among certified companies in Malaysia and environmental sustainability: Investigating the outcomes. *Resources, Conservation and Recycling*, 55(5), 495-506.

82. Faisal, M. N. (2010). Sustainable supply chains: a study of interaction among the enablers. *Business Process Management Journal*, 16(3), 508-529.

83. Falk, R. and Miller, N. (1992), *A primer for soft modeling*, The University of Akron, Akron, OH.

84. Farvar, M. T. & Milton, J. P. (1972). *Careless technology: ecology and international development. Conference held at Warrenton, Virginia, December 8--11, 1968* (No. CONF-681233). *Natural History Press*, Garden City, NY.

85. Filho, W. (2000). Dealing with misconceptions on the concept of sustainability. *International Journal of Sustainability in Higher Education*, *1*(1), 9-19.

86. Fink A. (1998). Conducting research literature reviews: from paper to the internet. Thousand Oaks: *Sage*.

87. Florida, R. (1996). Lean and Green - The move to environmentally conscious manufacturing. *California Management Review*, 39(1), 80-105.

88. Foerstl, K., Azadegan, A., Leppelt, T., & Hartmann, E. (2015). Drivers of Supplier Sustainability: Moving Beyond Compliance to Commitment. *Journal of Supply Chain Management*, *51*(1), 67-92.

89. Ford, D. (1980). The development of buyer-seller relationships in industrial markets. *European Journal of Marketing*, 14(5/6), 339-353.

90. Fornell, C. & Bookstein, F. L. (1982). Two structural equation models: LISREL and PLS applied to consumer exit-voice theory. *Journal of Marketing Research*, 440-452.

91. Fornell, C. & Cha, J. (1994). Partial least squares. *Advanced Methods of Marketing Research*, *407*, 52-78.

92. Fornell, C. & Larcker, D. F. (1981). Stuctural equation models with unobservable variables and measurement error: algebra and statistics, *Journal of Marketing Research*, 18(3), 382-388.

93. Fornell, C. Lorange, P., & Roos, J. (1990). The cooperative venture formation process: a latent variable structural modelling approach, *Management Science*, 36(1), 1246-1255.

94. Fortes, J. (2009). Green Supply Chain Management: A Literature Review. *Otago Management Graduate Review*, 7, 51-62.

95. Frazier, G. L. (1983). Interorganizational exchange behavior in marketing channels: a broadened perspective. *Journal of Marketing*, 47(Fall), 68-78.

96. Ganesan, S. & Hess, R. (1997). Dimensions and levels of trust: implications for commitment to a relationship. *Marketing Letters*, 8(4), 439-448.

97. Gao, Z. & Tang, L. (2003). A multi-objective model for purchasing of bulk raw materials of a large-scale integrated steel plant. *International Journal of Production Economics*, 83(3), 325–334.

98. Garg, R., Rahman, Z., Qureshi, M. N., & Kumar, I. (2012). Identifying and ranking critical success factors of customer experience in banks: an analytic hierarchy process (AHP) approach. *Journal of Modelling in Management*, 7(2), 201-220

99. Garside, J. (2013). Child labour uncovered in Apple's supply chain. *The Guardian. http://www.theguardian.com/technology/2013/jan/25/apple-child-labour-supply*, accessed on 7th march 2013.

100. Gill, J. & Johnson, P. (2002). *Research methods for managers*. Sage.

101. Gimenez, C. & Tachizawa, E. M. (2012). Extending sustainability to suppliers: a systematic literature review. *Supply Chain Management: An International Journal*, 17(5), 531-543.

102. Goenka, P. (2013). Time to shift the gears, Business Today, http://m.businesstoday.in/story/pawan-goenka-india-auto-sector-lowdown/1/195288.html. Accessed on 3rd November, 2013.

103. Gold, S., Seuring, S., & Beske, P. (2010). Sustainable supply chain management and inter-organizational resources: a literature review. *Corporate Social Responsibility and Environmental Management*, *17*(4), 230-245.

104. Golicic, S. L., Foggin, J. H., & Mentzer, J. T. (2003). Relationship magnitude and its role in interorganizational relationship structure. *Journal of Business Logistics*, 24(1), 57-75.

105. González-Benito, J. & González-Benito, Ó. (2006). The role of stakeholder pressure and managerial values in the implementation of environmental logistics practices. *International Journal of Production Research*, 44(7), 1353-1373.

106. Gopalakrishnan, K., Yusuf, Y. Y., Musa, A., Abubakar, T., & Ambursa, H. M. (2012). Sustainable supply chain management: A case study of British Aerospace (BAe) Systems. *International Journal of Production Economics*, *140*(1), 193-203.

107. Gorane, S. J. & Kant, R. (2013). Modelling the SCM enablers: an integrated ISM-fuzzy MICMAC approach. *Asia Pacific Journal of Marketing and Logistics*, 25(2), 263 – 286.

108. Govindan, K., Pokharel, S., & Sasi Kumar, P. (2009). A hybrid approach using ISM and fuzzy TOPSIS for the selection of reverse logistics provider. *Resources, Conservation and Recycling*, 54(1), 28-36.

109. Goyal, P., Rahman, Z., & Kazmi, A. A. (2013). Corporate sustainability performance and firm performance research: Literature review and future research agenda. *Management Decision*, 51(2), 361-379.

110. Green, K., Morton, B., & New, S. (1998). Green purchasing and supply policies: do they improve companies' environmental performance?. *Supply Chain Management*, 3(2), 89-95.

111. GRI, G. R. I. (2002). *Sustainability reporting guidelines*. Retrieved on June, 30, 2008.

112. Gronroos, C. (1990). Relationship approach to marketing in service contexts: The marketing and organizational behavior interface. *Journal of Business Research*, *20*(1), 3-11.

113. Grönroos, C. (1997). Value-driven relational marketing: from products to resources and competencies. *Journal of marketing management*, *13*(5), 407-419.

114. Güngör, Z., Serhadlıoğlu, G., & Kesen, S. E. (2009). A fuzzy AHP approach to personnel selection problem. *Applied Soft Computing*, *9*(2), 641-646.

115. Hadjikhani, A. & LaPlaca, P. (2013). Development of B2B marketing theory. *Industrial Marketing Management*, 41(3), 294-305.

116. Hagedoorn, J. (2002). Inter-firm R&D partnerships: an overview of major trends and patterns since 1960. *Research Policy*, *31*(4), 477-492.

117. Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W.C. (1998), Multivariate data analysis, *Pearson-Prentice Hall 5th Edition*, New Jersey: Prentice Hall.

118. Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R.L. (2006). Multivariate data analysis. *Pearson-Prentice Hall*, Upper Saddle River, NJ.

119. Hair, J. F., Ralph, E. A., & Ronald, L. T. (1987), Multivariate data analysis with readings, *2nd ed., Macmillan*, New York, NY.

120. Hall, J. (2000). Environmental supply chain dynamics. *Journal of Cleaner Production*, 8(6), 455-471.

121. Hamprecht, J., Corsten, D., Noll, M., & Meier, E. (2005). Controlling the sustainability of food supply chain. *Supply Chain Management: An International Journal*, 10(1), 7-10.

122. Handfield, R. B., Scroufe, R., & Walton, S. (2005). Integrating environmental management and supply chain strategies. *Business Strategies and the Environment*, 14(1), 1-9.

123. Hansen, J. M. (2009). The evolution of buyer-supplier relationships: an historical industry approach. *Journal of Business & Industrial Marketing*, 24(3/4), 227-236.

124. Haq, A. N. (1989). Modeling and analysis of production-inventory-distribution systems considering recycling at production stages. *International Conference on large scale systems in developing countries*, Nigeria, 26-29, July, 1989.

125. Haq, A. N. (2002). Design optimization of tolerances for gear trains using genetic algorithm (GA). *International Conference on Operations Research for Development*, 27-30 December, 2002, Chennai.

126. Haq, A. N., Vrat, P., & Kanda, A. (1991). An integrated production-inventory-distribution model for manufacture of urea: a case. *International Journal of production economics*, 25(1), 39-49.

127. Hartmann, J. & Germain, R. (2015). Understanding the Relationships of Integration Capabilities, Ecological Product Design, and Manufacturing Performance. *Journal of Cleaner Production* 92, 196-205.

128. Holland, L. (2003). Can the principle of the ecological footprint be applied to measure the environmental sustainability of business?. *Corporate Social Responsibility and Environmental Management*, *10*(4), 224-232.

129. Holt, D. & Ghobadian, A. (2009). An empirical study of green supply chain management practices amongst UK manufacturers. *Journal of Manufacturing Technology Management*, 20(7), 933-956.

130. Hong, P., Kwon, H., & Roh, J. J. (2009). Implementation of strategic green orientation in supply chain: An empirical study of manufacturing firms. *European Journal of Innovation Management*, 12(4), 512-532

131. Hsu, C. W. & Hu, A. H. (2009). Applying hazardous substance management to supplier selection using analytic network process. *Journal of Cleaner Production*, 17(2), 255-264.

132. Hsu, C. W., Kuo, T. C., Chen, S. H., & Hu, A. H. (2013). Using DEMATEL to develop a carbon management model of supplier selection in green supply chain management. *Journal of Cleaner Production*, 56, 164-172.

133. Huang, C. C., Chu, P. Y., & Chiang, Y. H. (2008). A fuzzy AHP application in government-sponsored R&D project selection. *Omega, 36*(6), 1038-1052.

134. Huang, J. H., Huang, C. H., & Shen, T. Y. (2002). Using Conjoint Analysis to Measure the Employed-learners' Preferences of Virtual MBA Programs. *Proceedings of The First Academic Conference on Service Marketing and Management, College of Business Administration, National Chia Yi University*.

135. Hulland, J. (1999). Use of partial least square (PLS) in strategic management research: a review of four recent studies. *Strategic Management Journal,* 20(2), 195-204.

136. Hutchins, M. J. & Sutherland, J. W. (2008). An exploration of measures of social sustainability and their application to supply chain decisions. *Journal of Cleaner Production*, 16(15), 1688-1698.

137. InvestIndia (2013) http://www.investindia.gov.in/?q=automobile-sector. Accessed on 3rd November 2013.

138. Jharkharia, S. & Shankar, R. (2005). IT-enablement of supply chains: understanding the barriers. *Journal of Enterprise Information Management*, 18(1), 11−27.

139. Kähkönen, A. K., Lintukangas, K., & Hallikas, J. (2015). Buyer's dependence in value creating supplier relationships. *Supply Chain Management: An International Journal*, 20(2), 151 – 162.

140. Kahraman, C., Cebeci, U., & Ulukan, Z. (2003). Multi-criteria supplier selection using fuzzy AHP. *Logistics Information Management*, 16(6), 382 – 394.

141. Kanda, A. & Deshmukh, S. G. (2008). Supply chain coordination: perspectives, empirical studies and research directions. *International Journal of Production Economics*, *115*(2), 316-335.

142. Keatinga, B., Quazib, A., Krizc, A., & Coltmana, T. (2008). In Pursuit of a Sustainable Supply Chain: insights from Westpac Banking Corporation. *Supply Chain Management: An International Journal*, 13(3), 175-179.

143. Kidd, C. V. (1992). The evolution of sustainability. *Journal of Agricultural and Environmental Ethics, 5*(1), 1-26.

144. Klassen, R. & Vachon, S. (2003). Collaboration and evaluation in the supply chain: the impact on plant-level environmental investment. *Production and Operations Management*, 12(3), 336-352.

145. Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd Edition ed.). The Guilford Press, New York.

146. Kogg, B. (2003). Greening the cotton textile supply chain: a case study of the transition towards organic production without a powerful focal company. *Greener Management International*, 43, 53-64.

147. Koplin, J., Seuring, S., & Mesterharm, M. (2007). Incorporating sustainability into supply management in the automotive industry-the case of the volkswagen AG. *Journal of Cleaner Production*, 15(11–12), 1053-1062.

148. Kordestani, A., Amini, M., & Salehi-Sangari, E. (2015). Environmentally and Socially Responsible Buyer Supplier Relationship Management. In *Ideas in Marketing: Finding the New and Polishing the Old* (pp. 445-446).

149. Kortelainen, K. (2008). Global supply chains and social requirements: case studies of labour condition auditing in the People's Republic of China. *Business Strategy and the Environment*, 17(7), 431-443.

150. Kotler, P., Keller, K., Koshy, A., & Jha, M. (2013). *Marketing management: A south Asian perspective*. Pearson Education India.

151. Krajnc, D. & Glavič, P. (2005). How to compare companies on relevant dimensions of sustainability. *Ecological Economics*, *55*(4), 551-563.

152. Krause, R. D. and Scannel, T. V. (2002), "Supplier development practices: product and service based industry comparisons", *The Journal of Supply Chain Management*, Vol. 38 No.2, pp. 13-21.

153. Ku, C. Y., Chang, C. T., & Ho, H. P. (2010). Global supplier selection using fuzzy analytic hierarchy process and fuzzy goal programming. *Quality and Quantity*, 44(4), 623-640.

154. Kudla, N. L. & Klaas-Wissing, T. (2012). Sustainability in shipper-logistics service provider relationships: A tentative taxonomy based on agency theory and stimulus-response analysis. *Journal of Purchasing and Supply Management*, 18(4), 218-231.

155. Kuhtz, S. (2007). Adoption of sustainable development schemes and behaviors in Italy Barriers and solutions – what can educator can do?. *International Journal of Sustainability in Higher Education*, 8(2), 155-169.

156. Kumar, D. & Rahman, Z. (2013). Modelling relationship marketing strategies for sustainability adoption. *International Journal of Intercultural Information Management*, *3*(4), 277-291.

157. Kumar, M., Vrat, P., & Shankar, R. (2004). A fuzzy goal programming approach for vendor selection problem in a supply chain. *Computers and Industrial Engineering*, 46(1), 69-85.

158. Kumar, M., Vrat, P., & Shankar, R. (2006). A fuzzy programming approach for vendor selection problem in a supply chain. *International Journal of Production Economics*, 101(2), 273-285.

159. Kumar, N. (1996). The power of trust in manufacturer-retailer relationships. *Harvard Business Review,* November-December, 92–106.

160. Kumar, P., Shankar, R., & Yadav, S. S. (2008). An integrated approach of analytic hierarchy process and Fuzzy linear programming for supplier selection. *International Journal of Operational Research*, 3(6), 614-631.

161. Kuo, R. J., Wang, Y. C., & Tien, F. C. (2010). Integration of artificial neural network and MADA methods for green supplier selection. *Journal of Cleaner Production*, 18(12), 1161-1170.

162. Kureshi, N., Qureshi, F., & Sajid, A. (2010). Current health of quality management practices in service sector SME- a case study of Pakistan. *The TQM Journal*, 22(3), 317-329.

163. Kushwaha, G. S. (2011). Sustainable development through strategic green supply chain management. *International Journal of Engineering and Management*, 1(1), 7-11.

164. Kwong, C. K. & Bai, H. (2003). Determining the importance weights for the customer requirements in QFD using a fuzzy AHP with an extent analysis approach. *Iie Transactions*, *35*(7), 619-626.

165. Lambert, D. M. & Cooper, M. C. (2000). Issues in supply chain management, *Industrial Marketing Management*, 29(1), 65-83.

166. Lambert, D. M. (2008). Supply chain management: process, partnership, performance. *(3rd ed.). Sarasota FL: Supply Chain Management Institute*, (chapter 7).

167. Lee, A. H. I. (2009). A fuzzy AHP evaluation model for buyer–supplier relationships with the consideration of benefits, opportunities, costs, and risks. *International Journal of Production Research*, 47(15), 4255-4280.

168. Lee, A. H. I. (2009). A fuzzy supplier selection model with the consideration of benefits, opportunities, costs and risks, *Expert Systems with Applications*, 36(2), pp. 2879-2893.

169. Lee, A. H. I., Kang, H. Y., & Wang, W. P. (2005). Analysis of priority mix planning for semiconductor fabrication under uncertainty. *International Journal of Advanced Manufacturing Technology*, 28(3–4), 351–361.

170. Lee, H. I., Kang, H. Y., Hsu, C. F., & Hung, H. C. (2009a). A green supplier selection model for high-tech industry. *Expert Systems With Applications*, 36(4), 7917-7927

171. Lee, H. I., Kang, H. Y., Hsu, C. F., & Hung, H. C. (2009b). Fuzzy multiple goal programming applied to TFT-LCD supplier selection by downstream manufacturers. *Expert Systems with Applications*, 36(3), 6318-6325.

172. Lee, S. (2008). Drivers for the participation of small and medium sized suppliers in green supply chain initiatives. *Supply Chain Management: An International Journal*, 13(3), 185-198.

173. Lee, S. Y. & Klassen, R. D. (2008). Drivers and enablers that foster environmental management capabilities in small and medium-sized suppliers in supply chains. *Production and Operations Management*, 17(6), 573-586.

174. Lee, T. R., Chen, C. W., & Dadura, A. (2011). Determining the Factors of Partner Selection A case of the 'Bridging the Digital Divide of SMEs' Project, *International Journal of Business Information System*, 7(3), 286-308.

175. Lee, T. R., Le, T. P. N., Genovese, A., & Koh, L. S. C. (2012). Using FAHP to determine the criteria for partner's selection within a green supply chain: the case of hand tool industry in Taiwan, *Journal of Manufacturing Technology Management*, 23(1-2), 25-55

176. Lee, T. R., Svensson, G., & Mysen, T. (2010). RELQUAL in Taiwanese business relationships. *International Journal of Business Excellence*, *3*(4), 433-451.

177. Lee, T. R., Tuan, T. Y., & Liu, M. C. (2008). The application of fuzzy analytic hierarchy process for supply chain decision making: a case study of original brand manufacturing of the sewing machine industry in Taiwan. *International Journal of Management and Decision Making*, *9*(2), 154-162.

178. Leek, S., Turnbull, P. W., & Naudé, P. (2002). Managing business-to-business relationships: An emerging model. *Journal of Customer Behaviour*, 1(3), 357-375.

179. Lele, U. (1989). Sources of growth in East African agriculture. *The World Bank Economic Review*, *3*(1), 119-144.

180. Li, L. Y. (2011). Marketing of competence-based solutions to buyers in exploratory relationships: Perspective of OEM suppliers. *Industrial Marketing Management*, 40(7), 1206-1213.

181. Lin, C. Y. (2007). Adoption of green supply practices in Taiwan's logistics industry. *Journal of International Management Studies,* 2(2), 91-98.

182. Lin, J. C. & Hsieh, P. (2011). Assessing the self-service technology encounters: development and validation of SSTQUAL scale. *Journal of Retailing*, 85(2), 194-206.

183. Linton, J. D., Klassen, R., & Jayaraman, V. (2007). Sustainable supply chain: an introduction. *International Journal of Operations Management*, 25(6), 1075-1082.

184. Lu, Y. Y., Wu, C. H., & Kuo, T. C. (2007). Environmental principles applicable to green supplier evaluation by using multi-objective decision analysis. *International Journal of Production Research*, 45(18-19), 4317-4331.

185. Lumley, S. & Armstrong, P. (2004). Some of the nineteenth century origins of the sustainability concept. *Environment, Development and Sustainability*, *6*(3), 367-378.

186. Luthra, S., Kumar, V., Kumar, S., & Haleem, A. (2011). Barriers to implement green supply chain management in automobile industry using interpretive structural modeling technique-An Indian perspective. *Journal of Industrial Engineering and Management*, 4(2), 231-257.

187. Mahdavi, I., Mohebbi, S., Zandakbari, M., Cho, N., & Mahdavi-Amiri, N. (2009). Agent-based web service for the design of a dynamic coordination mechanism in supply networks. *Journal of Intelligent Manufacturing*, 20(6), 727-749.

188. Mahdavi, I., Shirazi, B., Cho, N., Sahebjamnia, N., & Ghobadi, S. (2008). Modeling an e-based real-time quality control information system in distributed manufacturing shops. *Computers in Industry*, 59(8), 759-766.

189. Mahler, D. (2007). The sustainable supply chain. *Supply Chain Management Review*, November, pp. 59-60.

190. Malhotra, N. K. & Dash, S. (2009). *Marketing Research an applied orientation*. Pearson Education, New Delhi.

191. Málovics, G., Csigéné, N. N., & Kraus, S. (2008). The role of corporate social responsibility in strong sustainability. *The Journal of Socio-Economics, 37*(3), 907-918.

192. Mandal, A. & Deshmukh, S. G. (1994). Vendor selection using interpretive structural modeling (ISM). *International Journal of Operations and Production Management*, 14(6), 52−59.

193. Markley, M. J. & Davis, L. (2007). Exploring future competitive advantage through sustainable supply chains. *International Journal of Physical Distribution & Logistics Management*, 37(9), 763-774.

194. Marshall, D., McCarthy, L., Heavey, C., & McGrath, P. (2014). Environmental and social supply chain management sustainability practices: construct development and measurement. *Production Planning & Control*, (ahead-of-print), 1-18.

195. Matos, S. & Hall, J. (2007). Integrating sustainable development in the supply chain: the case of life cycle assessment in oil and gas and agriculture biotechnology. *Journal of Operation Management*, 25(6), 1083-1102.

196. Meadows, D. H., Meadows, D. L., & Randers, J. (1992). *Beyond the limits: global collapse or a sustainable future*. Earthscan Publications Ltd.

197. Mebratu, D. (1998). Sustainability and sustainable development: historical and conceptual review. *Environmental Impact Assessment Review*, 18(6), 493-520.

198. Medlin, C. J. (2012). Peter Drucker's ontology: understanding business relationships and networks. *Journal of Business & Industrial Marketing*, *27*(7), 513-520.

199. Meehan, J. & Wright, G. H. (2012). The origins of power in buyer–seller relationships. *Industrial Marketing Management*, 41, 669-679.

200. Michael, R. (1987). Sustainable Development. Exploring the contradictions. *London: Methuen*.

201. Michelsen, O. (2007). Investigation of relationships in a supply chain in order to improve environmental performance. *Clean Technology Environment Policy*, 9(2), 115-123.

202. Miemczyk, J., Johnsen, T. E., & Macquet, M. (2012). Sustainable purchasing and supply management: a structured literature review of definitions and measures at the dyad, chain,

and network levels. *Supply Chain Management: An International Journal*, 17(5), pp. 478-496.

203. Min, S., Roath, A. S., Daugherty, P. J., Genchev, S. E., Chen, H., Arndt, A. D., & Richey, R. G. (2005). Supply chain collaboration: what's happening?. *International Journal of Logistics Management*, *16*(2), 237-256.
204. Mishra, S. & Suar, D. (2010). Does corporate social responsibility influence firm performance of Indian companies?. *Journal of Business Ethics*, 95(4), 571–601.
205. Mitlin, D. (1992). Sustainable development: A guide to the literature. *Environment and Urbanization*, *4*(1), 111-124.
206. Moeller, S., Fassnacht, M., & Klose, S. (2006). A framework for supplier relationship management (SRM). *Journal of Business-to-Business Marketing*, 13(4), 69-94.
207. Monczka, R. M., Petersen, K. J., Handfield, R. B., & Ragatz, G. L. (1998). Success Factors in Strategic Supplier Alliances: The Buying Company Perspective. *Decision Sciences*, *29*(3), 553-577.
208. Morgan, R. M. & Hunt, S. D. (1994). The commitment-trust theory of relationship marketing. *The Journal of Marketing*, 20-38.
209. Muller, M., Dos Santos, V. G., & Seuring, S. (2009). The contribution of environmental and social standards towards ensuring legitimacy in supply chain governance. *Journal of Business Ethics*, 89(4), 509-523.
210. Nakano, K. & Hirao, M. (2011). Collaborative activity with business partners for improvement of product environmental performance using LCA. *Journal of Cleaner Production*, 19(11), 1189–1197.
211. Ni, D, Li, K. W., & Tang, X. (2010). Social responsibility allocation in two-echelon supply chains: Insights from wholesale price contracts. *European Journal of Operational Research*, 207(3), 1269-1279.
212. Norton, A. (2005). *Leo Strauss and the politics of American empire*. Yale University Press.
213. Nunnally, J. C. & Bernstein, I. H. (1994), *Psychometric theory*, 3rd ed., McGraw-Hill, New York.
214. Nunnally, J. C. (1978), *Psychometric Theory*, McGraw-Hill, New York, NY.

215. Oelze, N., Hoejmose, S. U., Habisch, A., & Millington, A. (2014). Sustainable Development in Supply Chain Management: The Role of Organizational Learning for Policy Implementation. *Business Strategy and the Environment*. DOI: 10.1002/bse.1869.

216. Olorunniwo, F. O. & Li, X. (2010). Information sharing and collaboration practices in reverse logistics. *Supply Chain Management: An International Journal*, 15(6), 454-462.

217. Pandey, S. K. & Wali, O. P. (2010). Management lessons from Indian epics in context to theory Z. *Journal of Human Values*, 16(1), 57-70.

218. Pandey, S. K. & Wali, O. P. (2011). Retailer's behavior towards salience of mature product brands–an empirical study on a major cola brand in a developing economy. *IIMS Journal of Management Science*, 2(1), 46-53.

219. Parashar S. & Mathur, S. (2013). Clean Energy Generation from Biomass – A Case Study of Chambal Power Limited, Rajasthan. *Conference proceedings of 2nd National Conference on 'Recent advances in Bio-Energy Research'* published by Sardar Swaran Singh National Institute of Renewable Energy, Kapurthala, Pages 62-78. (ISBN 978-81-927097-1-0).

220. Parashar, S. P. & Venkataramanaiah, S. (2008). Operationalisation of an auto cluster project: Indian experience. *International Journal of Indian Culture and Business Management*, 1(4), 475-485.

221. Parker, S. K., Griffin, M. A., Sprigg, C. A., & Wall, T. D. (2002). Effect of temporary contracts on perceived work characteristics and job strain: A longitudinal study. *Personnel Psychology*, *55*(3), 689-719.

222. Pavlou, P. A. & Fygenson, M. (2006). Understanding and predicting electronic commerce adoption: an extension of the theory of planned behaviour. *MIS Quartely*, 30(1), 115-143.

223. Pepper, D. 1996. *Modern environmentalism: an introduction*, London: Routledge

224. Peter, J. P. (1981). Construct validity: a review of basic issues and marketing practices. *Journal of Marketing Research,* 18(2), 133-145.

225. Peters, N. J., Hofdtetter, J. S., & Hoffmann, V. H. (2011). Institutional entrepreneurship capabilities for inter-organizational sustainable supply chain strategies. *International Journal of Logistics Management*, 22(1), 52-86.

226. Petrick, J. F., & Backman, S. J. (2002). An examination of the construct of perceived value for the prediction of golf travelers' intentions to revisit. *Journal of Travel Research*, *41*(1), 38-45.

227. Podsakoff, P. M., MacKenzie, S. B., Lee, J., & Podsakoff, N. P. (2003). Common method variance in behavioral research: a critical review of the literature and recommended remedies. *Journal of Applied Psychology,* 88(5), 879-903.

228. Prashar, S. & Jasial, S. S. (2008). Assuring input quality under TQM practices: a comparative analysis of four major Indian passenger car companies. *Asia Pacific Business Review,* 4(3), pp. 3-13.

229. Preuss, L. (2005). Rhetoric and reality of corporate greening-A view from the supply chain management function. *Business Strategy and Environment*, 14(2), 123-139.

230. Pullman, M. E., Maloni, M. J., & Dillard, J. (2010). Sustainability Practices in Food Supply Chains: How is Wine Different?. *Journal of Wine Research*, 21(1), 35-56.

231. Quarrie, J. (1992). Earth Summit'92. *The United Nations Conference on Environment and Development, Rio de Janeiro*.

232. Qureshi, M. N., Kumar, D., & Kumar, P. (2008). An integrated model to identify and classify the key criteria and their role in the assessment of 3PL services providers. *Asia Pacific Journal of Marketing and Logistics*, 20(2), 227-249.

233. Rahman, Z. & Siddiqui, J. (2006). Exploring total quality management for information systems in Indian firms: application and benefits. *Business Process Management Journal*, 12(5), 622-631.

234. Rahman, Z. (2004). Use of Internet in supply chain management: a study of Indian companies. *Industrial Management and Data Systems*, 104(1), 31-41.

235. Rao, P. & Holt, D. (2005). Do green supply chain lead to competitiveness and economic performance?. *International Journal of Operation & Production Management*, 25(9), 898-916.

236. Rao, P. (2002). Greening the supply chain a new initiative in south East Asia. *International Journal of Operations & Production Management*, 22(6), 632-655.

237. Ravi, V. & Shankar, R. (2005). Analysis of interactions among the barriers of reverse logistics. *Technological Forecasting and Social Changes*, 72, 1011−1029.

238. Reinartz, W. & Kumar, V. (2002). The mismanagement of customer loyalty. *Harvard Business Review*, 80(7), 86-95.

239. Rezaei, J. (2015). A two-way approach to supply chain partner selection. *International Journal of Production Research*. DOI: 10.1080/00207543.2014.1003663

240. Rinehart, L. M., Eckert, J. A., Handfield, R. B., Page, T. J., & Atkin, T. (2004). An assessment of supplier-customer relationships. *Journal of Business Logistics*, 25(1), 25-62.

241. Rinehart, L. M., Lee, T. R., & Page Jr, T. J. (2008). A comparative assessment of domestic and international supplier-customer relationship perceptions. *International Journal of Physical Distribution & Logistics Management*, *38*(8), 616-636.

242. Rocha, M., Searcy, C., & Karapetrovic, S. (2007). Integrating Sustainable Development into Existing Management Systems. *Total Quality Management & Business Excellence*, 9(2), 33-41.

243. Ronchi, S., Luzzini, D., & Spina, G., (2007). Supply Chain Coordination: The Problem of Risk and Benefit Sharing. *Supply Chain Forum: An International Journal*, 8(2), 54-66.

244. Routroy, S. (2009). Antecedents and drivers for green supply chain management implementation in manufacturing environment. *ICFAI Journal of Supply Chain Management*, 6(1), 20-35.

245. Rudawska, E. & Renko, S. (2012). Sustainability as the direction for the long-term success in banking: Poland vs. Croatia. *Folia Oeconomica Stetinensia*, 11(1), 97-117.

246. Rudawska, E. (2010). B2B relationships in the bank services market in Poland. *International Journal of Management Cases*, 12(2), 296-305.

247. Rudawska, E. (2011). The influence of customer relationships on the market value of a bank a methodological perspective. *Journal of Customer Behaviour*, 10(2), 181-199.

248. Saaty, R. W. (2003). Decision making in complex environment: the analytic hierarchy process (AHP) for decision making and the analytic network process (ANP) for decision making with dependence and feedback. *Pittsburgh, PA: Super Decisions*.

249. Sachdeva, A., Kumar, D., & Kumar, P. (2008). A methodology to determine maintenance criticality using AHP. *International Journal of Productivity and Quality Management*, *3*(4), 396-412.

250. Sagar, M., Khandelwal, R., Mittal, A., & Singh, D. (2011). Ethical positioning index (EPI): an innovative tool for differential brand positioning. *Corporate Communications: An International Journal,* 16(2), 124-138.

251. Sagar, M., Singh, D., & Agrawal, D. P. (2006). Framework of ethical brand positioning: A case study of anchor. *Journal of Management Research*, 6(2), 72-83.

252. Sahay, B. S. (2003). Supply chain collaboration: the key to value creation. *Work study*, *52*(2), 76-83.

253. Sakawa, M. (1993). Fuzzy Sets and Interactive Multi Objective Optimization. New York: Plenum Press.

254. Salam, M. A. (2008). An empirical investigation of the determinants of adoption of green procurement for successful green supply chain management. *IEEE Conference Publication of 4th IEEE International Conference IEEE Management of Innovation and Technology,* 1038-1043.

255. Salo, J. (2012). The role of mobile technology in a buyer-supplier relationship: a case study from the steel industry. *Journal of business & industrial marketing*, *27*(7), 554-563.

256. Sarkis, J. (1995). Supply chain management and environmentally conscious design and manufacturing. *International Journal of Environmentally Conscious Design and Manufacturing,* 4(2), 43-52.

257. Sarkis, J. (2001). Manufacturing's role in corporate environmental sustainability - concerns for the new millennium. *International Journal of Operations & Production Management,* 21(5), 666- 686.

258. Sarkis, J., Gonzalez-Torre, P., & Adenso-Diaz, B. (2010). Stakeholder pressure and the adoption of environmental practices: The mediating effect of training. *Journal of Operation Management*, 28(2), 163–176.

259. Sarstedt, M. (2008). A review of recent approaches for capturing heterogeneity in partial least squares path modelling. *Journal of Modelling in Management*, 3(2), 140 – 161.

260. Satty, T. L. (1990). How to make a decision: the analytic hierarchy process. *European Journal of Operational Research*, *48*(1), 9-26.

261. Saxena, J. P. & Vrat, P. (1990). Fuzzy interpretive structural modeling applied to energy conservation. *Socio-Economic Planning Science*, 3, 31-43.

262. Saxena, J. P., Sushil, S., & Vrat, P. (1992). Scenario building: a critical study of energy conservation in the Indian cement industry. *Technological Forecasting and Social Change*, 41, 121-46.

263. Seghezzo, L. (2009). The five dimensions of sustainability. *Environmental Politics*, *18*(4), 539-556.

264. Senge, P. & Prokesch, S. (2010). The sustainable supply chain. *Harvard Business Review*, 88(10), 70-72.

265. Sethuraman, R., Kerin, S. R., & Cron, W. L. (2005). A field study comparing online and offline data collection methods for identifying product attribute preferences using conjoint analysis. *Journal of Business Research,* 58(5), 602-610.

266. Seuring, S. & Muller, M. (2008a). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production.* 16(15), 1699-1710.

267. Seuring, S. & Muller, M. (2008b). Core issues in sustainable supply chain management-A Delphi study. *Business Strategy and Environment*, 17(8), 455-466.

268. Sharma, A., Iyer, G. R., Mehrotra, A., & Krishanan, R. (2010). Sustainability and business to business marketing: A framework and implications. *Industrial Marketing Management*, 39(2), 330-341.

269. Shaw, K., Shankar, R., Yadav, S. S., & Thakur, L. S. (2012). Supplier selection using fuzzy AHP and fuzzy multi-objective linear programming for developing low carbon supply chain. *Expert Systems with Applications.* 39, 8182-8192.

270. SIAM (2013). http://www.siamindia.com/Event/view-eventhead.aspx?id=286. Accessed on 3rd November 2013.

271. Simpson, D. F. & Power, D. J. (2005). Use the supply relationship to develop lean and green suppliers. *Supply Chain Management: An International Journal*, 10(1), 60-68.

272. Simpson, D., Power, D., & Samson, D. (2007). Greening the automotive supply chain: a relationship perspective. *International Journal of Operations & Production Management*, 27(1), 28-48.

273. Singh, M., Sachdeva, A., & Bhardwaj, A. (2014). An interpretive structural modelling approach for analysing barriers in total productive maintenance implementation. *International Journal of Industrial and Systems Engineering*, 16(4), 433-450.

274. Smerecnik, K. R. & Anderson, P. A. (2011). The diffusion of environmental sustainability innovations in North American hotels and ski resorts. *Journal of Sustainable Tourism,* 19(2), 171-196.

275. Smith, B. G. (2007). Developing sustainable food supply chains. *Philosophical Transactions of the Royal. Society B: Biological Sciences*, 363(1492), 849–861.

276. Sosik, J. J., Kahai, S. S., & Piovoso, M. J. (2009). Silve bullet or voodoo statistics? a primer for using the partial least square data analytic technique in group and organization research. *Group & Organization Management*, 34(1), 5-36.

277. Spence, L. J. & Rinaldi, L. (2014). Governmentality in accounting and accountability: A case study of embedding sustainability in a supply chain. *Accounting, Organizations and Society*, 39(6), 433-452.

278. Sridharan, R. & Simatupang, T. M. (2013). Power and trust in supply chain collaboration. *International Journal of Value Chain Management, 7*(1), 76-96.

279. Stiller, S. & Gold, S. (2014, March). Socially Sustainable Supply Chain Management Practices in the Indian Seed Sector: A Case Study. In *Supply Chain Forum: an International Journal* 15(1), 52-67.

280. Subulan, K., Taşan, A. S., & Baykasoglu, A. (2014). Designing Environmentally Conscious Tire Closed-Loop Supply Chain Network with Multiple Recovery Options via Interactive Fuzzy Goal Programming. *Applied Mathematical Modelling*. DOI:10.1016/j.apm.2014.11.004.

281. Svensson, G. (2007). Aspects of sustainable supply chain management (SSCM): conceptual framework and empirical example. *Supply Chain Management: An International Journal*, 12(4), 262-266.

282. Svensson, G. (2009). The transparency of SCM ethics: conceptual framework and empirical illustrations. *Supply Chain Management: An International Journal*, 14(4), 259-269.

283. Tabachnick, B. G. & Fidell, L. S. (2001). Using multivariate statistics. *4th ed., Allyn & Bacon*, New York.

284. Tachizawa, E. & Yew Wong, C. (2014). Towards a theory of multi-tier sustainable supply chains: a systematic literature review. *Supply Chain Management: An International Journal*, 19(5/6), 643-663.

285. Talib F., Rahman, Z., & Qureshi, M. N. (2011). Prioritising the practices of total quality management: an analytic hierarchy process analysis for the service industries. *Total Quality Management and Business Excellence*, 22(12), 1331-1351.

286. Tangpong, C., Michalisin, M. D., Traub, R. D., & Melcher, A. J. (2015). A review of buyer-supplier relationship typologies: progress, problems, and future directions. *Journal of Business & Industrial Marketing*, 30(2), 153-170.

287. Tejpal, G., Garg, R. K., & Sachdeva, A. (2013). Trust among supply chain partners: a review. *Measuring Business Excellence*, *17*(1), 51-71.

288. Tenenhaus, M., Vinzi, V. E., Chatelin, Y. M. & Lauro, C. (2005). PLS path modelling. *Computational Statistics and Data Analysis,* 48(1), 159-205.

289. Teuteberg, F. & Wittstruck, D. (2010). A systematic review of sustainable supply chain management research. what is there and what is missing?". *Proceedings of MKWI - Corporate Environmental and Sustainability Management conference held at Göttingen at the Georg-August-University*, 1001-1015.

290. Thakkar, J., Deshmukh, S. G., Gupta, A. D., & Shankar, R. (2006). Development of a balanced scorecard: an integrated approach of interpretive structural modeling (ISM) and analytic network process (ANP). *International Journal of Productivity and Performance Management*, 56(1), 25-59.

291. Tijmes, P. & Luijf, R. (1995). The sustainability of our common future: an inquiry into the foundations of an ideology. *Technology in Society*, *17*(3), 327-336.

292. Tiwari, R. N., Dharmahr, S., & Rao, J. R. (1987). Fuzzy goal programming-an additive model. F*uzzy Sets and Systems,* 24(1), 27–34.

293. Touboulic, A., & Walker, H. (2015). Theories in sustainable supply chain management: a structured literature review. *International Journal of Physical Distribution & Logistics Management*, *45*(1/2).

294. Touboulic, A., Chicksand, D. & Walker, H. (2014). Managing Imbalanced Supply Chain Relationships for Sustainability: A Power Perspective. *Decision Sciences*, *45*(4), 577-619.

295. Trzyna, T. C. (1995). *A sustainable world: defining and measuring sustainable development*. International Center for the Environment and Public Policy for the World Conservation Union (IUCN).

296. Tsang, J. H. Y. & Antony, J. (2001). Total quality management in UK service organisations: some key findings from a survey. *Managing Service Quality*, *11*(2), 132-141.

297. Tsoulfas, G. T. & Pappis, C. P. (2006). Environmental principles applicable to supply chain design and operation. *Journal of Cleaner Production*, 14(18), 1593–1602.

298. Turker, D. (2009). Measuring corporate responsibility: a scale development study. *Journal of Business Ethics*, 85(4), 411-427.

299. Vachon, S. & Klassen, R. D. (2006). Extending green practices across supply chain: Impact of upstream and downstream integration. *Journal of Operation and Production Management*, 26(7), 795-821

300. Vachon, S. & Klassen, R.D., (2008). Environmental management and manufacturing performance: the role of collaboration in supply chain. *International Journal of Production Economics*, 111(2), 299-315

301. Vachon, S. & Mao, Z. (2008). Linking supply chain strength to sustainable development: a country-level analysis. *Journal of Cleaner Production*, 16(15), 1552-1560.

302. Vachon, S. (2007). Green supply chain practices and the selection of environmental technologies. *International Journal of Production Research*, 45(18-19), 4357-4379.

303. Valentin, A. & Spangenberg, J. H. (2000). A guide to community sustainability indicators. *Environmental Impact Assessment Review*, *20*(3), 381-392.

304. Van Hoof, B. & Thiell, M. (2014). Collaboration capacity for sustainable supply chain management: small and medium-sized enterprises in Mexico. *Journal of Cleaner Production*, 67, 239-248.

305. Vasileiou, K. & Morris, J. (2006). The sustainability of the supply chain for fresh potatoes in Britain. *Supply Chain Management: An International Journal*, 11(4), 317-327.

306. Vassalo, D. & Smith, C. (2011). Optimizing the success of industrial energy efficiency improvement programs by driving culture change: lessons learned at dupont. http://www2.dupont.com/Sustainable_Solutions/en_US/assets/downloads/EE_Culture_Change_White_Paper.pdf, accessed on 21 January 2012.

307. Venkat, S. & Parashar, S. P. (2006). *Operationalisation of Pithampur Auto Cluster*. Working paper, IIM Indore.

308. Vermeulen, W. J. V. & Ras, P. (2006). The challenges of greening global product chains: meeting both ends", *Sustainable Development*, 14(4), 245-156.

309. Vermeulen, W. J. V. & Seuring, S. (2009). Sustainability through the market-the impacts of sustainable supply chain management: introduction. *Sustainable Development*, 17, 269-273.

310. Walker, H. Sisto, L. D., & Mcbain, D. (2008). Drivers and barriers to environmental supply chain management: lesson from the public and private sectors. *Journal of Purchasing and Supply Management,* 14(1), 69-85.

311. Walton, S. V., Handfield, R. B., & Melnyk, S. A. (1998). The green supply chain: integrating suppliers in to environmental management process. *International Journal of Purchasing and Material Management*, 34(2), 2-11.

312. Warfield, J. W. (1974). Developing interconnected matrices in structural modelling. *IEEE Transcript on Systems Men and Cybernetics*, 4(1), 51-81.

313. Watson, R. H. (1973). Interpretive structural modeling – a useful tool for technology assessment. *Technology Forecasting Social Change,* 11(2), 165-185.

314. Whetten, D. A. (1989). What constitutes theoretical contributions?. *Academy of Management Review,* Vol. 14 No. 4, pp. 490-495

315. Williams, L. J., Edwards, J. R., & Vandenberg, R. J. (2003). Recent advances in causal modeling methods for organizational and management research. *Journal of Management, 29*(6), 903-936.

316. Wilson, D. T. (1995). An integrated model of buyer-seller relationships. *Journal of the Academy of Marketing Science*, 23(4), 335-345.

317. Wold, H. (1985). *Partial Least Squares*. Kotz S. and Johnson N.L. (eds.), *Encyclopaedia of Statistical Sciences* Wiley, New York, 581-591.

318. Wong, H. L., Shen, T. Y., Yan, C. Y., & Tsai, M. C. (2009). The effects of time-limited pressure and perceived value on consumers' intention to purchase: A study of travel fairs. *WSEAS Transactions on Business and Economics*, 6(8), 446–455.

319. Wong, H. L., Wang, C. C., & Shen, T. Y. (2012). The effects of predictor variables and interval partition on fuzzy time series forecasting. *Applied Mechanics and Materials, 145*, 143-148.

320. Wu, Z. & Pagell, M. (2011). Balancing priorities-decision-making in Sustainable Supply chain Management. *Journal of Operations Management*, 29(6), 577-590.

321. Yin, R. (1994). *Case study research: design and methods*, 2nd ed., Beverly Hills, CA: York, Harper Collins.

322. Young, A. & Kielkiewicz-Young, A. (2001). Sustainable supply network management. *Corporate Environmental Strategy*, 8(3), 260-268.

323. Ytterhus, B. E. (1999). Environmental initiatives in the retailing sector: an analysis of supply chain pressure and partnership. *Eco-management and Auditing*, 6(4), 181-188.

324. Yu, C. S. (2002). A GP-AHP method for solving group decision-making fuzzy AHP problems. *Computers and Operations Research*, 29(14), 1969-2001

325. Zadeh, L. A. (1965). Fuzzy sets. *Information and Control*, 8, 338-353.

326. Zhen, L., Routray, J. K., Zoebisch, M. A., Chen, G., Xie, G., & Cheng, S. (2005). Three dimensions of sustainability of farming practices in the North China Plain: a case study from Ningjin County of Shandong Province, PR China. *Agriculture, Ecosystems & Environment*, *105*(3), 507-522.

327. Zhu, K. J., Jing, Y., & Chang, D. Y. (1999). A discussion on extent analysis method and applications of fuzzy AHP. *European Journal of Operational Research*, 116(2), 450-456.

328. Zhu, Q. H. & Sarkis, J. (2004). Relationship between operational practices and performance among early adopter of green supply chain management practices in Chinese manufacturing enterprises. *Journal of Operation Management*, 22(3), 265–289.

329. Zhu, Q. H. & Sarkis, J. (2007). The moderating effect of institutional pressure on emergent green supply chain practices. *International Journal of Production Research*, 45(18-19), 4333-4355.

330. Zhu, Q., Sarkis, J., & Lai, K. H. (2007a). Green supply chain management: pressure, practices, and performance within the Chinese automobile industry. *Journal of Cleaner Production*, 15(11-12), 1041–1052.

331. Zhu, Q., Sarkis, J., & Lai, K. H. (2007b). Initiatives and outcomes of green supply chain management implementation by Chinese manufacturers. *Journal of Environmental Management*, 85(1), 179–189.

332. Zhu, Q., Sarkis, J., & Lai, K. H. (2008). Confirmation of a measurement model for green supply chain management implementation. *International Journal of Production Economics,* 111(2), 261-273.

333. Zhu, Q., Sarkis, J., & Lai, K. H. (2008a). Green Supply chain management implications for “closing the loop". *Transportation Research*, 44(1), 1-18.

334. Zikmund, W. (2000), *Business research methods*, 6th ed., The Dryden Press, Fort Worth.

335. Zimmermann, H. J. (1978). Fuzzy programming and linear programming with several objective functions. *Fuzzy Sets and Systems*, 1(1), 45-55.

336. Zsidisin, G. A. & Hendrick, T. E. (1998). Purchasing’s involvement in environmental issues: a multi-country perspective. *Industrial Management & Data Systems*, 98(7), 313-320.

337. Zutshi, A. & Sohal, A. S. (2004). Adoption and maintenance of environmental management systems-Critical success factors. *Management of Environmental Quality: An International Journal*, 15(4), 399-419.

Publication from the Present Research

Publication Accepted in Refereed International Journals

- **Kumar, D.** and Rahman, Z. (forthcoming) Sustainability adoption through buyer supplier relationship across supply chain: A literature review and conceptual framework, *International Jouranl of Strategic Management Review*, (**Accepted - Elsevier**)
- **Kumar, D.** and Rahman, Z. (2013) Modelling relationship marketing relationship strategies, *International Journal of intercultural information management* Vol 3. No. 4 pp. 267-281.
- **Kumar, D**., Rahman, Z., and Goyal, P. (2012) Sustainability adoption through e-learning, *International Journal of the Computer, the Internet, and Management*. Vol. 19 No. SP2 pp. 1-4.
- **Kumar, D.,** Rahman, Z., and Kumar, I. (2011) Sustainable Consumption in India: Opportunities and Challenges. *International Journal of Management and Business Studies*, Vol. 2 Issue: 1.

Research papers: Submitted/under Review in International Journals

- **Kumar, D.,** Rahman, Z., and Qureshi, M.N. Analyzing enablers of sustainable supply chain (Under review) *Benchmarking: an International Journal* (Emerald)
- **Kumar, D.,** Rahman, Z., and Chan, F.T.S. Fuzzy AHP and Fuzzy Multi-objective linear programming model for order allocation in sustainable supply chain (Under review) *International Journal of Computer Integrated Manufacturing*. (Taylor & Francis)
- **Kumar, D.** and Rahman, Z. Relationship selection in sustainable supply chain (Under review) *Production, Planning & Control* (Taylor and Francis)
- **Kumar, D.** and Rahman, Z. Sustainability adoption in supply chain (Under review) *Journal of Cleaner Production* (Elsevier)

Award

- **Emerald IMA South Asian Management Research Fund Award** – 2013 for the project "Problems and prospects of compost marketing in Uttarakhand, India".

Conferences

- "Modelling the barriers of sustainable supply chain", 7th ICCB and GLOGIFT 14, Organized by Curtin University and Global Flexible System Management at Curtin University, Singapore on October 15-17, 2014.
- "Co-creation not everyone's cup of tea: An exploratory investigation", 6th IIMA conference on marketing in emerging markets, Organized by Indian Institute of Management Ahemedabad, India on 1/5/2015.
- "An empirical study of SSTs adoption in organized retail store", Internationlal Conference on Reseach and Sustainable Business 2014, Organized by Department of Management Studies, IIT Roorkee.
- "Modelling relationship marketing strategies for sustainable supply chain, ICOMB organized by Malviya National Institute of Technology, Jaipur on 18-19 May 2013.
- "Modelling market oriented sustainability strategies for competitive advantages", MARCON 2012, organized by Indian Institute of Management, Calcutta, on 28-30 December, 2012.
- "Sustainability adoption through relationship marketing across supply chain", Organized by Department of Management Studies, Indian Institute of Technology, Roorkee on 1-2 June, 2012.
- "Sustainability adoption through E learning", The Eight International Conference on E-learning, M learning and U learning, organized by Assumption University at Information Centre Bangkok Thailand on 23-24 February, 2012.
- "Green Marketing Mix: Rethinking Competitive Advantage During Climate Change", "The First International Congress of Interdisciplinary Research and Development" Organized by Assumption University at Impact Convention Centre Bangkok Thailand on June 1, 2011.
- "Marketing Responsibility to promote Sustainability in Supply Chain", "Conference on Excellence in Research and Education" Organized by Indian Institue of Management Indore on May 13-16, 2011.

Appendix 1 Fuzzy AHP response table

Appendix 1A: Stage 1 (Figure 5.1) (Final values can be checked in Table 5.5**)**

1. Comparison of Sustainability indicators for the selection of best form of relationship

	Ordering Cost			**Rejection on Quality**			**Late Delivery**			**Social welfare**			**Emission**			**Energy**			**Demand**			**Waste**		
Ordering Cost	1.00	1.00	1.00	1.51	1.82	2.94	0.48	0.66	0.93	1.59	2.08	3.17	1.59	2.08	2.83	1.62	1.91	3.05	1.59	2.08	3.17	1.35	1.82	2.62
Rejection on Quality	0.34	0.55	0.66	1.00	1.00	1.00	1.00	1.44	2.00	1.59	2.08	3.17	1.59	2.08	3.17	1.51	1.82	2.94	1.26	1.44	2.24	2.14	2.85	3.96
Late Delivery	1.07	1.52	2.08	0.50	0.69	1.00	1.00	1.00	1.00	1.41	1.73	2.52	1.51	2.18	2.94	1.91	2.62	3.70	1.59	2.08	3.17	1.51	2.04	3.14
Social welfare	0.31	0.48	0.63	0.31	0.48	0.63	0.40	0.58	0.71	1.00	1.00	1.00	1.00	1.12	2.14	0.46	0.56	0.87	0.92	1.07	1.73	0.41	0.45	0.78
Emission	0.35	0.48	0.63	0.31	0.48	0.63	0.34	0.46	0.66	0.47	0.89	1.00	1.00	1.00	1.00	1.26	1.44	2.52	1.41	1.73	2.83	1.00	1.00	1.41
Energy	0.33	0.52	0.62	0.34	0.55	0.66	0.27	0.38	0.52	1.15	1.78	2.15	0.40	0.69	0.79	1.00	1.00	1.00	1.26	1.44	2.52	1.12	1.20	1.59
Demand	0.31	0.48	0.63	0.45	0.69	0.79	0.31	0.48	0.63	0.58	0.93	1.09	0.35	0.58	0.71	0.40	0.69	0.79	1.00	1.00	1.00	0.89	0.89	1.78
Waste	0.38	0.55	0.74	0.25	0.35	0.47	0.32	0.49	0.66	1.29	2.24	2.42	0.71	1.00	1.00	0.63	0.83	0.89	0.56	1.12	1.12	1.00	1.00	1.00

Appendix 1B: Comparison of BOCR with respect to sustainability criteria

2.1 Comparison of BOCR with respect to Ordering Cost

Ordering Cost	B			O			C			R		
B	1.00	1.00	1.00	1.26	1.73	2.52	1.59	2.08	3.17	1.26	1.44	2.52
O	0.40	0.58	0.79	1.00	1.00	1.00	1.41	2.08	2.83	1.00	1.44	2.00
C	0.31	0.48	0.63	0.35	0.48	0.71	1.00	1.00	1.00	1.00	1.20	2.00
R	0.40	0.69	0.79	0.50	0.69	1.00	0.50	0.83	1.00	1.00	1.00	1.00

1.2 Comparison of BOCR with respect to Rejection on Quality

Rejection on quality	B			O			C			R		
B	1.00	1.00	1.00	1.26	1.44	2.52	1.35	1.51	2.62	1.26	1.44	2.52
O	0.40	0.69	0.79	1.00	1.00	1.00	1.00	1.00	1.41	0.89	1.00	1.41
C	0.38	0.66	0.74	0.71	1.00	1.00	1.00	1.00	1.00	1.26	1.73	2.52
R	0.40	0.69	0.79	0.71	1.00	1.12	0.40	0.58	0.79	1.00	1.00	1.00

1.3 Comparison of BOCR with respect to Late Delivery

Late Delivery	B			O			C			R		
B	1.00	1.00	1.00	1.26	1.44	2.52	1.12	1.20	2.24	1.41	1.73	2.83
O	0.40	0.69	0.79	1.00	1.00	1.00	1.12	1.44	2.00	1.00	1.20	2.00
C	0.45	0.83	0.89	0.50	0.69	0.89	1.00	1.00	1.00	0.89	1.00	1.78
R	0.35	0.58	0.71	0.50	0.83	1.00	0.56	1.00	1.12	1.00	1.00	1.00

1.4 Comparison of BOCR with respect to Social Welfare

Social Welfare	B			O			C			R		
B	1.00	1.00	1.00	1.51	1.82	2.94	1.26	1.44	2.52	1.59	2.08	3.17
O	0.34	0.55	0.66	1.00	1.00	1.00	1.12	1.20	1.59	1.00	1.00	1.41
C	0.40	0.69	0.79	0.63	0.83	0.89	1.00	1.00	1.00	1.00	1.20	2.00
R	0.31	0.48	0.63	0.71	1.00	1.00	0.50	0.83	1.00	1.00	1.00	1.00

1.5 Comparison of BOCR with respect to Emission

Emission	B			O			C			R		
B	1.00	1.00	1.00	2.14	3.15	4.15	1.12	1.20	2.24	1.41	2.08	2.83
O	0.24	0.32	0.47	1.00	1.00	1.00	0.89	1.20	1.59	1.12	1.20	2.24
C	0.45	0.83	0.89	0.63	0.83	1.12	1.00	1.00	1.00	1.12	1.44	2.24
R	0.35	0.48	0.71	0.45	0.83	0.89	0.45	0.69	0.89	1.00	1.00	1.00

1.6 Comparison of BOCR with respect to Energy

Energy	B			O			C			R		
B	1.00	1.00	1.00	1.59	2.08	3.17	1.26	1.44	2.52	1.26	1.73	2.52
O	0.31	0.48	0.63	1.00	1.00	1.00	1.00	1.20	1.59	1.26	1.44	2.52
C	0.40	0.69	0.79	0.63	0.83	1.00	1.00	1.00	1.00	2.14	3.15	4.15
R	0.40	0.58	0.79	0.40	0.69	0.79	0.24	0.32	0.47	1.00	1.00	1.00

1.7 Comparison of BOCR with respect to Demand

Demand	B			O			C			R		
B	1.00	1.00	1.00	1.12	1.20	2.24	1.26	1.44	2.52	1.26	1.73	2.52
O	0.45	0.83	0.89	1.00	1.00	1.00	1.00	1.20	1.78	1.12	1.44	2.24
C	0.40	0.69	0.79	0.56	0.83	1.00	1.00	1.00	1.00	0.79	1.00	1.59
R	0.40	0.58	0.79	0.45	0.69	0.89	0.63	1.00	1.26	1.00	1.00	1.00

1.8 Comparison of BOCR with respect to Waste

Waste	B			O			C			R		
B	1.00	1.00	1.00	1.41	1.73	2.83	1.51	1.82	2.94	1.41	1.73	2.83
O	0.35	0.58	0.71	1.00	1.00	1.00	1.12	1.20	1.59	1.00	1.00	1.41
C	0.34	0.55	0.66	0.63	0.83	0.89	1.00	1.00	1.00	1.35	1.82	2.62
R	0.35	0.58	0.71	0.71	1.00	1.00	0.38	0.55	0.74	1.00	1.00	1.00

Appendix 1C: Stage 2 (Figure 5.2)

3. Comparison of control criteria with respect to BOCR merits (Final values can be checked in Table 5.6**)**

3.1 Comparison of relationship benefits with respect to B

F-Financial Benefits, **O-**Operational Benefits, **S-**Sustainability Adoption

Benefits	**F**			**O**			**S**		
F	1.00	1.00	1.00	1.51	1.82	2.94	0.71	0.83	1.41
O	0.34	0.55	0.66	1.00	1.00	1.00	1.26	1.44	2.52
S	0.71	1.20	1.41	0.40	0.69	0.79	1.00	1.00	1.00

3.1.1 Comparison of financial benefits sub criteria with respect to financial benefit

RD-Reduce distribution cost, **CI-**Cost of information, **RI-**Reduce inventory cost

F	**RD**			**CI**			**RI**		
RD	1.00	1.00	1.00	1.12	1.44	2.24	1.26	1.73	2.52
CI	0.45	0.69	0.89	1.00	1.00	1.00	1.12	1.20	2.24
RI	0.40	0.58	0.79	0.45	0.83	0.89	1.00	1.00	1.00

3.1.2 Comparison of operational benefits sub criteria with respect to operational benefit

IP-Improved internal process, **RO-**Resource optimization, **OD-**On time delivery

O	**IP**			**RO**			**OD**		
IP	1.00	1.00	1.00	1.00	1.20	2.00	0.89	1.20	1.78
RO	0.50	0.83	1.00	1.00	1.00	1.00	0.71	1.00	1.41
OD	0.56	0.83	1.12	0.71	1.00	1.41	1.00	1.00	1.00

3.1.3 Comparison of sustainability adoption sub criteria with respect to sustainability adoption

SD-Improved quality on sustainability standards, **RP-**Reduced pressure, **SSC**-Sustainable supply chain

SA	**SD**			**RP**			**SSC**		
SD	1.00	1.00	1.00	0.79	1.00	1.59	1.51	1.82	2.94
RP	0.63	1.00	1.26	1.00	1.00	1.00	1.59	2.08	3.17
SSC	0.34	0.55	0.66	0.31	0.48	0.63	1.00	1.00	1.00

3.2 Comparison of relationship opportunities with respect to O

MA-Marketing Advantage, **TC-**Technical Capabilities, **MG-**Mutual Growth

Opportunities	MA			TC			JG		
MA	1.00	1.00	1.00	1.51	1.98	2.80	0.80	1.05	1.48
TC	0.36	0.51	0.66	1.00	1.00	1.00	1.51	1.82	2.94
JG	0.68	0.95	1.25	0.34	0.55	0.66	1.00	1.00	1.00

3.2.1 Comparison of marketing advantage sub criteria with respect to marketing advantage

IC-Improved corporate image, **PP-**Premium pricing, **PD-**Product differentiation, **NM-**New Market

MA	IC			PP			PD			NM		
IC	1.00	1.00	1.00	1.26	1.44	2.52	1.12	1.20	2.24	1.41	1.73	2.83
PP	0.40	0.69	0.79	1.00	1.00	1.00	1.12	1.44	2.00	1.00	1.20	2.00
PD	0.45	0.83	0.89	0.50	0.69	0.89	1.00	1.00	1.00	0.89	1.00	1.78
NM	0.35	0.58	0.71	0.50	0.83	1.00	0.56	1.00	1.12	1.00	1.00	1.00

3.2.2 Comparison of Technical capabilities sub criteria with respect to technical capabilities

ST-Sharing technology, **EE-**Educating employee, **DT-**Developing technical standards

TC	ST			EE			DT		
ST	1.00	1.00	1.00	1.51	1.82	2.94	0.71	0.83	1.41
EE	0.34	0.55	0.66	1.00	1.00	1.00	1.26	1.44	2.52
DT	0.71	1.20	1.41	0.40	0.69	0.79	1.00	1.00	1.00

3.2.3 Comparison of mutual growth sub criteria with respect to mutual growth

CBD-Capacity building & development, **SRI-**Sharing resource & information, **JSG-**Jointly setting goals

MG	CBD			SRI			JSG		
CBD	1.00	1.00	1.00	1.26	1.44	2.52	1.35	1.51	2.62
SRI	0.40	0.69	0.79	1.00	1.00	1.00	1.00	1.00	1.41
JSG	0.38	0.66	0.74	0.71	1.00	1.00	1.00	1.00	1.00

3.3 Comparison of relationship cost with respect to C

CR-Cost of relationship, **IR-**Impact of relationship, **CA-**Cost of adoption

COST	CR			IR			CA		
CR	1.00	1.00	1.00	1.00	1.20	2.00	0.76	0.95	1.48
IR	0.50	0.83	1.00	1.00	1.00	1.00	0.85	1.26	1.65
CA	0.68	1.05	1.31	0.61	0.80	1.18	1.00	1.00	1.00

3.3.1 Comparison of cost of relationship sub criteria with respect to cost of relationship

FI-Financial investment, **TR-**Time required for relationship, **RS-**Responsibility sharing

CR	FI			TR			RS		
FI	1.00	1.00	1.00	1.51	1.98	2.80	0.80	1.05	1.48
TR	0.36	0.51	0.66	1.00	1.00	1.00	1.51	1.82	2.94
RS	0.68	0.95	1.25	0.34	0.55	0.66	1.00	1.00	1.00

3.3.2 Comparison of impact of relationship sub criteria with respect to impact of relationship

RS-Perception of relationship success, **NS-**No improvement in sustainability performance, **PC-**Poor partner commitment

IR	RS			NS			PC		
RS	1.00	1.00	1.00	1.00	1.20	2.00	0.76	0.95	1.48
NS	0.50	0.83	1.00	1.00	1.00	1.00	0.85	1.26	1.65
PC	0.68	1.05	1.31	0.61	0.80	1.18	1.00	1.00	1.00

3.3.3 Comparison of cost of adoption sub criteria with respect to cost of adoption

TC-Technological changes, **PC-**Process Change, **PC-**Infrastructure development

CA	TC			PC			ID		
TC	1.00	1.00	1.00	0.63	1.00	1.26	0.40	0.69	0.79
PC	0.79	1.00	1.59	1.00	1.00	1.00	0.54	0.79	1.05
ID	1.26	1.45	2.52	0.95	1.26	1.85	1.00	1.00	1.00

3.4 Comparison of relationship risk with respect to R

MG-Management, **MR-**Market, **INV-**Investment

Risk	MG			MR			INV		
MG	1.00	1.00	1.00	1.78	2.50	3.56	1.51	1.82	2.94
MR	0.28	0.40	0.56	1.00	1.00	1.00	1.00	1.20	2.00
INV	0.34	0.55	0.66	0.50	0.83	1.00	1.00	1.00	1.00

3.4.1 Comparison of management sub criteria with respect to management

LT-Lack of trust, **PSR-**Problem in sharing risk, **LI-**Lack of integration

MG	LT			PSR			LI		
LT	1.00	1.00	1.00	0.79	1.00	1.59	0.45	0.83	0.89
PSR	0.63	1.00	1.26	1.00	1.00	1.00	0.63	1.00	1.26
LI	1.12	1.20	2.24	0.79	1.00	1.59	1.00	1.00	1.00

3.4.2 Comparison of market sub criteria with respect to market

DS-Dependency on few suppliers, **BP-**Bargaining power of supplier, **CF-**Competition in future

MR	DS			BP			CF		
DS	1.00	1.00	1.00	1.78	2.50	3.56	1.51	1.82	2.94
BP	0.28	0.40	0.56	1.00	1.00	1.00	1.00	1.20	2.00
CF	0.34	0.55	0.66	0.50	0.83	1.00	1.00	1.00	1.00

3.4.3 Comparison of investment sub criteria with respect to investment

HR-Huge investment in relationship, **URT-**Unavailability of required technology with partner, **BP-**Breaking partnership in between

INV	HR			URT			BP		
HR	1.00	1.00	1.00	0.71	1.00	1.41	0.45	0.83	0.89
URT	0.71	1.00	1.41	1.00	1.00	1.00	0.32	0.42	0.57
BP	1.12	1.20	2.24	1.74	2.41	3.16	1.00	1.00	1.00

Appendix 1D: Comparison of relationship alternatives with respect to BOCR (Final values can be checked in Table 5.7**)**

OTR- One time relationship, **FR**-Foundation relationship, **PSR**-Problem solving relationship, **LTR**-Long term relationship, **MDG**-Mutual development and growth

4.1 Comparison of relationship alternatives with respect to B

Benefits	**OTR**			**FR**			**PSR**			**LTR**			**MDG**		
OTR	1.00	1.00	1.00	1.00	1.00	2.00	0.35	0.42	0.57	0.26	0.36	0.49	0.24	0.33	0.44
FR	0.50	1.00	1.00	1.00	1.00	1.00	0.26	0.32	0.46	0.37	0.41	0.62	0.45	0.69	0.89
PSR	1.74	2.41	2.82	2.19	3.15	3.82	1.00	1.00	1.00	0.52	0.76	1.00	0.45	0.61	0.83
LTR	2.05	2.76	3.84	1.60	2.45	2.67	1.00	1.31	1.92	1.00	1.00	1.00	0.71	1.00	1.41
MDG	2.30	3.00	4.14	1.12	1.45	2.24	1.20	1.65	2.24	0.71	1.00	1.41	1.00	1.00	1.00

4.2 Comparison of relationship alternatives with respect to O

Opportunity	**OTR**			**FR**			**PSR**			**LTR**			**MDG**		
OTR	1.00	1.00	1.00	0.71	1.00	1.41	0.45	0.83	0.89	0.33	0.52	0.62	0.26	0.39	0.47
FR	0.71	1.00	1.41	1.00	1.00	1.00	0.32	0.42	0.57	0.26	0.37	0.44	0.40	0.69	0.79
PSR	1.12	1.20	2.24	1.74	2.41	3.16	1.00	1.00	1.00	0.50	1.00	1.00	0.45	0.69	0.89
LTR	1.62	1.91	3.05	2.25	2.68	3.92	1.00	1.00	2.00	1.00	1.00	1.00	0.50	0.83	1.00
MDG	2.14	2.59	3.82	1.26	1.45	2.52	1.12	1.45	2.24	1.00	1.20	2.00	1.00	1.00	1.00

4.3 Comparison of relationship alternatives with respect to C

Cost	OTR			FR			PSR			LTR			MDG		
OTR	1.00	1.00	1.00	0.79	1.00	1.59	0.45	0.83	0.89	0.37	0.47	0.71	0.23	0.30	0.44
FR	0.63	1.00	1.26	1.00	1.00	1.00	0.63	1.00	1.26	0.27	0.38	0.52	0.22	0.29	0.41
PSR	1.12	1.20	2.24	0.79	1.00	1.59	1.00	1.00	1.00	0.45	0.83	0.89	0.45	0.69	0.89
LTR	1.41	2.12	2.71	1.91	2.64	3.70	1.12	1.20	2.24	1.00	1.00	1.00	1.00	1.00	2.00
MDG	2.30	3.32	4.31	2.46	3.48	4.47	1.12	1.45	2.24	0.50	1.00	1.00	1.00	1.00	1.00

4.4 Comparison of relationship alternatives with respect to R

Cost	OTR			FR			PSR			LTR			MDG		
OTR	1.00	1.00	1.00	0.63	1.00	1.26	0.40	0.69	0.79	0.31	0.48	0.63	0.23	0.30	0.44
FR	0.79	1.00	1.59	1.00	1.00	1.00	0.54	0.79	1.05	0.34	0.55	0.66	0.28	0.42	0.51
PSR	1.26	1.45	2.52	0.95	1.26	1.85	1.00	1.00	1.00	0.45	0.83	0.89	0.50	1.00	1.00
LTR	1.59	2.09	3.17	1.52	1.82	2.94	1.12	1.20	2.24	1.00	1.00	1.00	0.89	1.00	1.78
MDG	2.30	3.32	4.31	1.95	2.41	3.55	1.00	1.00	2.00	0.56	1.00	1.12	1.00	1.00	1.00

Appendix-2

Department of Management Studies
Indian Institute of Technology Roorkee, Roorkee
Phone: Tel: 01332-285014, 285617 Fax: 01332-285565

Letter from Supervisor,

April 18, 2012

Dear Participants,

I wish to introduce *Mr. Divesh Kumar*. He is a research scholar in the Department of Management Studies and is enrolled for Ph.D. at the Indian Institute of Technology Roorkee (IITR), Uttrakhand, India. His doctoral thesis is a study on role of relationship marketing on sustainability adoption across supply chain in select automobile industry. This is a very important topic in the current era as increasing pressure from variety of stakeholder for the incorporation of sustainability practices. Improving the buyer supplier relationship can increase the sustainability performance of the supply chain. The research for the thesis is based primarily on survey data. It is critically important that he obtain your cooperation if he is to get a good result.

I am very much aware of how little time that someone with your responsibilities has. Nevertheless, by finding the time to complete this questionnaire you will enable us to gain a much better understanding of the reasons for the success of Indian manufacturing companies.

Let me further ensure you that the survey results will remain strictly confidential. We will only be presenting the aggregate results for all the companies participating in the survey. I would like to repeat how grateful I would be if you could assist Mr. Divesh Kumar.

Thanking you in anticipation,

Yours Sincerely,

Dr. Zillur Rahman
Associate Professor

Appendix-3

Department of Management Studies
Indian Institute of Technology Roorkee, Roorkee
Phone: Tel: 01332-285014, 285617, Fax: 01332-285565

First Cover Letter,

April 18, 2012

Subject: Role of relationship marketing in sustainability adoption across supply chain in select automobile companies.

Dear [Name and Title]:
[Address}

I am a research scholar in the Department of Management Studies, Indian Institute of Technology, Roorkee (IITR), Uttrakhand, India working on my Ph.D. thesis under the supervision of Dr. Zillur Rahman, Associate Professor in the same department. I am writing to ask for your cooperation in participating in my research work. I would appreciate it if you could take some time to complete the attached questionnaire and **return the same within three weeks**.

My research work is on role of relationship marketing on sustainability adoption across supply chain in select automobile industry. The purpose of this study is to know the role of buyer supplier relationship on the sustainability performance of the supply chain in select Indian automobile companies.

You have been identified as one of the respondent in your company who will be able to provide the necessary data/information for this study. I would also like to ensure that your response would be kept strictly confidential. Information from this survey will be generalized and participating companies will not be identified. The questionnaire takes 20-30 minutes to complete.

Please, indicate your decision by placing a "tick" or "cross" in the appropriate number/space against each question/item.

If you have any enquiries or questions about this research, please feel free to contact me at +91-9761662211 or at my e-mail ID (diveshcms@gmail.com). My department fax number is +91-1332-285565, 273560. I hope that you will assist in adding to the body of knowledge regarding developing the sustainable supply chain of the Indian automobile companies. Thank you very much for your valuable time.

Yours Faithfully,
Divesh Kumar
Research Scholar
Indian Institute of Technology Roorkee (IITR)
Roorkee, District Haridwar, Uttrakhand, India-247667

Appendix-4

Department of Management Studies
Indian Institute of Technology Roorkee, Roorkee
Phone: Tel: 01332-285014, 285617 Fax: 01332-285565

First Reminder Letter (Follow-up Letter)

Wednesday, 9 May, 2012

Subject: Role of relationship marketing in sustainability adoption across supply chain in select automobile companies.

Dear [Name and Title]:
[Address]

I am a research scholar in the Department of Management Studies, Indian Institute of Technology, Roorkee (IITR), Uttrakhand, India. I am writing to ask you to assist me in my research. Three weeks ago I sent you a questionnaire asking you the questions on buyer supplier relationship and its role in improving sustainability performance of supply chain.

I would be very grateful if you could take some time to complete the attached questionnaire and **return it to me within a week. If you have already returned your questionnaire, please ignore this letter.**

Thank you very much for your valuable time and cooperation.

Yours Faithfully,

Divesh Kumar
Research Scholar
Indian Institute of Technology Roorkee (IITR)
Roorkee-247667
District Haridwar, Uttrakhand, India

Appendix-5

Department of Management Studies
Indian Institute of Technology Roorkee, Roorkee
Phone: Tel: 01332-285014, 285617 Fax: 01332-285565

Second Reminder Letter (Follow-up Letter)

Wednesday, 27 June, 2012

Subject: Role of relationship marketing in sustainability adoption across supply chain in select automobile companies.

Dear [Name and Title]:
[Address]

I am a research scholar in the Department of Management Studies, Indian Institute of Technology, Roorkee (IITR), Uttrakhand, India. I am writing to ask you to assist me in my research. Last month I sent you a questionnaire asking you the questions on buyer supplier relationship and its role in improving sustainability performance of supply chain

I would be very grateful if you could take some time to complete the attached questionnaire and **return it to me within a week. If you have already returned your questionnaire, please ignore this letter.**

Thank you very much for your valuable time and cooperation.

Yours Faithfully,

Divesh Kumar
Research Scholar
Indian Institute of Technology Roorkee (IITR)
Roorkee-247667
District Haridwar, Uttrakhand, India

Appendix-6

A Sample Questionnaire role of relationship marketing in sustainability across supply chain

Introduction

This questionnaire is a part of a study of role of relationship marketing in sustainability adoption across supply chain. The study address factors and items which need to assess for the development of sustainable supply chain of the company which may be part of your work and many other process of implementing and improving sustainability performance, therefore your responses are very important.

Purpose

The main objective of this study is to know the role of relationship marketing in sustainability adoption across supply chain. All responses given will be treated with the utmost confidence. The results of the present study will be used for research purposes only and no attempts will be made to identify any individual or company in any publication. Please do not place your name on any part of this questionnaire.

About Questionnaire

The present questionnaire is divided into three (04) sections. Each section is supposed to collect particular information. Section –I consist of questions related to brief profile of the respondents and firm he/she is working in. Section –II comprise of question related to the triggers developing top management commitment. Section-III collects information on the buyer supplier relationship. Section IV consists of questions regarding the sustainability performance of the supply chain.

Instructions

1. Please read each item carefully before answering them.
2. Indicate your decision by placing a tick ("√") or cross ("×") in the box to the right of the items.
3. Make sure to complete **ALL** items.
4. Please answer the items which suit your company. If you are not sure, please answer to the best of your ability.
5. Please, return the completely filled questionnaire within **three** weeks from the date of receipt of this questionnaire on the following e-mail ID: diveshcms@gmail.com.

Research Instrument

(Scale numbering and coding will be removed from the actual survey)

Informed consent statement: I understand the procedures and conditions of my participation described in the preceding e-mail. My questions have been answered to my satisfaction, and I agree to participate in this study, and acknowledge that the preceding e-mail if my record of this agreement.

☐ Yes (Proceed the survey) ☐ No (Skip to thank you and Exit)

Section I

Please provide some demographic information below:

1) My position within my company is:

a) President, VP, Executive Director b) Senior manager

c) Middle level d) Multiple

2) Experience

a) Less than 5 years

b) 5-10 years

c) More than 10 years

d) Multiple

(3) Yes, I would be interested in receiving an acknowledgment e-mail about my participation in this survey.

E-mail:_____

Section II

1. Expected benefits of sustainability adoption

Please rate the level of relative benefits offered by the sustainable supply chain over conventional supply chain, on the 7 point likert scale (1- strongly disagree to 7- strongly disagree).

S. N.	Benefits (BENF)	1	2	3	4	5	6	7
BENF1	Improve corporate Image/ Reputation							
BENF2	Product Differentiation							
BENF3	Premium Pricing							
BENF4	Provide New Market							

2. External pressure/influence

Please rate the level of external influence for implementing sustainability practices in supply chain, on the 7 point likert scale (1- strongly disagree to 7- strongly disagree).

S.N.	External influence (EXT)	1	2	3	4	5	6	7
EXT1	Fear of loss of business							
EXT2	Penalty							
EXT3	Reputation loss							
EXT4	Focal company sharing expertise							

3. Top management commitment

Please rate the level of top management commitment required for the implementation of sustainability practices in supply chain, on the 7 point likert scale (1- strongly disagree to 7- strongly disagree).

S.N.	Top management commitment (TC)	1	2	3	4	5	6	7
(TC1)	Allocation of fund							
(TC2)	Allocation of resources							
(TC3)	Looking for developing relationship							
(TC4)	Integrating sustainability in corporate strategy							
(TC5)	Developing team to ensure sustainability integration							

Section III

4. Supplier selection

Please rate the supplier selection activities for improving sustainability performance of supply the chain, on the 7 point likert scale (1- strongly disagree to 7- strongly disagree).

S.N.	Supplier selection (SS)	1	2	3	4	5	6	7
(SS1)	Developing selection standards							
(SS2)	Allocation of order with respect to performance							
(SS5)	Feasibility of developing relationship							

5. Supplier development

Please rate the supplier development activites for improving sustainability performance of the supply chain, on the 7 point likert scale (1- strongly disagree to 7- strongly disagree).

S.N.	Supplier development (SD)	1	2	3	4	5	6	7
(RS1)	Technology sharing							
(RS2)	Resource allocation							
(RS3)	Information sharing							
(RS4)	Knowledge sharing							
(RS5)	Joint teams							

6. Performance review of supplier

Please rate the supplier performance review activities for improving sustainability performance of the supply chain, on the 7 point likert scale (1- strongly disagree to 7- strongly disagree).

S.N.	Performance review of supplier (PR)	1	2	3	4	5	6	7
(PR1)	Suppliers evaluation and assessment							
(PR2)	Rating and classification							
(PR3)	Deciding on relationship continuation							

Section IV

7. Environmental Supply Chain

Please rate the environmental sustainability indicators for improving sustainability performance of the supply chain by buyer supplier relationship, on the 7 point likert scale (1- strongly disagree to 7- strongly disagree).

S.N.	**Environmental Supply Chain (EVS)**	1	2	3	4	5	6	7
(EVS1)	Reverse logistics							
(EVS2)	Energy efficiency							
(EVS3)	Pollution & emission minimization							
(EVS4)	Waste minimization							

8. Social supply chain

Please rate the social sustainability indicators for improving sustainability performance of the supply chain by buyer supplier relationship, on the 7 point likert scale (1- strongly disagree to 7- strongly disagree).

S.N.	**Social supply chain (SSC)**	1	2	3	4	5	6	7
(SSC1)	Rights to employees							
(SSC2)	Fair trade and transparency							
(SSC3)	Social welfare							

9. Economical Supply Chain

Please rate the economical sustainability indicators for improving sustainability performance of the supply chain by buyer supplier relationship, on the 7 point likert scale (1- strongly disagree to 7- strongly disagree).

S.N.	**Economical Supply Chain (ECS)**	1	2	3	4	5	6	7
(ECS1)	Asset utilization							
(ECS2)	Cost reduction							
(ECS3)	Late delivery							

Thank you for completing the survey. You are now done. Your time and effort is greatly appreciated and will be a valuable contribution to the educational community. If you have any closing comments or remarks please enter them below:

_____

_____

End.

Appendix 7 Studies used in literature review

S.No.	Author	Country	Year	Objective	Findings	Statistical Methods
1.	Elkington, J.	USA	1994	To discuss about the challenges and opportunities for the sustainable development	Companies need to work in cooperation with suppliers, customers and other stakeholders.	Conceptual paper
2.	Sarkis, J	USA	1995	To know the internal functions related to the environmental design and manufacturing	Supply chain is very necessary for the environmental practices and supply chain relationships are also important to form an ecological system.	Conceptual paper
3.	Florida, R.	USA	1996	To find out the various factors required for the environment conscious manufacturing in the organization and its supply chain.	Proper relationships with internal and external stakeholders are required for the joint effort and reduce the resistance.	Factor analysis and cluster analysis
4.	Green, K, Morton, B. & New, S.	UK	1998	To find out the factors influence and change structure for the green supply chain	Proper auditing and collaboration with supplier is necessary for the environmental performance.	Conceptual paper
5.	Zsidisin, G.A. And Hendrick, T.E.	USA	1998	To find out the purchasing role in environmental issues related to different countries	Supplier-buyer cooperation is necessary in order to achieve green objectives. Reverse logistics, investment recovery are other factors to affect environment performance	ANOVA
6.	Walton, S.V., Handfield, R.B., and Melnyk, S.A.	USA	1998	To know the ways by which supplier can be integrated in developing environment friendly supply chain.	Supply chain management is relationship management. Supply relationships can be used for improving sustainability performance	Conceptual paper
7.	Ytterhus, B.E.	Norway	1999	To know the trends towards sustainable practices in retail supply chain.	Supply chain relationship and pressure can play important role in adoption of environmental practices than the laws alone.	Conceptual paper
8.	Hall, J.	Canada	2000	To find out the mechanism of developing environmental supply chain	Proper relationship tends to adoption of green practices for both buyer and supplier. Channel power can be used to influence other supply chain members. Non regulatory pressure also play vital role in environmental sustainability adoption	Case Study

9.	Young, A and Kielkiewicz-Young, G	Norway	2001	How sustainability practices affecting the shape of supply chain and relationship with the supply chain partners.	Internal integration is vital for the innovation, high skilled labor, and making cross functional team to provide solution. External integration deal with the integration with supply chain members in logistics and transport.	Survey
10.	Bowen,F.E., Cousins,P.D., Lamming,R.C., and Faruk,A.C.	UK	2001	How a green supply chain can be developed?	Close cooperation with supplier help in enabling green supply chain.	Survey
11.	Rao, P.	Philippines	2002	To know the greening status of supply chain and guidelines for the stakeholders to implement the same	Environmental performance of the firm depends upon the supply of environment friendly products from suppliers. Environmental objectives can be achieved by partnering with the suppliers and helping them.	SEM,
12.	Carter, C.R., Jenning, M.M.	USA	2002	To find out the relationship between socially responsible activities and supply chain management	Social responsibility increases the trust and commitment in the supply chain partners and it also reduces functional conflicts	SEM,
13.	Klassen, R. and Vachon, S.	Canada	2003	To find out the role of collaborative and evaluative activities in extending plant level environment program to the supply chain partners.	Supplier collaboration is essential for extending plant level environment program to the supply chain	Chi square, bivariate correlation, Hierarchical linear regression
14.	Kogg, B.	Sweden	2003	To know the greening mechanism of the Verner Frang companies' supply chain	Good relationship development played a vital role in greening the supply chain. Focal companies' role is very crucial in order to facilitate greening.	Case Study
15.	Zutshi, A. and Sohal, A. S.	Australia	2004	To find out the factors necessary for implementation of EMS	Training, awareness, relationship with suppliers is required. Paper also talked of resource sharing and allocation.	Conceptual finding of a project
16.	Zhu, Q.H., Sarkis, J.	China	2004	To know the relation of operational practices and supply chain performance.	Quality management and Just in time help in influencing the green practices and performance outcome. Relation is very vital for the adoption of green practices in supply chain. Collaboration with supply chain partners increases the environmental and economical performance. Early adoption is beneficial as it creates competitive advantage	Factor Analysis, Correlation, Hierarchical regression,

17.	Hamprecht, J., Corsten, D., Noll, M. and Meier, E	Switzerland	2005	Sustainable practices of Nestle in Switzerland	Collaboration with supply chain partners and other competing firm is necessary to bring same standards in the industry in order to deal with the increase cost of supply chain at suppliers end	Case Study
18.	Rao, P. and Holt, D	Philippines	2005	To find out the role of Green supply chain management in environmental, economic and competitive performance	Green supply chain is associated with the integration of supply chain partner which ultimately increase the environmental, economic and competitive performance of the supply chain.	SEM
19.	Blowfield, M.E	USA	2005	To find out the ways by which companies are incorporating social standards in global supply chain	Company should have proper relationship in supply chain and with other stakeholder in order to know the global as well as local societal standards to be corporate citizen	Conceptual paper
20.	Handfield, R.B., Scroufe, R. and Walton, S.	USA	2005	To know the role of purchasing on supply chain sustainability	Supply chain relationship are vital for the environmental performance	Case Study
21.	Preuss, L.	Scotland	2005	To know the contribution the supply chain functions function can make to environmental protection.	Green supply chain is the coordination between supply chain partners, companies need to think about the composition of incoming product and its effect to customer, employee and others.	Eisenhardt method for case study
22.	Simpson, D. F. and Power, D. J.	Australia	2005	To find out the relationship when supplier firm adopting environmental activities in lean supply chain	Relationship with supplier is very necessary to extend environmental practices.	Case study of 2 companies
23.	Clemens, B and Douglus, T.J.	USA	2006	To find the relationship between coercion, superior firm resource and green initiatives.	Cooperation of firms and regulators can be a good way to promote sustainability. Companies with superior firm resources on environmental issues do need coercion for the sustainability initiatives.	Cronbach's alpha
24.	Tsoulfas, G.T. and Pappis, C.P.	Germany	2006	To know the environmental principles applicability to supply chain.	Environmental objectives can be achieved by proper cooperation with supply chain partners. There is need to improve internal process and partners processes.	Conceptual paper

25.	Vachon, S. and Klassen, R.D.	USA	2006	Extension of collaboration in supply chain research	Technological sharing and development is very important for the green adoption in supply chain, activities comprising a direct involvement of the buying organization.	Hierarchical linear regression, exploratory factor analysis for refining scales
26.	Vermeulen, W.J.V., and Ras, P	Netherland	2006	To discuss the various challenges in greening the supply chain	Cooperation with supply chain partners, commitment and trust help in the greening of supply chain.	Conceptual paper
27.	González-Benito, J. and González-Benito, Ó.	Spain	2006	This paper reviews the literature in order to identify the determinant factors of a company's environmental proactivity.	Stakeholders' pressure is distinguished as a central determinant factor.	Conceptual paper
28.	Vasileiou, K. and Morris, J.	UK	2006	To find out drivers related to the sustainable supply chain management	Sustainability in supply chain is related to proper integration with partners	Conceptual paper
29.	Ellis, N. & Higgins, M.	UK	2006	To know the role of relationship marketing in implementing code of ethics.	Relationship marketing is better approach for the adoption of ethical code of practices across supply chain. Social standards can be adopted by proper relationship between supply chain partners and approach should be win-win.	Conceptual paper
30.	Lin, C.Y	Taiwan	2007	To know green supply chain adoption factors related to organizational, environmental and technological aspects	Companies need to take care of organizational, technological and environmental factors for adoption of green supply chain practices	Factor analysis
31.	Svensson, G	Norway	2007	To find out the factors related to the sustainable supply chain	Product life should be handled throughout its end and sustainability can be incorporated by using n-order supply chain	Empirical Example
32.	Smith, B.G	UK	2007	To review the factors related to the development of sustainable food supply chain	Type of supply chain, supply chain partners business attitude, interpersonal trust and joint working and cooperation between different stakeholder including supply chain partners has been found very important to make supply chain more sustainable	Conceptual paper
33.	Zhu, Q., Sarkis, J., Lai, K-H	China	2007	To know the effect of various pressures on the environmental practices and supply chain performance	Companies are facing huge pressure from the adoption of green practices in the supply chain and performance of environmental standards has increased due to these pressures. The	Regression Analysis

					impact of this adoption is not same for the economic performance due to poor external relationship	
34.	Vachon, S	Canada	2007	To find out the link between environmental collaboration and environmental monitoring and the selection of technologies	Collaborative activities are directly related to the development of environmental technologies. Supplier side play bigger role than the customer in the environmental performance.	Survey
35.	Simpson, D., Power, D. and Samson, D.	Australia	2007	Impact of supply chain relationship on green supply	Supply chain relationship is necessary for the green adoption in supply chain. This study supports the previous research findings.	Linear Regression
36.	Koplin, J., Seuring, S., and Mesterharm, M	New Zealand	2007	To know the factors responsible for the sustainability integration in supply chain	Early detection of problems, Suppliers monitoring and selection, Normative requirements all are necessary for the sustainability adoption. Information sharing and other cooperative strategies can be used for the proper adoption of social and environmental standards in supply chain	Case Study
37.	Zhu, Q., Sarkis, J., Lai, K-H	China	2007	To find out the relation between Green supply chain practices and supply chain performance	There is difference in green practices implementation across the industries due to various reasons. All the practices related to green supply chain discussed in the paper need cross functional and inter firm cooperation.	ANOVA, CFA
38.	Matos, S., Hall, J.	Canada	2007	To know the ways for making a balance in economical, social and environmental dimensions of sustainable development	Social dimensions had been neglect in the literature. While LCA has been found as the only tool to know the environmental performance. In many cases social sustainability can affect the environmental performance due the impact of new technology on society. the proper cooperation is need with all stakeholders	Conceptual paper
39.	Rocha, M., Searcy, C. & Karapetrovic, S.	Mexico	2007	To develop framework for the sustainability integration in the business	All the activities should be directed towards the satisfaction of the all stakeholder whether it is employees, customer, supplier or the government, ngo and other groups, building relationship with those stakeholders is one the way towards the sustainable development.	Conceptual paper

40.	Michelsen, O.	Norway	2007	To know the impact of environmental assessment and supply chain relationship	Environmental assessment is necessary to know the current level of environmental activities of whole supply chain and proper supply chain relationship knowledge should be gathered.	LCA
41.	Linton, J.D., Klassen, R., Jayaraman, v.	Canada	2007	To know the factors to be focused in developing sustainable supply chain.	A focus on supply chain is a step towards the broader adoption and development of sustainability, resource depletion, pollutants and waste incurred cost	Literature review
42.	Attaran, M. & Attaran, S.	USA	2007	To know the effect of collaboration on sustainability practices adoption	Collaboration is needed for the proper demand planning, product design, forecasting and increasing performance. Collaborative supply chain is been treated as the efficient and more sustainable.	Case study
43.	Markley, M. J. and Davis, L.	USA	2007	To know the benefits by the development of sustainable supply chain	Sustainable supply chain creates competitive advantage for the firm and successful partnership is required for economic and sustainability advantage.	Survey
44.	Cramer, J. M.	Netherland	2007	To know the role of supply chain relationship in extending social sustainability practices in international product supply chain.	Focus on the supplier is very necessary for developing a sustainable supply chain. Monitoring the supplier performance to avoid any deviance from supplier side should be checked.	Case study
45.	Ansett	Spain	2007	To know the initiatives taken by Gap Inc. to improve labor standards and stakeholder engagement to improve sustainability.	Gap Inc. has introduced many initiatives like collaborating with supplier and other stakeholders.	Case study
46.	Carter, C.R., and Rogers, D.S.	USA	2008	To develop concept of sustainability in supply chain and find relationship between social, economical and environmental factor	Risk management, transparency, strategy and culture are other supporting factors of sustainability	conceptual theory building
47.	Asif, M., Bruijn, E. J. D., Fisscher, O. A. M. & Steenhuis, H.	Netherland	2008	To find out how all dimension of sustainability can be achieved	A holistic approach is needed with the integration of all supply chain partners and their functions	Conceptual paper

48.	Salam, M. A.	Thailand	2008	To find the factors related to green procurement in supply chain	Supply relationship in Green Procurement Adoption have positive role. Collaboration is needed in order to adopt green practices across supply chain.	Multiple Regression
49.	Hutchins, M. J. & Sutherland, J.W.	USA	2008	To find out the ways how social sustainability can be measured in the supply chain	Four indicators have been proposed to measure the social sustainability which is: health, labor equity, Philanthropy, Safety for individual companies. For whole supply chain formula has been proposed which is related to the social activities of all supply chain partners and their contribution to the supply chain	Conceptual paper
50.	Zhu, Q., Sarkis, J., Lai, K-H	China	2008	To develop the construct for the measurement model for green supply chain management implementation	Following factors have been proposed with sub factors to measure the green supply chain practices: Internal environmental management, Green purchasing, Cooperation with customers, Eco-design, Investment recovery. These factors are to be related with the environmental, economic and operational outcomes.	Validity, reliability and CFA for measurement model
51.	Seuring, S. and Muller, M.	Germany	2008	To find out the core issues related to the sustainable supply chain	Cooperation and partnership is necessary for sustainability. External pressures are also major driver for sustainability adoption in supply chain. More emphasis has been found for the win-win situation for three dimensions of sustainability over trade among them	Delphi Study
52.	Walker, H., Sisto, L. D. and Mcbain, D.	UK	2008	To find the factors related which influence and hinder organizations to adopt green initiatives	Big companies can influence their suppliers for sustainability adoption due to favorable power of balance. Collaboration with suppliers will give win win opportunities to both parties.	Literature Review
53.	Lee, S	South Korea	2008	To find out the factors which facilitate green adoption in small and medium size supplier firms	Supply chain relationship and integration with suppliers help in green supply chain practices adoption across supply chain. Different level of resources and capabilities is directly related to the environmental activities of that firm. Environmental sustainability adoption is directly related to the Buyers green initiative and supplier's readiness.	Hierarchical linear regression

54.	Vachon, S. and Klassen, R.D.	Canada	2008	Role of collaborative activities with supply chain partners on the supply chain performance	Collaborative activities in the supply chain are directly related to the environmental performance of the supply chain.	CFA, Multiple regression
55.	Darnall, N., Jolley, G.J. and Horvath, A	USA	2008	To find out environmental impact of supply chain partners on companies adopting environment management sytem	Environment management system require proper tracking of waste, suppliers environmental impacts and harm, and sharing information to minimize the impact on environment	Factor analysis, chi square, Two tailed t test
56.	Seuring, S. and Muller, M.	Germany	2008	To establish a conceptual framework for the sustainable supply chain management	Supplier management and supply chain management for the sustainable products are found essential for the sustainable supply chain	Literature Review
57.	Zhu, Q.H., Sarkis, J. and Lai, k.H.	China	2008	To know the perception of companies about the green supply chain practices and its impact on closing the loop	Various pressures are influencing companies to adopt supply chain and facilitating cooperation between supply chain partners for the internal process and GSCM practices.	Chi Square, Multiple Regression
58.	Bitzer, V, Francken, M and Glasbergen, P	Netherland	2008	To know the role of partnership in coffee supply chain sustainability	Partnership with all stakeholders is necessary for the coffee supply chain. Supply chain relationships are also found vital for the sustainability. Role of NGOs is very crucial in the coffee supply chain sustainability practices.	Conceptual Paper
59.	Ciliberti, F., Pontrandolfoa, P., and Scozzi, B.	Italy	2008	To knew the various social practices adopted by companies	Cross functional findings for the social sustainability of companies publishing non financial reports have been proposed	Inductive–deductive approach
60.	Cai, S., Souza1, R. D., Goh, M., Li, W., Lu, Q. and Sundarakani1, B.	Singapore	2008	To propose a research model for green supply chain adoption	Model has been given to test further.	Research proposal
61.	Beske, P., Koplin,J. and Seuring, S.	Germany	2008	To develop a model for the SSCM and empirical testing	External pressure have big impact on companies to adopt sustainability, internal coordination is also needed for the successful implementation	Model
62.	Brito, M., P. D., Carbone, V. and Blanquart, C.	Netherland	2008	How sustainability practices affecting the shape of supply chain and relationship with the supply chain partners.	Internal integration is vital for the innovation, high skilled labor, and making cross functional team to provide solution. External integration deal with the integration with supply chain members in logistics and transport.	Conceptual paper

63.	Keatinga,B., Quazib, A. Krizc, A. & Coltmana, T.	Australia	2008	To know the governance system for the sustainable supply chain	Supply chain relationship play vital role in governance system for sustainability. Supplier assessment need to be done to know the need and status of willingness for sustainability adoption	Case Study
64.	Vachon, S. & Mao, Z.	Canada	2008	To know the relationship between supply chain strength and sustainable development	Supply chain strength is positively related to the sustainability performance of the supply chain.	Conceptual Paper
65.	Cote, R. P., Lopez, J., Marche, S., Perron, G. M., Wright, R.	USA	2008	To know the various practices of environmental sustainability in supply chain and identify the various opportunities.	There are enough opportunities of adopting environmental practices. But the expected benefits identified in this study were very small.	Case study
66.	Kortelainen, K.	USA	2008	To know the social auditing items in the global supply chain using labor audit as its part.	Based on the experiences of the case studies, labour condition auditing is seen as a beneficial tool for inducing continuous improvement in supply chain management, but it requires a new set of skills from the auditors	Survey
67.	Holt, D. and Ghobadian, A.	UK	2009	To find out the degree of greening in UK manufacturing	Internal drivers and legislation exert maximum pressure to adopt greening of Supply Chain	Principal components analysis,
68.	Routroy, S.	India	2009	To find out the antecedents and drivers of the green supply chain practices	Top management commitment and government initiatives are proposed as antecedent and green designing, green sourcing, green manufacturing, environmental management system, customer awareness all of them are proposed as the drivers for the GSCM	Conceptual paper
69.	Hong, P., Kwoon, H. & Roh, J.J.	USA	2009	To know the impact of integration of green practices, suppliers and internal practices on the environmental performance outcomes	Green implementation is supported by supply chain coordination, integrative product development, commitment by companies which in result provide performance outcome	SEM
70.	Vermeulen, W.J.V., and Seuring, S	Germany	2009	To find out the ways why which companies are approaching towards sustainability.	Sustainability in supply chain can be increased by collaboration or using power. Suppliers generally do not understand the social and environmental condition of the customer firm without proper collaboration.	Conceptual paper

71.	Muller, M., Dos Santos, V.G., and Seuring, S	Germany	2009	To know the impact of sustainability adoption on the legitimacy of supply chain.	Various standards increase the legitimacy of supply chain. All the certification is only related to the Plants. They all not supply chain specific. Hence transparency is needed when suppliers adopt these standards. Certification of suppliers is needed but it should be transparent and easy to control.	Conceptual paper
72.	Svensson, G.	Norway	2009	The objective is to describe a conceptual framework and empirical illustrations of the transparency of SCM ethics in supply chains as a whole	SCM ethics should also comprise indirect business relationships. The transparency of SCM ethics opens up challenging opportunities for further research of great value to the theory generation and best practices of SCM.	Literature Review
73.	Fortes, J.	Otago	2009	To know the status of green supply chain literature and provide a framework	Green design, green operations, reverse logistics, waste management and green manufacturing are the components of green supply chain.	Literature Review
74.	Gold et al., Seuring, S. & Baske, P.	Finland	2009	To explores the role of sustainable supply chain management as a catalyst of generating valuable inter-organizational resources and thus possible sustained inter-firm competitive advantage through collaboration	Inter-firm resources and capabilities emerging from supply-chain-wide collaboration are prone to become sources of sustained inter-firm competitive advantage, since they are socially complex, causally ambiguous and historically grown and hence particularly difficult to imitate by competitors.	Literature Review
75.	Bommel, W.V.	Netherland	2010	To find out the reasons for the influence of a company to adopt sustainability	Various external and internal pressure influence companies to adopt sustainability. Cooperation and integration is very necessary for the sustainability adoption in supply network	Conceptual paper
76.	Teuteberg, F. and Wittstruck, D.	Germany	2010	To find out the sustainability trends and to find out the research gap	Need to develop model with software implementation	Literature review
77.	Bai, C. and Sarkis, J.	China	2010	To find out the factors related to the green supplier development	Green supplier can be developed with the help of collaborative approach and developing relationship. Various factors has been identified in the paper	Conceptual paper

78.	Olorunniwo, F. O. and Li, X	USA	2010	To know the role of information sharing and collaboration on the reverse logistics	In reverse logistics companies need to facilitate collaboration with its supply chain partners, only information cannot increase the reverse logistics performance alone. Coloration directly related to improves reverse logistics performance. Information sharing is used for the better collaboration.	ANOVA
79.	Ni, D, Li, K. W. & Tang, X.	China	2010	to know the factors related to the social responsibility allocation in supply chain	Suppliers should be made responsible for the social activities and power should be use to gain system wide benefits.	Conceptual paper with mathematical formulation
80.	Sarkis, J., Gonzalez-Torre, P. and Adenso-Diaz, B.	USA	2010	To find out the effect of stakeholder pressure to adopt sustainability and role of training	Different stakeholder has different role in influencing the companies sustainability strategy	Discriminate validity analysis, SEM
81.	Sharma, A., Iyer, G. R., Mehrotra, A., Krishanan, R	USA	2010	To know the role of B2b marketing on the sustainability across companies	Author focused on Build to order strategy with the cooperation between supply chain partners.	Conceptual paper
82.	Closs, D. J., Speier, C. & Meacham, N.	USA	2010	Sustainability framework and the various strategies used by firms to be sustainable	Sustainability has four dimensions: environmental, educational, ethical and economical	Grounded theory approach
83.	Zhu, Q and Sarkis, J.	China	2010	To find out the influence from various source in adoption of Green supply chain practices	Pressure from buyer in supply chain influence a lot to adopt green supply chain practices.	Moderated hierarchal regression analysis
84.	Curkovic, S. and Sroufe, R.	USA	2010	To know the role of ISO adoption on supply chain sustainability	Supply chain sustainability results in competitive advantage and can be adopt by proper integration with supply chain partners.	Case Study
85.	Pullman, M. E. , Maloni, M. J. & Dillard, J.	USA	2010	To know the sustainability practices in wine industry	Sustainability adoption is related to the supply chain relationship. Sustainability adoption is related to the increased environmental performance but it is different for the social sustainability	T test, Regression,
86.	Senge, P.	USA	2010	Challenges of focal firm to extend sustainability across supply chain	Lack of trust and relationship in supply chain. Lack of idea execution and change in the market are some of the challenges.	Survey
87.	Buyukozkan, G. & Cifci, G.	Turkey	2010	To analyze the barrier of sustainability adoption in supply chain	Model has been proposed and cost has been found biggest barrier in sustainability adoption.	Model

88.	Diabata,A. & Govindan, K.	United Arab Emirates	2011	To find out the drivers of green adoption in supply chain	Collaboration with supply chain partners found to be one of the most driving factor for sustainability adoption	ISM
89.	Wu, Z. and Pagell, M.	USA	2011	To find out the ways by which companies can manage between short term profit and long term sustainability objectives	Supplier and customer relationship is one of the important factor of the sustainable supply chain practices and strategies	Grounded theory building approach
90.	Nakano, K. & Hirao, M.	Japan	2011	How collaborative activities can help to increase environmental activities in supply chain	There is need of expert or third party to execute the data gathering from the supply chain partners for the LCA. Proper information sharing and relationship management is needed.	Case Study
91.	Eltayeba, T.K., Zailani, S. and Ramayah, T.	Malaysia	2011	To find out the various factors taken in to account by companies to adopt green practices in supply chain.	Green initiatives by all Supply chain partners contribute towards the sustainability	Multiple Regression, reliability test, factor analysis
92.	Peters, N.J., Hofdtetter, J.S., and Hoffmann, V.H.	Switzerland	2011	To find out the role of interorganizational relation on proactive sustainability adoption	The following factors have been found- external stakeholder integration, cross-functional integration, the management of loosely coupled business units, supply chain implementation, process improvement and cultural framing.	Case Study
93.	Cheung, Y. K.F. and Rowlinson, S.	China	2011	To find out the ways by which sustainability can be adopted in supply chain through relationship	Sustainability in supply chain is dependent upon the structure of organization, its culture and commitment to it.	Survey
94.	Kushwaha, G.S.	India	2011	To find out drivers related to the sustainable supply chain management	sustainability in supply chain is related to proper integration with partners	Conceptual paper
95.	Ageron, B., Gunasekaran, A. & Spalanzani, A.	France	2011	To develop a model for the SSCM and empirical testing	External pressure have big impact on companies to adopt sustainability, internal coordination is also needed for the successful implementation	Likert scale, Mean and S.D.
96.	Smerecnik, K. R. and Anderson, P. A.	USA	2011	To find out the various factors related to the adoption of sustainability adoption in hotel industry.	Simple and advantageous Sustainability innovations are easy to adopt	Factor analysis and reliability test

97.	Daugherty, P. J.	USA	2011	To know the scope of relationship management in reverse logistics	Supply chain relationship is very vital for success of reverse logistics in any supply chain. These relationships can be used to increase the supply chain performance.	Literature review
98.	Luthra, S., Kumar, V., Kumar, S. & Haleem, A.	India	2011	To develop a model for the barriers of green supply chain.	The classification and interrelationship among the barriers of green supply chain has been done.	ISM, MICMAC
99.	Carbone, V. & Moatti, V	France	2011	To identify the link between companies' green strategic intent and their concrete initiatives in the supply-chain	Firms are following different patterns when they implement a green strategy to their supply chain	Survey
100.	Ashby	UK	2012	To investigate systematically the discipline of supply chain management (SCM) within the context of sustainability.	SSCM and the integration of sustainability into supply chains is a significant but evolving field evidenced by a current bias in the literature towards theory development and highly qualitative research methods. The environmental dimension is significantly better represented in the literature through specific processes at all stages of the supply chain. The social dimension is recognised, but receives less emphasis than expected	Conceptual paper
101.	Gopalakrishnan et al.	UK	2012	This paper examines the drivers of sustainability and related key features based on extant literature and a case study.	Supplier management and integration, quality and safety protocol, review of supplier for sourcing material are some of the initiative suggested.	Case study
102.	Hsu, et al.	France	2013	Find out the drivers of green supply chain in emerging economy.	Drivers found in this study are Green purchasing, design-for-environment and reverse logistics initiatives.	Survey