Spring 2014

Sustainability Strategies in Supply Chain Management

Amit Arora

SUSTAINABILITY STRATEGIES IN SUPPLY CHAIN MANAGEMENT

by

AMIT ARORA

(Under the Direction of Gerard J. Burke)

ABSTRACT

Managers no longer view sustainability of organizations only in terms of profitability and economic growth of shareholders. Various competitive pressures are forcing managers to broaden the scope of sustainability to include explicit environmental and societal objectives too. These pressures are emanating from various sources such as depleting natural resources, regulatory policies from governments, erratic weather cycles, demanding customers and brand damage due to exposure about poor working conditions in supplier factories located in other countries. This dissertation consists of three essays that contribute to the practice and literature of strategic sustainable supply chain management by examining its four aspects: measure, manage, mitigate, and market. The purpose of this dissertation is to utilize a multi-method approach and multiple secondary data sources to examine sustainable supply chain management from a strategy point of view.

Three separate but connected studies form the core of this dissertation. Chapter Two of this dissertation proposes a framework of seven market-oriented sustainability strategies by objectively analyzing sustainability reports of leading organizations of four industry sectors using structured content analysis and linear programming techniques.

Chapter Three utilizes linear aggregation methodology and data envelopment analysis to form a sustainability index comprising of various sustainability indicators in logistics and shipping services industry. This index may be used as a decision making tool by managers to evaluate sustainability efforts of their organizations and also to benchmark their sustainability performance over the competition.

Chapter Four examines the sources of differential environmental performance of manufacturing facilities using risk screening environmental indicators database and Markov chain Monte Carlo estimation procedure. The results provide support that resource-based view explains the maximum differential environmental performance of firms as opposed to industry-based view or institutional theory.

INDEX WORDS: Market-oriented sustainability, Sustainable supply chain management, Structured content analysis, Linear Programming, Linear aggregation, Data envelopment analysis, Cross-classified models, Markov chain Monte Carlo estimation.

SUSTAINABILITY STRATEGIES IN SUPPLY CHAIN MANAGEMENT

by

AMIT ARORA

B.S., Aligarh University, India, 1997

M.S., Indian Institute of Technology, India, 2006

A Dissertation Submitted to the Graduate Faculty of Georgia Southern University in

Partial Fulfillment of the Requirements for the Degree

DOCTOR OF PHILOSPHY

STATESBORO, GEORGIA

2014

SUSTAINABILITY STRATEGIES IN SUPPLY CHAIN MANAGEMENT

by

AMIT ARORA

Dissertation Committee Chair: Gerard J. Burke
Committee: Ednilson Bernardes
Alan Mackelprang
Christopher Boone

Electronic Version Approved:
May 2014

DEDICATION

This dissertation is dedicated to my lovely wife, Anshu, who has been a constant source of strength throughout this long journey.

ACKNOWLEDGMENTS

"If this was easy, everybody would do it". These words of encouragement by my dissertation committee chair, Dr. Jerry Burke, kept me going through my dissertation journey. I owe this dissertation to Dr. Burke who has had a profound influence on me during my PhD studies at GSU. He is my mentor, advisor, guru, philosopher and a great friend. No words are enough to express my gratitude towards him. He has always believed in me and stood by me whenever I needed him.

I am thankful and deeply indebted to my dissertation committee – Dr. Ed Bernardes, Dr. Alan Mackelprang, and Dr. Christopher Boone, who supported and helped give direction and shape to my dissertation. I am grateful to all faculty and staff members of College of Business Administration especially operations management, logistics and marketing for their continued invaluable support during my PhD program. I am also grateful to my fellow colleagues – PhD students who have been a source of strength for me to carry on the tough journey of a PhD program.

I wish to thank my dear wife, Anshu who has been a constant source of strength and inspiration; my wonderful sons, Aryaman and Amay; my parents; my father-in-law; my sister and her family; and my friends for their invaluable support and encouragement during the past few years. I would also like to acknowledge Dr. D.P. Kothari, my mentor in India, who always believed that I will be successful in my endeavor.

Above all, I would like to thank God, the invisible hand for giving me the mental and physical strength to never give up.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Understanding sources and strategies for sustainable competitive advantage is a well-established pursuit of academicians and managers (Porter 1985; Barney 1991; Oliver 1997). Supply chain (SC) strategies often target firm capabilities such as cost efficiency, response speed, and flexibility (Qi, Zhao, & Sheu, 2011). The logic is that correct alignment between strategies and capabilities of a firm improves that firm's performance (Wagner, Grosse-Ruyken, & Erhun, 2012; Hill, 1995; Flynn, Schroeder, & Flynn, 1999; Fisher, 1997). Effective SC strategy can be viewed as patterns of decisions related to sourcing products, capacity planning, conversion of raw materials, demand management, communication across the supply chain, and delivery of products and services (Narasimhan, Kim, & Tan, 2006); thereby, supply chain management (SCM) strategies should harmonize with business unit and corporate level strategies. Furthermore, many companies view their supply chain activities strategically due to factors such as: scarcity of resources, turbulence in supply markets, and intensified competition. In a business-strategy context, sustainability of organizations has often been viewed in terms of profitability and economic well-being of the shareholders. Organizations are obliged to create wealth and economic value for individuals and entities invested in the organization. This legacy of obligation can be summarized as: businesses exist "for the sake of economic performance" (Drucker, 1999a, p. 36). However, the business world's traditional singular focus on profitability is under increasing pressure due to depleting natural resources and demands of action from regulatory agencies, non-profit organizations and environmentally conscious customers (Pagell

& Shevchenco, 2014). Hence, organizations are broadening their obligations to include explicit societal and environmental objectives. Integration of social, environmental and economic objectives across core business functions fall within the domain of SCM is termed as sustainable supply chain management (SSCM) (Morali & Searcy, 2013).

Since business competition is no longer just firm versus firm, but also between supply chains (Kuei, Madu, & Lin, 2001; Li, Raghunathan, Raghunathan & Subbarao, 2006), it is critical for companies to evaluate and develop their supply chains globally to enhance their organizational performance. Thus, supply chain management practices support and enable or constitute sustained competitive advantage of many organizations (Barney, 2012; Fisher, 1997; Hartmann & De Grahl, 2011; Azadegan, 2011; Golicic & Smith, 2013; Paulraj, 2011). For example, Toyota's lean manufacturing approach and purchasing system have rendered themselves inimitable and have been a source of sustained competitive advantage (Barney, 2012; Iyer, Seshadri, & Vasher, 2009). Hence, firms can leverage resources and capabilities emerging from their supply chains as sources of sustained inter-firm competitive advantage (Porter, 1992) and develop supply chain management strategies to strengthen a firm's capabilities, create opportunities for customers by providing direct or indirect benefits, and reduce costs. However, in today's globally competitive business environment, achieving sustained competitive advantage as a result of supply chain strategies is not enough. "Green-ness" of the supply chain is a deciding factor for many manufacturers, shipping partners and customers (Wyatt, 2013).

There is substantial evidence that attests to the importance of environmental and social concerns in SCM. For example, a recent study from ProPurchaser found that 80 percent of purchasing managers favor suppliers exhibiting sustainability practices (Wyatt, 2013). Another recent survey conducted by Boston Consulting Group and MIT Sloan Management Review revealed that more than one third of managers identified sustainability as a source of profits and nearly half of responding companies changed their supply chain practices as a result of this (Sirkin, 2013; Kiron, Kruschwitz, Haanaes and Fuisz-Kehrbach, 2013). The term “sustainable” is no longer referent primarily to describe “competitive advantage”. It is the basis for the term “sustainability”, which focuses not just on a “bottom line” (i.e., profits or economic performance), but also on the “triple bottom line” (i.e., economic, environmental and social performance).

Globalization is another characteristic of modern business that emphasizes on SSCM. The creation of global supply chains has provided organizations with new strategic avenues to improve their competitiveness and performance. In order to reduce costs, many organizations transfer manufacturing processes to suppliers in countries having lower labor costs (Beske, Koplin, & Seuring, 2008; Reuter, Foerstl, Hartmann, & Blome, 2010). In addition to the creation of new and cost advantageous markets for sourcing and manufacturing, many organizations have used these new markets for selling their products, thereby, contributing to increased sources of revenues and profits for their shareholders. While longer global supply chains have contributed to wealth and value creation for organizations and their shareholders, they have also become a source of complexity and risk. For example, large global retailers like Walmart, Target, Hennes & Mauritz AB, Gap, and many more were in the news recently when a building housing the garment-making suppliers to these global giants collapsed in Bangladesh killing more than 1,000 factory workers (Kapner, Mukherji, & Banjo, 2013). This building is just one of more than 5,000 garment-making factories which have sprung up in Bangladesh in the last five years. These factories contribute approximately $20 billion to the Bangladesh economy annually. After the accident, global retailers faced the dilemma of either cutting off ties with unsafe factories or helping to fix these unsafe factories. They chose the latter and developed safer working conditions for workers, thereby improving work-related safety and global compliance to environmental regulations in the emerging economies. These global retailers are now focusing on strengthening their supply chains for social and environmental sustainability as means to achieving economic sustainability (Savitz, 2013).

Balanced concern for minimizing societal costs and maximizing global benefits is of paramount importance today (Wyatt, 2013). These wide-ranging concerns include focal areas on energy consumption and greater transparency of environmental and social initiatives of firms. Globally sustainable supply chain companies perform well on measures of profitability, as well as on an extended conceptualization of performance that includes social and natural (environmental) dimensions (Pagell & Wu, 2009). This extended concept is commonly known as the *triple bottom line* (Elkington, 1998; Kleindorfer, Singhal, & Wassenhove, 2005). Truly sustainable supply chains are difficult to achieve since there are trade-offs involved – what may result in profitability may not be desirable from social and environmental standards, or vice versa. According to Johnson (2006), there are five major issues that supply chain managers face: 1. globalization and outsourcing; 2. ever-changing and evolving information technologies; 3. economic forces within and between supply chains; 4. risk management including supply chain complexities and security threats; and 5. product lifecycle management. These major issues often pit economic, social and environmental objectives against one another. Hence, organizations find it increasingly difficult to achieve 'true' sustainability on triple bottom line parameters.

The use of the term "sustainability" to describe a triple bottom line orientation became popular after the report of the World Commission on Economic Development (WCED, 1987) was published. WCED defined sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs (p. 43)." This definition emphasizes the importance of environmental dimension of sustainability (Siegel, 2009; Strong, 1997). Varadrajan (1992) was one of the early researchers to argue that sustainability practices were likely to become increasingly important for the survival, growth and profitability of businesses. These practices or strategies should not just focus on corporate shareholders, but on all stakeholders in the supply chain. As the concept of sustainability in this regard has become more popular, (Closs, Speir, & Meacham, 2011) organizations have broadened their focus from shareholders to stakeholders.

Widespread concerns in businesses about people, planet and profits are being explicitly addressed by organizations. Economic drivers relate to how people and businesses meet their resource needs and desires (e.g., securing food, water, shelter, human comforts, and financial security). Economic dimensions of supply chain sustainability stress increased return on investment, increased revenue, lower cost, and reduced assets, leading to reductions in wastes and exposures to financial risk (Linton, Klassen, & Jayaraman, 2007; Siegel, 2009; Closs et al., 2011). Environmental concerns encompass voluntary or regulated activities to protect, conserve and restore ecosystems and natural resources (e.g., climate change policies, preservation of natural resources, and minimization and prevention of toxic wastes) (Dou & Sarkis, 2010). Social dimensions address conditions and actions that specifically affect humanity (e.g., poverty, unemployment, education, injustice, human health and rights) (Brown, 2007). Closs et al. (2011)

emphasizes global supply chain strategies as means to achieve reduction in global waste and cost for long-term operational efficiency gains and profits; regulatory compliance; and strategic environmental competence. Thus, tremendous opportunities exist for integration of sustainability in supply chain strategies of organizations for achieving competitive advantage.

Focus of the Dissertation

Given the extensive scope of business functions associated with economic, environmental and social responsibilities of organizations, this dissertation focuses on these triple-bottom line objectives and develops three essays to examine different aspects of sustainability in the context of strategic supply chain management. Specifically, this dissertation can be viewed within a practical framework of the four Ms of sustainability: measure, manage, mitigate, and market. ‘Measure’ and ‘manage’ aspects focus on quantitatively measuring sustainability of organizations and rests on the premise that in order to manage something it is imperative to first measure it. The ‘mitigate’ aspect focuses on moderating or diminishing risks associated with sustainability performance of firms. Finally, the ‘market’ aspect focuses on communication and distribution of a firm’s sustainability efforts to its customers and stakeholders. The purpose of this dissertation is threefold. First, while focusing on the ‘market’ aspect of sustainability, this dissertation strives to characterize and synthesize themes and strategies in sustainability reports that pertain to market-oriented supply chain management. Second, keeping in view ‘measure’ and ‘manage’ aspects of sustainability, this dissertation measures and compares sustainability efforts of major logistics organizations to facilitate competitive benchmarking. Finally, a focus on the ‘mitigate’ aspect, steers the dissertation to examine the variation of manufacturing firms’ historical environmental risk performances and partitions this variability into manufacturing plant, parent firm, industry, and regulatory effects.

To better define the context and areas of inquiry, the next section of this introductory chapter will discuss the concept of "sustainability" in supply chain management. The next three chapters address important issues pertaining to sustainable supply chain management, to include their respective importance and relevance. Chapter 2 investigates strategies pertinent to market-oriented supply chain management utilizing data from corporate sustainability reports of an appropriate sample of organizations. Chapter 3 investigates a crucial aspect of managing sustainable supply chains, i.e., sustainability and performance measurement, with a focus on developing a methodology for jointly measuring and comparing the sustainability performance of companies in a particular industry. The method is demonstrated using three major firms in the logistics and shipping services industry. Chapter 4 investigates the sources of variation of environmental performance of manufacturing facilities in the United States.

Concept of "Sustainability" and Sustainable Supply Chain Management

Sustainability has been interpreted by the industry and in the literature through various terms and management approaches (Crittenden, Crittenden, Ferrel, Ferrel, & Pinney, 2011). However, the common theme that emerges from the various definitions of sustainability put forth by professional organizations and researchers is the simultaneous focus on three dimensions of performance – economic, environmental and social. Such a conceptualization of performance is the so-called *triple bottom line* (Elkington, 1998; Closs et al., 2011; Kumar, Teichman, & Timpernagel, 2012). Table 1.1 provides a chronologically arranged sample summary of sustainability definitions found in the literature.

Table 1.1: Definitions of Sustainability

Definition	Sources	Focus
Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.	WCED (1987)	Environment
Consumption that can continue indefinitely without the degradation of natural, physical, human, and intellectual capital.	Costanza, Daly, & Bartholomew (1991)	Environment, Society
A business approach that creates long-term shareholder value by embracing opportunities and managing risks deriving from economic and social developments	Dow Jones Sustainability Index (2003)	Economic, Society
The strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key interorganizational business processes for improving the long-term economic performance of the individual company and its supply chains.	Carter & Rogers (2008)	Economic, Environment, Society
The definition encompasses the business role in addressing environmental, social (human rights and labor) and corporate governance issues.	United Nations Global Compact (2010)	Environment, Society
A way of doing business that creates profit while avoiding harm to people and the planet.	Center for Sustainable Enterprise (2010)	Economic, Environment, Society
The ability to meet current needs without hindering the ability to meet the needs of future generations in terms of economic, environmental and social challenges.	Institute for Supply Management (ISM)	Economic, Environment, Society

Efforts a company makes related to conducting business in a socially and environmentally responsible manner. It includes elements including sustainable development, corporate social responsibility (CSR), stakeholder concerns, and corporate accountability.	Council for Supply Chain Management Professionals (CSCMP)	Economic, Environment, Society

The first definition of sustainability by WCED (1987) was very broad in its scope and lacked specificity, thereby, keeping it open to different interpretations. However, it provided a starting point for organizations to incorporate sustainability as part of their core business strategy. The early focus of SCM was on faster and more reliable deliveries of raw material and finished products to buyers; therefore, a main challenge for companies was to enhance operational efficiency and smooth flow of product and information along value chains. Additionally, companies were looking at ways to minimize waste, not for environmental or social concerns, but for economic reasons (Lai & Cheng, 2009; Sarkis, Zhu, & Lai, 2011). Carter and Rogers (2008) advanced understanding of non-economic factors to include in SCM by holistically defining sustainability and presenting a framework of sustainable supply chain management. This marked a new stream of research in SCM. In recent years, emerging issues such as rising energy prices, limited availability of non-renewable resources, questions surrounding climate change, and concerns for improving the quality of life have created new challenges for companies resulting in greater awareness of the sustainable supply chains research area (Carter & Rogers, 2008; Nagurney, Liu, & Woolley, 2007; Kleindorfer et al., 2005). Table 1.2 provides a sample summary of definitions related to this topic.

Table 1.2: Definitions of Sustainability Related Terms in SCM

Term	Definition	Sources
Sustainable supply chain	A supply chain that performs well on both traditional measures of profitability as well as on the extended conceptualization of performance that includes social and natural dimensions.	Pagell and Wu (2009)
Supply chain sustainability	Management of environmental, social and economic impacts, and the encouragement of good governance practices, throughout the lifecycles of goods and services.	United Nations Global Compact (2010)
Sustainable supply chain management	The management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements	Seuring and Muller (2008)
Sustainability performance	Sustainability performance is defined as an outcome related term measuring the intersection of economic, environmental and social dimensions.	Carter and Rogers (2008); Paulraj (2011).
	Sustainability performance can be defined as the performance of a company in all dimensions and for all drivers of corporate sustainability	Schaltegger and Wagner (2006)

All sustainability definitions in the context of SCM were conceptualized during the last decade. Tables 1 and 2 help us establish sustainability definitions and advance our understanding of sustainability as a concept comprising not only environmental, but also economic and social dimensions.

Sheth, Sethia and Srinivas (2011) suggest a more comprehensive definition of sustainability is emerging and gaining worldwide acceptance. This assertion is evidenced by the growing interest in sustainability by both corporations and academics. Two recent reviews of published sustainability research suggest integration of sustainability practices in supply chain management is relatively new, but growing continuously (Seuring, Muller, & Rao, 2008). Seuring and Müller (2008) conducted a literature review of articles published on SSCM in leading academic journals. Their results indicate that 191 papers on sustainable supply chain management were published during the years 1994 – 2007, with a high number of publications starting from the year 2001 indicating a considerable academic interest in sustainable supply chain management in recent years. Their results also suggest that external pressures and incentives may lead companies to make their supply chains sustainable. Based on these pressures and incentives, the authors identified two sustainability strategies. The first strategy is "supplier management for risks and performance", which is followed by companies that fear reputational risks associated with sustainability issues. Hence, additional environmental and social criteria are taken up to complement economically based supplier evaluation. The second strategy is "supply chain management for sustainable products", which is implemented according to life-cycle based standards for environmental and social performance of products.

Carter and Easton (2011) conducted a systematic review of SSCM literature in the major logistics and supply chain management journals across a 20-year time period. A total of 130 papers were published from the period 1991 to 2010. Their findings suggest that research in the field of SSCM is evolving from a focus on standalone aspects of sustainability to a multidimensional focus on all aspects of the triple bottom line objectives.

Corporate interest in sustainability has also been increasing in recent years as evidenced by an increase in the number of corporate sustainability reports (known by different names in various companies) published by companies each year. According to Makower (2012), currently 48% of S&P 500 companies publish sustainability reports (as of 2011); and according to another statistic by CorporateRegister.com, more than 5,500 such reports are published worldwide. These reports cover environmental and social activities and capture strategies directed towards sustainability of the focal organization and in many cases its supply chain as well. Thus, academic and corporate interest in sustainable supply chain management has become pervasive.

The remainder of this chapter is devoted to briefly summarize the three essays of this dissertation which are organized as three separate chapters as follows.

Chapter 2: Strategy Framework of Market-oriented Supply Chain Sustainability

Many organizations realize that to be truly sustainable, a system-wide view must be taken and that it is important to focus on all stakeholders in the supply chain. This notion is captured by the market-oriented sustainability concept (Hult, 2011). Market-orientation was conceptualized with an explicit focus on customers and profitability, but has broadened to include various stakeholders (Slater & Narver, 1995; Matsuno & Mentzer, 2000). Market-orientation measures the degree to which firms generate, disseminate and respond to market intelligence. Market-oriented sustainability strives to build a sustainability perspective akin to Porter's five forces framework (Porter, 2008), whereby stakeholders' influences on businesses are investigated through market orientation (Narver & Slater, 1990; Jaworski & Kohli, 1993) and macro-marketing approaches (van Dam & Apeldoorn, 1996; Homburg & Pflesser, 2000; Shultz, 2004; Layton, 2007). Market-oriented sustainability is a stakeholder approach integrating corporate social responsibility (Maignan, Ferrell, & Ferrell, 2005; Wheeler, Colbert, & Freeman, 2003), with the triple bottom line concept (WCED, 1987; Chichilnisky, 1997; Goodland, 1995; Shrivastava, 1995).

Market-oriented sustainability (Crittenden et al. 2011) guides managers to position their organizations in such a manner so as to gain strategic advantage over the competition. An organization that strategically aligns itself with the market-oriented needs of its customers, as well as keeps in mind the interests of multiple stakeholders, will develop better strategies to achieve market-based sustainability (Hult, 2011). Sustainability frameworks that do not involve customers and other stakeholders cannot be linked to a firm's competitive advantage (Hult, 2011). However, due to the challenges of the undertaking, companies struggle to devise strategies that address sustainability systemically across the entire supply chain. As such, Chapter 2 of this dissertation investigates the following critical research question:

> What strategies are used by sustainability-driven organizations to address market-oriented sustainability across their supply chains?

The purpose of this chapter of the dissertation is to present a framework of market-oriented supply chain sustainability derived from corporate reports of firms that are highly regarded for their sustainability efforts. To achieve this purpose, a structured content analysis using Crawdad software on sustainability reports is conducted and optimization routines for teasing out themes from these data are developed.

Chapter 3: Benchmarking Approaches for an Integrated Index for Triple Bottom Line Performance: Cases of the Big Three Firms in the Logistics and Shipping Services Industry

Strategy provides direction and coherence to the actions and decisions of an individual or organization towards a goal or objective (Grant, 2008). Strategically, managing sustainability is complex and requires a sound management framework that integrates environmental and social performance with economic business performance (Johnson, 2006; Schaltegger & Wagner, 2006; Epstein & Roy, 2003). Measuring performance allows management to assess the success of the firm's adaptation to changing environments by measuring performance goals that are long-term, such as maximizing profits and firm value over the lifetime of the company.

According to the Intergovernmental Panel on Climate Change (IPCC, 2007), the logistics industry is a major source of carbon dioxide emissions and accounts for 13.1% of global greenhouse gas emissions. Many perceive these emissions as extremely harmful to the natural balance of our planet and lives of its inhabitants. As supply chains become longer and global trade increases in volume, the logistics industry will continue to grow within and across nations. This will result in higher energy consumption, and as a result - higher emissions, unless new strategies are implemented to improve energy efficiency. Therefore, including environmental and social dimensions in decision-making by logistics and shipping services is widely recognized as the right way to do business (Ciliberti, Pontrandolfo, & Scozzi, 2008).

A big problem in the logistics and shipping services industry is how to balance positive wealth generation by supporting consumption in urban and rural areas (Anderson, Allen, & Browne, 2005) and negative pollution impacts arising from emissions due to burning of fossil fuels (May, Jopson, & Matthews, 2003). Epstein (2008) indicates that managers are increasingly asking how companies can identify, manage and measure the drivers of improved sustainability and the systems and structures that can be created to improve performance measurements. This is becoming more important as companies realize that environmental and social dimensions of sustainability can have a direct impact on economic sustainability. Thus, practices such as "slowgistics" and innovations in routing and modes like increased use of canals and airships that ship goods in environmentally friendly, lighter-than-air blimps are gaining traction among today's supply chain professionals (Oracle Report, 2013).

Given the rate at which congestion is clogging up shipping hubs and motorways, shipping service companies, such as DHL, support sustainable freight transport and gauge the benefits of sustainability versus speed for managing the triple bottom line (Oracle Report, 2013). Thus, sustainability performance measurement (SPM) should include key factors based on economic, ecological, and societal issues (Epstein, 2008; Johnson, 2006; Waddock, Bodwell, & Leigh, 2007; Schaltegger & Wagner, 2006). There are numerous sustainability indicators in the logistics industry that are used to measure economic, environmental and social sustainability. However, these indicators are often measured in different units across different companies. There are no common reporting standards for these metrics. Fundamental intricacies of relationships between consumption, conservation and institutional reporting make sustainability measurement and comparisons of measures especially perplexing. Therefore, Chapter 3 of this dissertation addresses the following critical questions in the logistics and shipping services industry:

> How can the non-standard sustainability efforts of organizations in the logistics and shipping services industry be measured quantitatively using relative influences of economic, environmental and social dimensions?
>
> How can we identify the specific factors of economic, environmental and social dimensions that need to be improved within a firm?

Chapter 4: Environmental Risk Performance of Manufacturing Facilities: Plant, Firm, Industry and State Regulatory Effects

External pressures from various stakeholders such as employees, communities, environmental activists, governments, and nongovernmental organizations are forcing companies in either a reactive or a proactive manner to consider sustainability principles of supply chains (Chen, Shih, Shyur, & Wu, 2012; Sueyoshi & Goto, 2010). Barney (1991) states that resource-based view (RBV) theory takes into account the firm's valuable and nearly unimitable firm resources and capabilities as key sources of sustainable competitive advantage. According to the sustainable supply chain literature, superior environmental performance leads to better industry performance (Porter & Van der Linde, 1995; Russo & Fouts, 1997; Rosen 2001; Chen et al. 2012). According to Klassen and McLaughlin (1996), environmental management is an important dimension of firm management and operations strategy, and strong environmental performance increases the value of companies.

While much research has looked into the impact of environmental performance and regulations on firm performance (Golicic & Smith, 2013; Chen et al. 2012; Sueyoshi & Goto, 2010; Klassen & McLaughlin, 1996; Corbett & Klassen, 2006), analyses of environmental performance of firms have largely ignored the role of the industry as an important source of variation for a firm's environmental performance. Apart from the industry, there may be other factors contributing to the environmental performance of a firm, such as the geographical location of the firm. The state where a firm is located may have a direct influence on the environmental performance of the firm due to the variability of environmental laws in different states. Institutional theory examines the effects of external pressure on a company (Hirsch, 1975). Failure of a firm to conform to critical, institutionalized norms of acceptability can threaten the firm's legitimacy, resources and, ultimately, its survival (DiMaggio & Powell, 1991; Scott, 1987; Bansal, 2005). Previous studies have shown that coercive pressures, especially by the government, are an essential element to drive environmental management (e.g., Kilbourne, Beckmann, & Thelen, 2002) and promote voluntary environmental management practices (Rivera, 2004).

Chapter 4 of this dissertation examines variation in a firm's environmental performance over time and partitions this variability into plant, firm, industry, and regulatory effects. The specific research question that this chapter seeks to answer is:

> What is the extent to which firm, industry and regulatory effects explain the environmental performance differences across manufacturing plants?

In this chapter, the focus is to figure out how much each theory (RBV, industrial organization theory, and institutional theory) contributes to explain the environmental performance. This chapter attempts to fulfill the gap in the literature by explaining whether it is the firm, the industry or the regulations influence on the environmental risk performance of the manufacturing facilities.

In summary, in order to position this research in the broader areas of supply chain, strategy and sustainability, this chapter has provided an overview of SCM strategy, sustainability definitions, sustainable supply chain management, and how sustainability in SCM can be a source of competitive advantage for organizations and their supply chains. As just previewed, Chapters 2, 3 and 4 are devoted to three studies specifically addressing critical research questions that are relevant for modern supply chain managers. Chapter 5 provides a summary of key results and conclusions from this research, and discussion of opportunities for future research.

CHAPTER 2

STRATEGY FRAMEWORK OF MARKET-ORIENTED SUPPLY CHAIN SUSTAINABILITY

Introduction

A recent global survey of about 1,500 industry managers conducted by the Boston Consulting Group and MIT's *Sloan Management Review* revealed that 70% of respondents had not developed any clear strategy for addressing sustainability in their organizations (Berns, Townend, Khayat, Balagopal, Reeves, & Hopkins, 2009). This is an intriguing finding considering 92% of respondents indicated that environmental and social issues will have an economic impact on strategic decision making. These findings indicate that organizations today struggle to achieve the conceptualization of the triple bottom line (Elkington, 1998), through their supply chain strategies. In recent years, organizations have been recognizing environmental and social issues as important to strategic goals (Siegel, 2009). Reflective of the strategic importance of organizational commitment to sustainability, in 1999, the Dow Jones Sustainability Indices (DJSI) were launched to track the financial performance of over 300 leading sustainability-driven companies worldwide (Paulraj, 2011).

Sustainability concerns are being echoed not just in business organizations and their supply chains but even beyond at broader levels of national governance. As recently as June 2013, China's President stated that growth should not be judged solely on accelerating gross domestic product; instead, more importance needs to be placed on social development and environmental quality (Luo & Hamlin, 2013). These developments and multi-leveled initiatives signal a trend away from the singular focus on economic growth and towards a more balanced approach of addressing social and environmental concerns, along with economic concerns. The ultimate goal of achieving a balanced triple bottom line approach to sustainability will not be realized until and unless this important strategic concept is ingrained along the entire supply chain (Preuss, 2005) with a strong focus on all the important stakeholders of value chains (Hult, 2011).

A market-oriented approach to sustainability has the potential to become a competitive capability and a resource advantage for the firm (Crittenden et al., 2011). Hult (2011) conceptualizes market-oriented sustainability as consisting of a market-orientation, engagement of stakeholders, and commitment to corporate social responsibility (CSR). He further states that the key to market-oriented sustainability is good management of and relationship building with all vital stakeholders – employees, customers, consumers, supply chain partners, competitors, investors, lenders, insurers, nongovernmental organizations, media, the government, and society, with oftentimes "customers" as the most important stakeholder. An organization which strategically aligns itself with the market-oriented needs of its customers, as well as keeps in mind the interests of multiple stakeholders, will develop better strategies to achieve market-based sustainability (Hult, 2011). A primary way in which corporations communicate their joint economic, environmental and social concerns is through publishing voluntary sustainability reports.

Researchers agree on the importance of sustainability along the supply chain as an important strategic goal; however, most research has focused on a single function or activity rather than looking at the entire supply chain (Rao & Holt, 2005; Pagell & Wu, 2009). Also, most research does not focus on sustainability in a holistic manner, i.e., there is a dearth of research focusing simultaneously on economic, environmental and social well-being. Some recent studies focusing on sustainability across supply chains include Pagell and Wu (2009), who focus on management practices that supply chain managers need to engage in to create a sustainable supply chain. Their study is accomplished using case studies from 10 exemplar firms. Their case study analysis resulted in five key bundles of practices: Commonalities, Cognitions and Orientations; Ensuring supplier continuity; Reconceptualize the chain; SCM practices; and Measurement. Tate, Ellram and Kirchoff (2010) focus on different environmental and economic themes, which leaders in environmental sustainability lay emphasis upon in their CSR reports. Their findings revealed ten themes which integrate and improve triple bottom line. These ten themes are supply chain, institutional pressure, community focus, customer orientation, external environment, risk management, measures, energy, health, and green building. Paulraj (2011) aims to advance theory building within supply management by developing a model linking firm-specific antecedents, sustainable supply management and sustainability performance. His findings provide support that enviropreneurship and strategic purchasing play a significant role in managing sustainable supply practices and organizational sustainability. Carter and Rogers (2008) advanced the understanding of supply chain management (SCM) literature by presenting a framework of sustainable SCM. They introduced the concept of sustainability to the logistics and SCM literature and positioned sustainability within the broader domain of sustainable SCM. These recent studies take an important step towards advancing our holistic understanding about sustainability. However, these studies do not address the critical issue of how sustainability is strategically presented for all stakeholders of an organization. Specifically, these studies do not focus on supply chain strategies to address market-oriented sustainability. It has been posited that sustainability frameworks that do not involve customers and other stakeholders cannot be linked to a firm's competitive advantage (Hult, 2011). In keeping with this logic, a study examining various frameworks that surface from analyzing the content of publicly available sustainability reports will help define themes that companies are centering on to develop consistent messages for strategy development in this arena.

Also, keeping in view the academic research literature and industry viewpoint on the need to address market-oriented sustainability, and thereby, a potential competitive advantage for the firm, there exists a need to add to the body of literature through a more robust understanding of the process and strategies that leads to the achievement of a sustainable market-oriented supply chain. The primary purpose of this research is to present a theoretical framework to systematically categorize strategies that sustainability-driven firms adopt across their supply chains to address market-oriented sustainability. In particular, this research is guided by the following question:

What strategies are used by sustainability-driven organizations to address market-oriented sustainability across their supply chains?

In order to achieve the objective of this research, we utilize an exploratory research method by objectively coding and analyzing sustainability reports of leading sustainable organizations using text analysis software. Software-assisted coding was preferred over human coding in order to mitigate biases arising from researchers' experience, training or social position, while coding data (Maxwell, 1992; Bluhm, Harman, Lee, & Mitchell, 2011).

The next section focuses on the relevant literature review related to market-oriented sustainability and its link to strategic SCM. The subsequent sections elaborate on the research method used to identify market-oriented sustainability strategies and the leadership approaches that sustainability driven organizations are using to address market-oriented sustainability.

Conceptual Background

A sustainability-driven organization will exhibit a market-orientation approach that includes all key stakeholders, not only the customers, and will have distinctive sustainable supply chain strategies. Such a market-oriented approach to sustainability may result in a resource advantage for the firm (Hult, 2011).

The concept of market-orientation has evolved over time and now is broader in its domain. As per Hunt and Morgan (1995), market-orientation of a firm is an intangible resource that results in its competitive advantage and superior performance. As per Deshpande and Webster (1989), market-orientation is an organizational culture. Market-orientation is important in every market environment and, therefore, is the foundation of an organization's strategy for competitive advantage (Narver & Slater, 1990).

There are three overlapping streams of research in market-orientation which have similarities as well as underlying differences in their perspectives (Crittenden et al., 2011). The first stream was initially conceptualized by Kohli and Jaworski (1990). It focuses on the behavioral perspective of market-orientation, and identifies three pillars of a market-orientation - customer focus, profitability, and coordinated marketing. The other two streams, proposed by Narver and Slater (1990) and Deshpande, Farley and Webster (1993) respectively, focus on a cultural perspective, which is reflective of profound underlying characteristics of an organization. Narver and Slater (1990) advocate a long-term focus of a firm on customer orientation, competitor orientation, and inter-functional coordination, leading to sustained profitability. Deshpande et al. (1993) focus on the customer orientation and corporate culture, as important factors leading to innovativeness and business performance. In spite of their differences, all three streams have a strong focus on the customer. Later on, Slater and Narver (1995) called for inclusion of key stakeholders like suppliers, governments, businesses in other industries, and consultants in the scope of market-orientation. Matsuno and Mentzer (2000) also proposed a broader domain of market-orientation to include suppliers, buyers, and competitors, as well as external influences such as social, cultural, regulatory, and macroeconomic factors. To summarize, market-orientation has evolved over time from its initial conceptualization focusing on the end consumer (customer) to inclusion of various key stakeholders along the entire supply chain. This extended conceptualization is in line with the stakeholder perspective of sustainability research (Crittenden et al., 2011).

There is no clear consensus on the definition of sustainability and hundreds of different interpretations have evolved to operationalize the concept (Linton et al., 2007). Sustainability was first defined in the 1987 Brundtland Report of the World Commission on Environment and Development (WCED), where it is referred to as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The focus of this definition is on conserving natural resources and the importance of environmental dimension of sustainability (Strong, 1997). Costanza et al. (1991) defined sustainability as "consumption that can continue indefinitely without the degradation of natural, physical, human, and intellectual capital". The Center for Sustainable Enterprise defines sustainability as "a way of doing business that creates profit while avoiding harm to people and the planet." Pagell and Wu (2009) define a sustainable supply chain as "one that performs well on both traditional measures of profitability as well as on the extended conceptualization of performance that includes social and natural dimensions".

The concept of sustainability and corporate social responsibility (CSR) often go hand in hand; however, the two concepts are distinct from each other. CSR is defined as situations where the firm goes beyond compliance and engages in "actions that appear to further some social good, beyond the interests of the firm and that which is required by law" (McWilliams & Siegel, 2001). CSR focuses more on the actions directed towards the good of society and excludes direct focus on profitability. Early research on sustainability has mostly focused on environmental concerns and environmental sustainability is still a major issue for organizations today. In today's market-oriented business environment, sustainability-driven organizations have realized that economic, environmental and social sustainability need not be mutually exclusive and often go hand in hand.

For the purpose of this research, 'market-oriented sustainability' is defined as competitive advantage gained by organizations resulting from economic development of stakeholders along supply chains while simultaneously seeking to minimize negative effects on the natural environment and maximizing benefits to society as a whole. The underlying theme in market-oriented sustainability is the inclusion of customers and key stakeholders in the framework to foster competitive advantage over business rivals.

Elevating sustainability objectives and indicators to overall strategic objectives of the organization helps to integrate sustainability into organizational activities (Azzone & Noci, 1998). The same strategies that improve quality, cut costs, reduce waste, and improve economic competitiveness of an organization can be used to improve environmental outcomes as well. This implies that various stakeholders and objectives along a supply chain can be satisfied simultaneously (Curkovic, Melnyk, Handfield, & Calantone, 2000).

Oftentimes, strategies are based on measurable financial goals focusing on cost reductions and improved quality in manufacturing through process innovation; and increased market share (Buysse & Verbeke, 2003; Russo & Fouts, 1997). Increasingly, environmental and economic sustainability are generally accepted as key factors in the success of long term business dealings between firms (Kuosmanen & Kuosmanen, 2009). This is likely a consequence of the perceived importance that corporations sense to create new environmentally sustainable organizations, while enhancing shareholder value (Closs et al., 2011). To facilitate this important goal, effective strategies need to be employed that focus not only within organizations but also across organizations to align extended supply chain. However, Basu and Palazzo (2008) state that academicians are yet to develop an understanding of the activities that address sustainability of organizations. To be more specific, researchers and managers need to comprehend strategies that leading, sustainable organizations pursue across their supply chains to position themselves as economically, environmentally and socially viable for the future. An understanding of current strategies employed for sustainability in supply chains by those organizations that are renowned for being proficient in triple bottom line objectives will generally illuminate these sorts of efforts of supply chain managers. The objective of this research is to fill this gap in supply chain sustainability research by objectively and systematically searching contemporary sustainability reports of leading corporations featured in “Global 100 Most Sustainable Corporations of the World” 2011 report and classifying emergent strategies for market-oriented sustainability in supply chains.

Research Method

Logistics and supply chain research has traditionally relied upon the use of surveys for data collection and empirical analysis. However, in order to expand our understanding of logistics and supply chain phenomenon, use of methodologies based on secondary data is critical (Rabinovich & Cheon, 2011). The concept of market-oriented sustainability is still in its nascent stage and has not been conceptualized in a very coherent form. Furthermore, the strategies used by sustainability driven firms to address market-oriented sustainability have not been defined clearly in the literature. Keeping the above in mind, an exploratory approach which relies on secondary data sources was used to develop a SCM framework for market-oriented sustainability. In order to achieve the research objective, data in the form of publicly available sustainability reports were coded and analyzed through structured content analysis using commercially available software.

Sustainability reports have been previously used as a secondary data source for research in the area of supply chain sustainability (e.g., Closs et al., 2011; Tate et al., 2010; Hofer, Cantor, & Dai, 2012). Closs et al. (2011) analyzed sustainability reports of firms in food, pharmaceutical, electronics, and retail industries and applied a grounded theory approach to develop four dimensions of sustainability – environmental, ethical, educational, and economic. Tate et al. (2010) analyzed sustainability reports of socially and environmentally responsible firms using content analysis software. They developed ten themes of sustainability – supply, institutional pressure, community focus, consumer orientation, external environment, risk management, measures, energy, health, and green building. Companies are increasingly using their websites and company reports as a public relations medium to share important and relevant information with different stakeholders (Closs et al. 2011). Additionally, even though not legally mandated as with financial reports, many of these sustainability reports are verified by external auditors; thereby, providing assurance of accurate reporting by companies. Lastly, since customers are the most vital stakeholders in a market-oriented supply chain, these publicly available reports are an effective means to communicate with customers as well as all other stakeholders. As such, it was deemed reasonable that sustainability reports would constitute a reliable source of secondary data to explore SCM strategies employed by key firms to address market-oriented sustainability in their supply chains.

Data collection

Regarding the selection of sustainability-driven firms, the "Global 100 Most Sustainable Corporations of the World" 2011 report, which shortlists the top sustainability and financial performers from a global universe of 3,500 stocks (2010 Global 100 Project, 2011), was used as the sample frame. These global 100 companies are ranked by a set of Key Performance Indicators (KPIs) calculated using environmental, social, governance (ESG) and financial data collected by Corporate Knights Research Group (www.corporateknights.com) and verified with The Bloomberg Professional® service, with supplemental financial information provided by FactSet Research Systems. This list of sustainable corporations has been used for prior academic research (e.g., Markley & Davis, 2007; Ameer & Otham, 2012). The sample of large, global firms was purposefully selected for two main reasons. First, since such firms deal globally with different cultures and countries, therefore, they are more likely to be sophisticated in their approach to sustainability initiatives (Closs et al. 2011). These companies are more likely to employ specific SCM strategies to address sustainability across their supply chains. Second, leading, global companies have been used in the past due to their leadership position in the industry, which can be used for the purpose of benchmarking (Choi & Hong, 2002; Fisher, 2007).

The list for the year 2011 consists of 20 industry sectors out of which 12 pertain to services such as banks, insurance, media, software services, and healthcare services. Since we are primarily interested in companies with tangible products involved in their supply chains, this research focuses on manufacturing sectors. Therefore, the 12 industry sectors pertaining to services were not included in the data sample. Out of the remaining 8 manufacturing industry sectors, 4 were purposefully selected for data analysis based upon three key decision criteria: a) ranking of the sector in the Global 100 list as per revenue generated; b) performance of the sector in the global manufacturing industry during the recent economic downturn; and c) value of the Purchasing Managers Index (PMI) for the sector. Revenue was considered an important decision criterion as it shows the monetary impact of the sector worldwide. Recent economic downturn saw manufacturing activity going down all over the world. However, those sectors that performed above the average global manufacturing level were regarded as most important, as the demand for these sectors was high even during the time of recession. Finally, PMI indicators are a composite index of production level, new customer orders, supplier deliveries, inventories, and employment level, and are considered as a very important reading of the global economy (ISM 2013). Based on these three decision criteria, the top three firms from each of the four manufacturing industry sectors were selected for data analysis. These sectors were automobiles and components, food and beverage, pharmaceuticals and biotechnology, and semiconductor and technology equipment. Out of all manufacturing sectors, semiconductor and technology equipment, automobiles and components, and pharmaceutical biotechnology industries topped the "Global 100 Most Sustainable Corporations of the World" 2011 report in terms of annual revenue, which was about $363 billion, $325 billion, and $201 billion respectively. Therefore, they were considered as important sectors to be included in the data sample. Furthermore, as per Markit Global Sector Purchasing Managers Index (PMI), which is a monthly survey of 20,000 companies in 28 countries, manufacturers of auto, food and beverage, pharmaceuticals and biotechnology, and semiconductor and technology equipment have consistently outpaced the global manufacturing average with PMIs greater than 51 (Young, 2013). A reading of greater than 50 indicates growth, whereas an output of less than 50 indicates contraction. In the manufacturing sector, food and beverages, automobiles and components, and pharmaceuticals and biotechnology industries sector topped the PMI with an output of 58.8, 56.2, and 54.1 respectively. Due to the reasons discussed above, this research focused on four specific industry sectors. The selection criteria along with ranking of the four industry sectors are presented in Table 2.1.

Table 2.1: Selection Criteria for Four Industry Sectors for Analysis

Industry	Ranking in Global 100 list as per revenue generated	Performance in manufacturing during economic downturn	PMI output
Semiconductor and Technology Equipment	1	above average	51.2 (expansion)
Automobiles and Components	2	above average	56.2 (expansion)
Pharmaceuticals and Biotechnology	3	above average	54.1 (expansion)
Food and Beverages	6	above average	58.8 (expansion)

Data in the form of annual reports, corporate social responsibility (CSR) reports and sustainability reports were collected. Each report was an average of 99 pages long with a total of 1188 pages analyzed. The longest report was 120 pages while the shortest one was 68 pages in length. Table 2.2 provides descriptive statistics of the firms used for coding through structured content analysis.

Table 2.2: List of 12 Companies from Four Industry Sectors Selected from Global 100 Most Sustainable Corporations in the World (2010 Global 100 Project, 2011)

Industry	Organization Name	Revenue (US$ billion)	Country of Headquarters
Automobiles and Components	Johnson Controls Inc.	35.43	United Sates
	Nissan Motor Co. Ltd.	84.30	Japan
	Toyota Motor Co.	205.13	Japan
Food Beverage and Tobacco	Kraft Foods Inc.	40.39	United States
	Coca-Cola Enterprises	21.65	United States
	Unilever Plc	55.53	Britain
Pharmaceuticals & Biotechnology	Johnson & Johnson	61.90	United States
	Agilent Technologies Inc.	4.48	United States
	GlaxoSmithKline Plc	44.42	Britain
Semiconductor and Technology	Intel Corp.	35.13	United States
	Hewlett-Packard Co.	114.55	United States
	Samsung Electronics Co. Ltd.	70.75	Korea

Structured Content Analysis

Structured content analysis methodology was used to analyze corporate reports in a scientific, systematic and quantitative way. This methodology has been widely used in the field of social science and humanities literature such as communications, history and political science (Tate et al., 2010). More recently, it has also been used in operations, supply chain and strategic management literature. Table 2.3 summarizes a few papers in operations, logistics and supply chain literature that have employed this methodology.

Table 2.3: Summary of SCM Papers Employing Structured Content Analysis Methodology

Author (Year)	Publication	Title	Description of methodology
Hofer, Cantor and Dai (2012)	Journal of Operations Management	The competitive determinants of a firm's environmental management activities: Evidence from US manufacturing industries	- Each text analyzed individually for influence values of words. - All reports analyzed simultaneously – 500 most influential words occurring in at least half the reports (total reports = 162). - Correlation matrix generated – 500 x 500 = 250,000 combinations. - 53,000 positively correlated combinations. - Top down approach to filter out relevant themes that identify 33 EM activities defined by Montabon et al. (2007).
Tate, Ellram and Kirchoff (2010)	Journal of Supply Chain Management	Corporate Social Responsibility Reports: A thematic analysis related to supply chain management	- All reports analyzed simultaneously - 300 most influential words common in two or more reports. - Theme development using EFA. Themes in EFA provided a starting point for naming themes. - Each researcher independently developed names for ach theme – latent coding. - 79 out of 300 influential words were eliminated due to very low loadings in EFA. - 10 themes emerged after putting all 221 influential words in separate themes.
Rossetti and Dooley (2010)	Journal of Supply Chain Management	Job types in the supply chain management profession	- Analysis of words that appeared in at least 20 job descriptions. - Average influence score for each word. - ANOVA used to test whether average influence value of a particular word was different.
Lee and James (2007)	Strategic Management Journal	She'-e-os: Gender effects and investor reactions to the announcements of top executive appointments	- Articles separated in two groups: male CEO and female CEO announcements. - Top influential 15 words and least influential 15 words in two groups generated to identify importance / influence of gender in announcements.
Rossetti, Handfield and Dooley (2011)	International Journal of Physical Distribution and Logistics Management	Forces, trends, and decisions in pharmaceuticals supply chain management	- 3 categories of forces identified using industry experts. - All interviews aggregated into single text and analyzed. - 250 words with highest average influence.

Structured content analysis, using Crawdad software, was used to extract data on a firm's market-oriented sustainability strategies from its annual corporate and sustainability reports. Analysis was performed on all firms listed in Table 2.2.

In order to perform structured content analysis on the text contained in the sustainability and corporate reports, this research employed a centering resonance analysis (CRA) technique using Crawdad software. Two important concepts form the basis of this CRA technique – influence values and correlation values of words contained in a text.

This process of valuation using CRA relies on an automated coding algorithm, which mathematically assesses the centrality of a topical theme within a textual document (Hofer et al. 2012). The automated process helps mitigate the common problem of subjective biases with a manual coding process. This technique not only counts the frequency of occurrence of a keyword or a string of keywords, but also assesses the interconnectedness of keywords in the document based on network analysis (McPhee, Corman, & Dooley, 2002; Hofer et al., 2012). Keywords with many connections to other words may be described as "central". In other words, the more words that connect to a particular keyword, the greater the "betweenness centrality (BC)" of that keyword. The focus of this CRA technique is to identify those keywords that have high BC scores as measured by the influence level of keywords in a text. Mathematically, the influence (I) of a keyword in a text T is represented using a social network metric as follows (Corman, Kuhn, McPhee, & Dooley, 2002):

$$I_i^T = \frac{\sum_{j<k} g_{jk}^{(i)} / g_{jk}}{\left[\frac{(N-1)(N-2)}{2}\right]}$$

where

I_i^T = influence of a word i in text T

g_{jk} = number of shortest paths connecting j_{th} and k_{th} words

$g_{jk}^{(i)}$ = number of those paths containing word i

N = numbers of words in the network

Crawdad also calculates the correlation value between two words. A positive correlation between a pair of words suggests that the given pair tends to co-occur in close proximity in the text (Hofer et al. 2012). This is defined mathematically by Corman et al. (2002) as follows

$$P_{ij}^T = I_i^T \,.\, I_j^T \,.\, F_{ij}^T$$

where

P_{ij}^T is the correlation value between words w_i^T and w_j^T

I_i^T is the influence of word w_i^T

I_j^T is the influence of word w_j^T

F_{ij}^T is the number of times that w_i^T and w_j^T co-occur (their corresponding nodes are connected directly by an edge) in text T

The objective of structured content analysis in this research was to pull out relevant excerpts from company reports that reflect various themes and strategies related to market-oriented supply chain sustainability. In order to achieve this objective, only those excerpts had to be extracted which reflected keywords related to market-orientation and supply chain management, and also contained most influential words in the reports. The process adopted to achieve this objective is described as follows.

Keywords related to market-orientation as conceptualized by Slater and Narver (1995) and Matsuno and Mentzer (2000) were shortlisted. These keywords are: market, employee, customer, staff, stakeholder, passenger, people, society, shareholder, investor, government, supplier, and competitor. The keywords representing supply chain management were shortlisted as per Rossetti and Dooley (2010) who provide a list of keywords associated with supply chain management. These keywords are: operation, network, supply, chain, source, management, transport, schedule, quality, procurement, purchasing. The keywords representing sustainability and strategy were not included in the matrix because the reports being analyzed in this research are by definition "sustainability reports" and we are arriving at strategies from these reports. Altogether, 24 words, as listed in Table 2.4, were shortlisted.

Table 2.4: Keywords Related to Market-orientation and Supply Chain Management

Term / Concept	Keywords	Source
Market-orientation	market, employee, customer, staff, stakeholder, passenger, people, society, shareholder, investor, government, supplier, and competitor	Slater and Narver (1995) Matsuno and Mentzer (2000)
Supply chain management	operation, network, supply, chain, source, management, transport, schedule, quality, procurement, purchasing	Rossetti and Dooley (2010)

The most influential words in sustainability reports were generated using Crawdad software. Files in PDF for each report were downloaded from company websites and converted to a text file. The next step was to generate the maximum number of most influential words common across all the reports. Crawdad has a limitation to generate a maximum of 500 such words. We started with the most stringent condition by trying to generate the 500 most influential common words occurring in all 12 reports. However, this condition generated less than 100 words; thereby, narrowing the scope of analysis. Therefore, we relaxed the condition step-by-step to generate common words in decreasing numbers of reports (11, 10, 9 … and so on). Crawdad was able to generate 500 most common influential words if the condition was set to at least half (50%) of the reports. This constraint that a word must appear in at least 50% of the reports not only fully populated the keyword list; it is also consistent with previous research (Hofer et al., 2012; Tate et al., 2010). Thus this rule was used to generate the initial list of keywords in our reports.

A word influence value greater than .01 is considered significant (Corman & Dooley, 2006). Therefore, out of the 500 words generated, 422 words with an influence value less than .01 were eliminated. This resulted in a list of 78 significantly influential words that were present in at least half of the reports. These 78 words were scanned for uniqueness and any duplication of words was remedied. The final list of most influential words consisted of 60 words. The 18 words removed from the list of influential words along with reasons for elimination are listed in Table 2.5.

Table 2.5: Influential Words Eliminated from List for Analysis

Word		Reason	Word retaining logic
eliminated	**Retained**		
Âeuro		Artifact of software for punctuation in text.	
Percent		General words having no specific link to sustainability strategies.	
Use			
Good			
Vehicle			
Child			
u.s.		Words related to countries	
Japan			
China			
environmental	environment	Words with similar meaning	Greater value of average correlation across all keywords.
Sustainability	Sustainable		
Staff	Employee		Greater value of average correlation across all most influential words.
People		Duplicate words with market-oriented and SCM words	
Supplier			
Management			
Employee			
Customer			
Market			
Quality			

Out of the 24 keywords related to 'market-orientation' and 'SCM', 2 words were not found in the 500 words generated initially from at least half the reports. Therefore, the final words included for analysis consisted of 22 keywords related to market-orientation and SCM, and 60 words common across at least half the reports and having an influence value greater than .01.

Our next step was to group the 22 keywords representing market-orientation and SCM into different clusters with each cluster consisting of groups of most closely correlated (in the nearest vicinity of each other) words. In order to accomplish this step, a correlation matrix of the 22 keywords was optimized in pairs with a linear programming (LP) model in MS Excel using large scale Frontline Solver software. The objective function of the model was to maximize the sum of word pair correlations with the constraint that each keyword can occur in a pair only once.

This resulted in generation of 22 highest correlated keyword pairs. The solution to this LP model is shown in Appendix 1. The 22 keyword pairs were then grouped into clusters based upon common words found in keyword pairs. Specifically, if two word pairs had a common keyword, then both word pairs were grouped into a single cluster. This process resulted in 22 keywords being grouped into 7 clusters. The keywords “staff” and “employee” are similar in meaning, with “staff” having a lower influence value of .00038 as compared to the influence value of .04666 for “employee”. Due to this reason, the keyword “staff” was eliminated, resulting in 21 keywords grouped in 7 clusters.

The next step involved extending the 7 word clusters generated in the previous step to include only those unique influential words (out of 60 such words) that were most closely correlated with each cluster. The logic behind this step was to generate unique word clusters with each representing tightly linked market-orientation and SCM words with other most influential words found in the reports. Such word clusters could then be conceptualized as market-oriented sustainable SCM strategies of leading global companies. In order to achieve this conceptualization, a correlation matrix of 7 x 60 was generated which contained 7 clusters of keywords (containing average correlation values of all words in a cluster) and 60 most influential words. This correlation matrix was then optimized to match the 60 words to 7 clusters with a LP model in MS Excel using large scale Frontline Solver software. The objective function of the model was to maximize the sum of pair correlations consisting of influential word and keyword cluster with the constraint that each influential word can be matched to a keyword cluster only once.

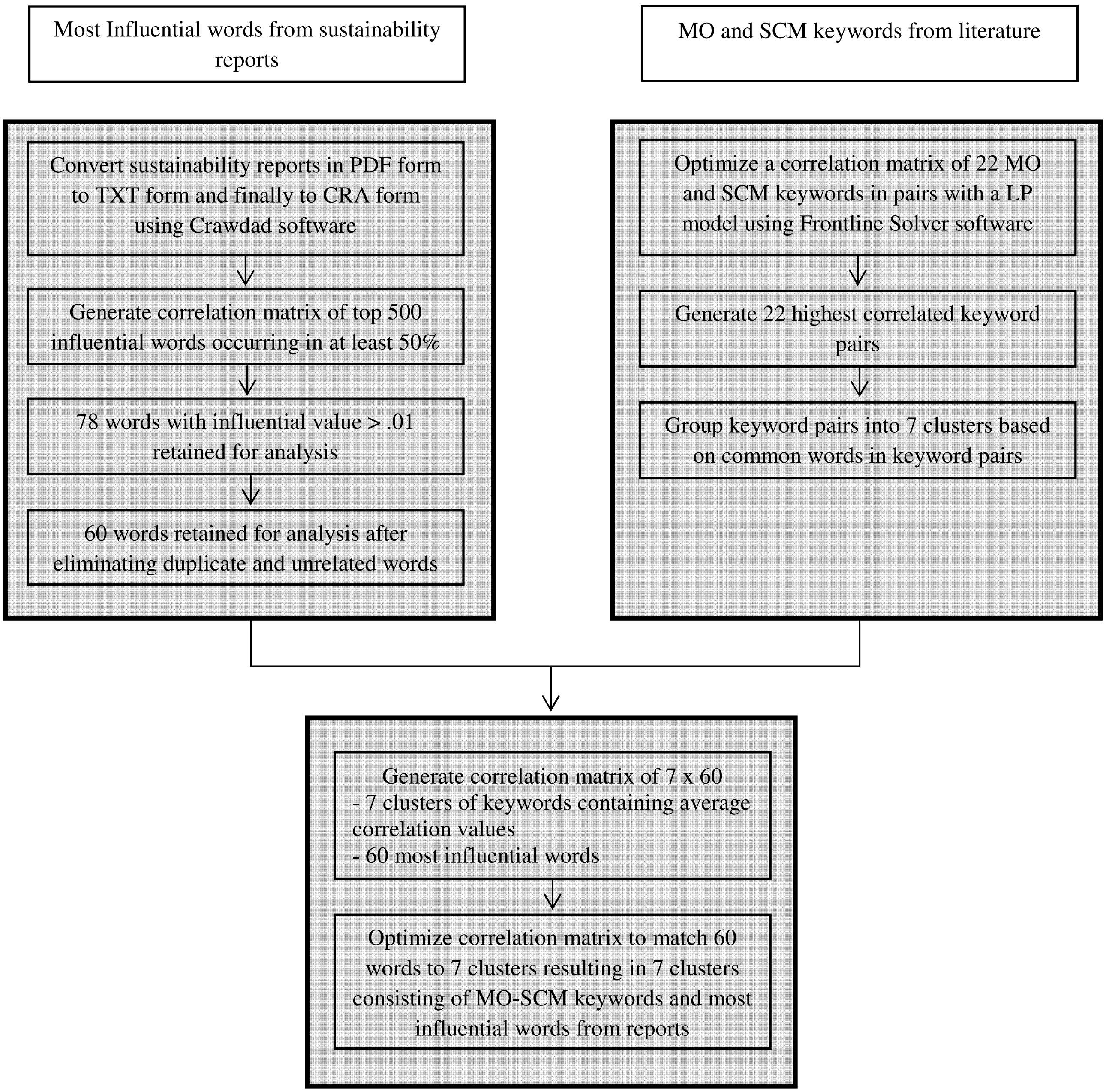
This resulted in generation of 7 clusters consisting of keywords and influential words as illustrated in Table 2.6. Aggregate influence score for each cluster was found to be greater than 0.02 and therefore, each cluster is considered as significant as suggested by Corman et al. (2002) and Hofer et al. (2012). The solution to this LP model is attached as Appendix 2.

Table 2.6: Clusters of Keywords and Most Influential Words

	Cluster 1		**Cluster 2**		**Cluster 3**		**Cluster 4**		**Cluster 5**		**Cluster 6**		**Cluster 7**	
	Word	Av. Inf. Value	Word	Av. Inf. Value	Word	Av. Inf. Value	Word	Av. Inf. Value	Word	Av. Inf. Value	Word	Av. Inf. Value	Word	Av. Inf. Value
MO and SCM Keywords	people transport	0.0203 0.0014	supplier source purchase	0.0173 0.0017 0.0004	management shareholder employee	0.0146 0.0012 0.0467	customer market	0.0089 0.0087	quality society investor	0.0063 0.0021 0.0005	operation government stakeholder competition media	0.0042 0.0038 0.0023 0.0006 0.0004	supply chain network	0.0037 0.0026 0.0016
Influential Words	product water world consumer material sustainable country waste goal packaging number approach large impact	0.0469 0.0268 0.0155 0.0128 0.0126 0.0119 0.0105 0.0102 0.0089 0.0060 0.0070 0.0053 0.0057 0.0052	food facility local industry partnership	0.0099 0.0091 0.0075 0.0058 0.0056	program health corporate safety policy standard high site total process social	0.0258 0.0233 0.0105 0.0081 0.0075 0.0073 0.0070 0.0063 0.0066 0.0058 0.0051	business global energy new year technology performance service change leader	0.0325 0.0252 0.0169 0.0161 0.0148 0.0126 0.0088 0.0081 0.0065 0.0051	system activity group emission part environment effort	0.0206 0.0087 0.0083 0.0076 0.0075 0.0065 0.0061	company development community report initiative work project education resource	0.0350 0.0121 0.0105 0.0105 0.0067 0.0065 0.0060 0.0057 0.0052	information data area organization	0.0131 0.0088 0.0079 0.0065
Agg. Inf Score		**0.2070**		**0.0573**		**0.1757**		**0.1641**		**0.0741**		**0.1095**		**0.0443**

The process leading to generation of seven word clusters in table 2.6 is illustrated in figure 2.1.

Figure 2.1: Protocol Developed to Generate 7 Word Clusters of MO-SCM and Most Influential Words



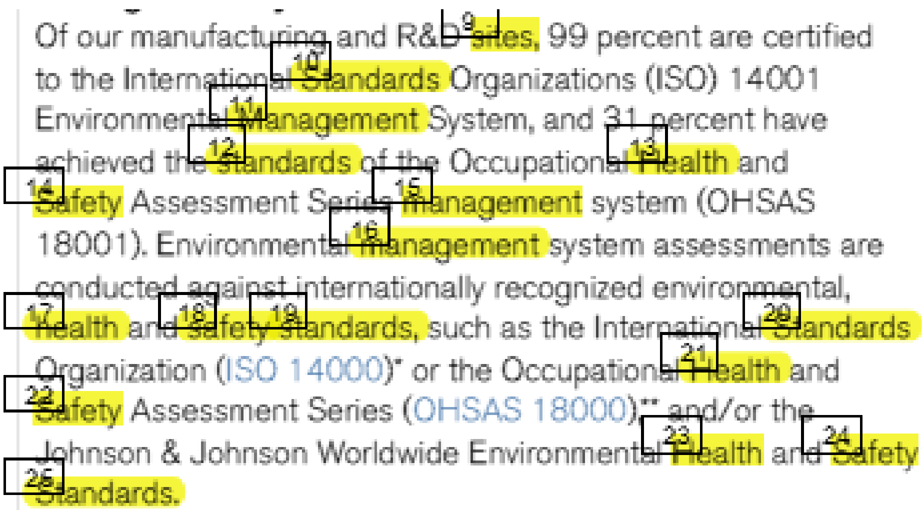
To add context to the clustered themes, each cluster was then used as the basis to search for sentences and paragraphs in the reports which represented various themes and strategies. A selection protocol was developed to choose the sustainability reports for extracting sentences and paragraphs from them. The protocol was developed in order to ensure that no report is chosen arbitrarily, which could bias the findings, and each report should get proportional representation for extraction of themes and strategies. Sustainability reports of Intel and Toyota were eliminated for selection as these reports were found to be highly secure and ‘search’ and ‘markup’ function of PDF Converter Professional 8.1 software was blocked for these reports. The protocol is explained with the help of an example illustrating the selection of reports for cluster 1. As seen in Table 2.6, the word “product” has the highest average influential value of 0.0469. Therefore, the word “product” was searched in individual reports and the report having the highest influential value for “product” (in this case, Unilever, having the influential value of 0.1491 for the word “product”) was selected for searching cluster 1. Next, the word “water” having second highest average influential value (0.0268 from Table 2.6) was searched in individual reports and the report having the highest influential value for “water” (in this case, Coke, having the influential value of 0.0830 for the word “water”) was selected for searching cluster 1 again. This process was repeated for each cluster with top 2 words being selected for each cluster. The constraint was that each report can be used only once and can be repeated only after all reports had been exhausted for selection. The reports selected for each cluster are shown as highlighted in Table 2.7. For cluster 6, the word “company” had the highest average influential value (refer Table 2.6); however, since “company” is a generic word and common across all reports, it was not included in the protocol.

Table 2.7: Report Selection for Each Cluster of Words

Organization	Cluster 1		Cluster 2		Cluster 3		Cluster 4		Cluster 5		Cluster 6			Cluster 7	
	product	water	supplier	food	employee	Program	business	global	system	Activity	company	development	community	information	data
Agilent	0.0197	0.0138	0.0139	0.0064	0.1230	0.0520	0.0275	0.0218	0.0221	0.0188	0.0300	0.0158	0.0240	0.0084	0.0175
Coke	0.0219	0.0830	0.0124	0.0038	0.0075	0.0303	0.0508	0.0373	0.0341	0.0029	0.0758	0.0178	0.0302	0.0102	0.0058
GSK	0.0390	0.0064	0.0115	0.0003	0.0280	0.0000	0.0193	0.0094	0.0098	0.0068	0.0151	0.0112	0.0067	0.0115	0.0166
H-P	0.0331	0.0082	0.0269	0.0001	0.0335	0.0262	0.0290	0.0215	0.0219	0.0026	0.0171	0.0091	0.0048	0.0212	0.0354
Intel	0.0194	0.0373	0.0198	0.0011	0.0712	0.0410	0.0236	0.0112	0.0197	0.0046	0.0117	0.0115	0.0088	0.0147	0.0089
J&J	0.0735	0.0144	0.0072	0.0000	0.0586	0.0192	0.0445	0.0243	0.0023	0.0018	0.0699	0.0129	0.0049	0.0126	0.0024
Johnson controls	0.0258	0.0027	0.0282	0.0016	0.0482	0.0318	0.0553	0.0362	0.0328	0.0015	0.0383	0.0095	0.0059	0.0115	0.0030
Kraft	0.0749	0.0220	0.0377	0.0948	0.0499	0.0356	0.0310	0.0357	0.0117	0.0002	0.0355	0.0078	0.0227	0.0070	0.0013
Nissan	0.0085	0.0032	0.0138	0.0001	0.0399	0.0150	0.0264	0.0325	0.0481	0.0391	0.0360	0.0162	0.0018	0.0154	0.0004
Samsung	0.0513	0.0051	0.0060	0.0000	0.0330	0.0330	0.0384	0.0381	0.0236	0.0173	0.0544	0.0081	0.0055	0.0168	0.0027
Unilever	0.1491	0.0988	0.0125	0.0012	0.0204	0.0000	0.0120	0.0089	0.0000	0.0001	0.0008	0.0132	0.0000	0.0147	0.0030

Once all reports were selected, PDF Converter Professional 8.1 software was employed to search and markup multiple words simultaneously for each cluster. For example, all 14 words of cluster 3 from table 2.6 were fed into PDF Converter Professional software and the occurrence of the words were searched and highlighted in the sustainability reports of Johnson & Johnson and Johnson Controls. Similarly, all words of each cluster from table 2.6 were fed into PDF Converter Professional software and the occurrence of the words were searched and highlighted in the sustainability reports of different reports from table 2.7. The paragraphs and sentences which were found to have a dense clustering of highlighted words were extracted from the reports. A sample of one such paragraph extracted from Johnson & Johnson sustainability report using PDF Converter Professional 8.1 software for cluster 3 is illustrated in Figure 2.1. The excerpts extracted from various reports are shown in Table 2.8.

Figure 2.2: Snapshot of Paragraph extracted from J&J Report using PDF Converter Professional 8.1


Of our manufacturing and R&D sites, 99 percent are certified to the International Standards Organizations (ISO) 14001 Environmental Management System, and 31 percent have achieved the Standards of the Occupational Health and Safety Assessment Series Management system (OHSAS 18001). Environmental Management system assessments are conducted against internationally recognized environmental, Health and Safety Standards, such as the International Standards Organization (ISO 14000)* or the Occupational Health and Safety Assessment Series (OHSAS 18000)** and/or the Johnson & Johnson Worldwide Environmental Health and Safety Standards.

Next, all excerpts extracted from sustainability reports of firms using each word cluster were subjected to latent coding to look for underlying implied meaning of all excerpts for each word cluster. Latent coding helps to connect words in order to form themes (Neuman, 2000; Tate et al., 2010). In this research, latent coding helped to connect the highlighted words in the excerpts to strategies of the 12 firms in our sample. This process resulted in the emergence of seven distinct market-oriented supply chain sustainability strategies. These proposed seven strategies with their associated seven word clusters, and excerpts from sustainability reports are presented in seven tables: table 2.8 – table 2.14.

Table 2.8: Word Cluster 1 and associated Excerpts and Proposed Strategy

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
Cluster 1: People, transport,	Unilever	"However, our impact goes beyond our factory gates. The sourcing of raw materials and the use of our products by the consumer at home have a far larger footprint. We recognize this and so our plan	Product Lifecycle Assessment

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
product, water, world, consumer, material, sustainable, country, waste, goal, packaging, number, approach, large, impact		is designed to reduce our impacts across the whole lifecycle of our products."	
	Unilever	"Most of our GHG emissions come from the hot water needed to use our soaps, shower gels and shampoos. To achieve our goal we will have to provide consumers with products and tools that will enable them to use less water."	
	Unilever	"Packaging protects our products and allows us to transport them safely, but at the same time it can end up as waste. Our approach to sustainable packaging takes a lifecycle perspective. We will achieve our waste reduction targets through a combination of reducing, reusing, recycling and eliminating packaging materials."	
	The Coca-Cola Company	"In 2005, The Coca-Cola Company and USAID launched the Water and Development Alliance (WADA)—a unique partnership to address community water needs in developing countries around the world. In conjunction with local USAID Missions and Coca-Cola system partners (foundations and bottling facilities), and with support from the Global Environment and Technology Foundation (GETF), WADA contributes to protecting and improving the sustainability of watersheds, increasing access to water supply and sanitation services for the world's poor, and enhancing productive uses of water. With a combined investment of over $30 million since 2005, the partnership is having a positive impact on the lives of people and the health of ecosystems in 23 countries in Africa, Asia, Latin America and the Middle East, providing clean drinking water to over 500,000 people, ensuring access to basic sanitation to over 55,000 people, and protecting more than 400,000 hectares of critical watersheds."	
	The Coca-Cola Company	"In 2010, we improved our water use efficiency for the eighth consecutive year, reducing the average amount of water required to produce each beverage serving. Since 2005, we estimate that we have replenished 23 percent of the water used in our finished products, and we are gaining momentum toward achieving our goal of water neutrality by 2020. We also aspire to treat all wastewater from our manufacturing processes. As of the end of 2010, we had achieved 93 percent alignment, and by the end of 2011 we estimate 96 percent alignment with our stringent standards. To	

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
		read more about our water stewardship efforts, please refer to the Water Stewardship section of this report."	
	The Coca-Cola Company	"A positive recent trend we see in the movement toward zero waste is the development of common metrics for more sustainable packaging being facilitated by The Consumer Goods Forum. A common language along with a framework and measurement system on 'packaging sustainability' will help businesses, governments, consumers and NGOs as we all work toward eliminating waste."	

Table 2.9: Word Cluster 2 and associated Excerpts and Proposed Strategy

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
Cluster 2: supplier, source, purchase, food, facility, local, industry, partnership	Kraft	"Similarly, in 2010, Kraft Foods led an industry wide initiative to create and publish guidance for the safe production of nuts and made it available to nut suppliers and producers."	Supplier Relationships
	Kraft	"Partnerships are vital to our success. Internally, our 10 employee resource groups, made up of diverse employees around the world, help us promote and drive diversity and inclusion. External partnerships with organizations and associations that share our commitment to diversity and inclusion help us accelerate the pace of change."	
	Kraft	"I want to elaborate a bit on Partnerships. Even though there is a lot we can do as the world's second-largest food company, many of the issues we're tackling are so big that we can only achieve lasting change when we work with others. So together with our suppliers, customers and consumers … with governments, multilateral organizations and nongovernmental organizations (NGOs) … we look for innovative"	
	Agilent	"In addition to formal charity campaigns, Agilent held numerous fundraisers and collection drives to gather food and supplies for local humanitarian organizations."	
		"In 2010, Agilent and its foundation provided more than $1.2 million for programs and	

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
		partnerships that cultivate hands-on, inquiry-based science in alignment with local and national standards and initiatives."	
	Agilent	"Our Standards of Business Conduct clarify the extension of our values to our suppliers. It states that we will not establish or maintain a business relationship with a supplier if we believe that its practices violate local laws or basic international principles relating to labor standards or environmental protection."	

Table 2.10: Word Cluster 3 and associated Excerpts and Proposed Strategy

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
Cluster 3: management, shareholder, employee, program, health, corporate, safety, policy, standard, high, site, total, process, social	Johnson & Johnson	"We believe good corporate governance results from sound processes that ensure our directors are well-supported by accurate and timely information, sufficient time and resources, and unrestricted access to management. Additionally, we believe the business judgment of the Board must be exercised independently and in the long-term interests of our shareholders."	Global Governance and Accountability
	Johnson & Johnson	"The Public Policy Advisory Committee (PPAC) assists the Board of Directors by reviewing and making recommendations regarding Company positions on public policy issues facing the Company, public health issues, the health and safety of employees, the environment and other issues pertinent to our social, environmental and economic performance."	
	Johnson & Johnson	"Of our manufacturing and R&D sites, 99 percent are certified to the International Standards Organizations (ISO) 14001 Environmental Management System, and 31 percent have achieved the standards of the Occupational Health and Safety Assessment Series management system (OHSAS 18001) Environmental management system assessments are conducted against internationally recognized environmental, health and safety standards, such as the International Standards Organization (ISO 14000) or the Occupational Health and Safety Assessment Series	

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
		(OHSAS 18000), and/or the Johnson & Johnson Worldwide Environmental Health and Safety Standards"	
	Johnson Controls	"Johnson Controls' community programs support education, arts, the environment, leadership development and social services. This year, Johnson Controls employees volunteered more of their time than ever before - a total of 130,600 hours."	
	Johnson Controls	"The GPC oversees our enterprise-wide supply chain survey that provides guidance to our procurement teams on the environmental and social performance of suppliers. This includes details on labor, discrimination, freedom of association, health and safety, the environment, management systems and ethics. The survey was developed in partnership with key customers, socially responsible investment funds and non-governmental organizations."	

Table 2.11: Word Cluster 4 and associated Excerpts and Proposed Strategy

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
Cluster 4: Customer, market, business, global, energy, new, year, technology, performance, service, change, leader.	Samsung Electronics	"The ultimate goal of our business philosophy is to promote the public interest and contribute to bettering society. We devote our talent and technology to provide superior products and services that satisfy customers' needs. Our business philosophy expresses our mission and reveals our ultimate objective and direction."	Innovation
	Samsung Electronics	"Employees consider Samsung to be a global company, especially in terms of revenue, brand value and market share etc. We are proud to work in a company that has demonstrated such outstanding success in all regions of the world in such a short period of time. What truly made Samsung to continue its growth in the middle of rapid global economic changes and challenging industry trends were our people? I believe our people are certainly the key. It is their creativity and commitment that has made the Company successful to date. Going forward, the Company's	

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
		ability to generate new growth depends on the ability of our employees to spot new ideas and opportunities, argue for them”	
	Samsung Electronics	“Samsung Electronics continues to launch energy efficient products and carry out voluntary initiatives to collect and recycle waste electronic products in the North American markets. We also contribute to raising consumers’ environmental awareness through green marketing practices and education on energy conservation. For our proactive approach, we received the ENERGY STAR Award for Excellence for two consecutive years.”	
	Nissan	“Our work in zero-emission mobility is an important pillar in our sustainability strategy. We remain on track to bring new electric vehicles to the Japanese, U.S. and European markets in 2010 and to mass-market our zero-emission lineup globally two years later.”	
	Nissan	“To steadily reduce CO_2emissions, we aim to provide effective technologies at prices customers can afford and to spread these technologies widely with a focus on their total contribution. Our basic approach to introducing technology is the “four rights”—providing the right technology, at the right time, in the right market and at the right value to the customer.”	
	Nissan	“Each year Nissan recognizes the contributions of its suppliers with awards presented in each of the regions where we operate, as well as with two worldwide supplier awards, the Global Quality and Global Innovation Awards. These are presented to suppliers that have contributed to our business performance at the global level.”	

Table 2.12: Word Cluster 5 and associated Excerpts and Proposed Strategy

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
Cluster 5: Quality, society,	HP	“HP holds quarterly discussions with Ceres, a network of investors, environmental organizations, and other public interest groups working to address sustainability challenges. We seek their	Stakeholder Engagement and Diversity

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
investor, system, activity, group, emission, part, environment, effort.		input on HP's efforts in environmental sustainability and their advice on furthering employee engagement in this area. The report by Ceres, The 21st Century Corporation, highlights HP's sustainability efforts."	
	HP	"Each employee has an individual responsibility to understand and support our environmental, health and safety policies and to actively participate in programs to ensure our goals are achieved. We believe our company must work with employees, suppliers, partners, customers, and governmental, nongovernmental and community organizations to protect and enhance health, safety and the environment."	
	HP	"Over the years, the HP Women's Network in Munich has grown to more than 260 members. The success of the group in part reflects Chantal's dedication to creating a work environment where women are heard, feel supported, and can thrive."	
	GSK	"Patients rely on us to provide an uninterrupted supply of medicines, manufactured to the highest-quality standards. An effective and responsibly managed supply and distribution system is essential for us to get high-quality products to the right place at the right time."	
	GSK	"In this section we focus on our relationships with third-party suppliers and explain the standards we set for them. We aim to source from companies that maintain high standards for quality, labour and the environment, and protect their employees' human rights. Our standards are explained in our quality, EHS and human rights clauses in supplier contracts."	
	GSK	"The panel is drawn from customers, suppliers, regulators, public interest groups, environmental organisations and investors. Two senior EHSS representatives from GSK regularly participate and other GSK managers attend discussions on specific topics. The panel is facilitated by the Environment Council, an independent charity."	

Table 2.13: Word Cluster 6 and associated Excerpts and Proposed Strategy

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
Cluster 6: Operation, government, stakeholder, competition, media, company, development, community, report, initiative, work, project, education, resource.	The Coca-Cola Company	"We continued working to make The Coca-Cola Company—and our entire system—a great place to work, starting with an unwavering commitment to workplace and human rights. We have increased the number of women in system leadership roles, going from 23 percent in 2008 to just over 27 percent in 2010. And we will build on this progress through employee development and recruitment. To read more about our workplace initiatives, please refer to the Great Place to Work section of this report."	Social Initiatives
	The Coca-Cola Company	"With the help of The Nature Conservancy, academics and other key water stakeholders, we have developed a methodology to quantify how much water we have replenished through our community water projects. While our most recent analysis has not yet been peer-reviewed, we estimate 23 percent of the water used in our finished beverages (based on 2009 unit case volume) was replenished through projects we conducted between 2005 and 2010—up from the 22 percent we reported in our last sustainability report, the 2009/2010 Sustainability Review."	
	The Coca-Cola Company	"Around the world, our bottling partners are engaging in community water projects as a way to achieve their replenish targets and build connections with local residents, governments and NGOs. To date, we have engaged in 320 community water projects in 86 countries, which include 96 education and awareness programs."	
	Agilent	"Agilent values, policies and our ISO14001 management system help us to achieve our energy-saving goals year after year. To get there, we have a broad range of initiatives: capital spending for energy conservation projects and solar power, operational improvements and employee action. In our 2010 fiscal year, we implemented energy conservation projects and operational improvements totaling 9.5 million Kilowatt-Hours, a 3.6 percent reduction from fiscal 2009."	
	Agilent	"Drive continuous improvement in environmental sustainability through recycling, conservation of resources, prevention of pollution, product development, and promotion of environmental responsibility among our employees. Ensure our operations comply with relevant environmental	

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
		regulations. Conduct our operations in a manner committed to the conservation of resources, prevention of pollution and promotion of environmental responsibility."	

Table 2.14: Word Cluster 7 and associated Excerpts and Proposed Strategy

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
Cluster 7: Supply, chain, network, information, data, area, organization	HP	"HP also maintains separate councils dedicated to global citizenship issues such as the environment, supply chain, ethics, and privacy, as the graphic above illustrates. These councils include leaders with relevant expertise from our business units, regional organizations, and functions. Each council meets periodically to evaluate whether HP's global citizenship strategies are being implemented effectively, and to establish goals and assess progress. To ensure alignment, leaders from each focus area also sit on HP's Global Citizenship Council."	Supply Chain Collaboration
	HP	"Enterprises, government agencies, and consumers increasingly consider companies' global citizenship when choosing information technology (IT) products, solutions, and services. HP provides information, tools, and resources to educate customers about global citizenship issues and to help them evaluate our performance in areas such as the environment, supply chain management, and privacy."	
	HP	"Optimizing distribution networks decreases the distance products need to travel and therefore reduces fuel use and GHG emissions. This is one of four main aspects of a global supply chain optimization initiative started in 2010, designed to enhance, simplify, and standardize our supply chain systems and processes."	
	GSK	"We only collect and retain information about individuals that is relevant to the research study. This includes medical information such as health status, medical conditions (including, on occasion, genetic data), treatment of conditions and ethnic origin. We inform research participants about the	

Word Cluster	Firm	Excerpt from Sustainability Report	Proposed Market-oriented Supply Chain Sustainability Strategy
		medical information that will be collected as part of a study, explain why we are collecting it, and describe the types of third parties we work with to perform the study. Participants can withdraw their consent to future collection of medical information at any time."	
	GSK	"They are responsible for ensuring our standards are applied consistently, and their local knowledge helps us meet the challenges associated with GSK's growth in these regions. All team members can share information via our global quality database. In 2010 for example, we collaborated with a supplier in China to improve product quality so they could supply GSK."	
	GSK	"We have begun to measure some of our suppliers' performance to identify areas for improvement. Collecting data on the different materials we buy has been challenging, especially for materials that we do not buy directly and for which there are numerous supplier tiers."	
	GSK	"All existing and new suppliers will be required to complete a Request for Information that will provide a greater understanding and awareness of the environmental and social impacts of our supply chain, helping to identify potential risks and opportunities for improvement."	

Results: Market-oriented Supply Chain Sustainability Strategies

The structured content analysis performed on the sample of sustainability reports resulted in seven proposed market-oriented SCM strategies: Product Lifecycle Assessment, Supplier Relationships, Global Governance and Accountability, Innovation, Stakeholder Engagement and Diversity, Social Initiatives, and Supply Chain Collaboration through Information Sharing. These seven strategies are defined and discussed below.

1. Product Life Cycle Assessment: Product life cycle assessment identifies and quantifies the materials used and sources of waste released in the environment along the entire supply chain of the product or process, starting from the raw material stage to customer stage and finally to the end of life disposal (Chaabane, Ramudhin, & Paquet, 2012). This includes the upstream and downstream stages of the supply chain, inbound and outbound logistics, manufacturing activity, customer use, recycling and final disposal. Management of the entire product life cycle information is emerging as one of the most significant challenges in organizations for competitive advantages (He, Hee, Lu, Ming, & Ni, 2006). As such, information technology (IT) plays a major role in integrating the business processes along the entire supply chain. GlaxoSmithKline uses life cycle assessment of inhalers to track the carbon footprint of entire value chain to identify main contributors of carbon footprint – which are materials used in processes and from product use by customers. Product life cycle assessment at Unilever revealed that most of their greenhouse gas emissions were at the customer end during the use of hot water required to use their detergents. In order to reduce the identified environmental impact, Unilever innovated in their manufacturing process in order to provide their customers with products that use less water.

2. Supplier Relationships: Supplier relationship management as a strategy consists of three related aspects of selection, evaluation and development (Schiele, 2007; Leppelt, Foerstl, Reuter & Hartmann, 2013). In order to minimize costs in their supply chains, many companies have globalized their operations in order to source products and services from low cost and better quality suppliers resulting in an increase in outsourcing activities. Therefore, the perception and reputation of these companies depends not only on their own operations but also on the operations of their suppliers (Awaysheh & Klassen, 2010; Krause, Vachon, & Klassen, 2009; Leppelt et al., 2013). This was quite evident when major US retailers like Walmart, Target, Gap, etc. took swift actions to develop safety plans and standards for their garment suppliers located in Bangladesh after a major building, which housed these suppliers, collapsed resulting in more than 1100 deaths. All 12 firms used in our research focused on working diligently with their suppliers to build strong relationships in order to identify, prevent and mitigate any negative social and environmental impacts due to their operations and activities. For example, fresh fruit, corn, sugar, and coffee are some of the raw material sourced by Coca-Cola enterprises from agricultural communities. Hence, Coca-Cola focuses on relationship building with suppliers to advance more sustainable farming practices as the whole business depends on the agricultural supply chain. Similarly, H-P has implemented a four-phase supplier management system for its key production as well as non-production suppliers which provides each of its suppliers with a framework to progress through H-P's social and environmental responsibility program.

3. Global Governance and Accountability: Governance is among the pillars of a sustainable market-oriented supply chain. Good governance is a top down leadership approach which entails transparency and accountability of the top management towards all the stakeholders of the extended supply chain. Since large and global corporations have operations spanning the entire globe, it is imperative to have same critical governance standards and principles across the entire span of operations. Equity among all employees from different cultures and countries, and equitable quality standards and frameworks in all parts of the globe ensure good global governance strategy. Getting good governance calls for global scale improvements in organizations to manage supply chains and deliver goods and services to customers and it implies changes in top management of the organization, the representation of interests of stakeholders, and processes for public debate and policy decision-making (Grindle, 2002). Not surprisingly, advocating good governance raises a host of questions about what needs to be done, when it needs to be done, and how it needs to be done (Grindle, 2002). The term governance has been defined broadly as a "mode of organizing transactions" (Williamson & Ouchi, 1981). Palay (1984, p. 265), defines it as "a shorthand expression for the institutional framework in which informal contracts are initiated, negotiated, monitored, adapted, and terminated." Stated differently, governance is a multidimensional phenomenon between a set of parties and includes elements of establishing and structuring exchange relationships as well as aspects of monitoring and enforcement (Hiede, 1994). For example, global internal audit is an independent department established by Nissan which reports directly to the chief operating officer on issues related to Nissan's operations globally. Intel's board of directors created a Corporate Governance committee which provides oversight for corporate responsibility and sustainability issues at Intel. The committee acts as an internal business advisor to a number of groups and cross-functional teams within Intel.

4. Innovation: In a supply chain context, innovation involves any change in the process or product that results in increased efficiency (Roy, Sivakumar, & Wilkinson, 2004). In the era of long and complicated supply chains, innovation has become inter-organizational spanning organizations both upstream and downstream. Technology has played a major role in proliferation of innovation across the supply chain. Organizations are now linked internally through enterprise resource planning systems, externally through customer relationship management systems and supply chain management systems (Roy et al. 2004). Organizational and technological innovations results in sustainability because by becoming environment-friendly lowers costs as companies reduce the inputs used in their products and processes

(Nidumolu, Prahlad, & Rangaswami, 2009). Innovation which results in lowering of input costs in the supply chain may result in better products and creation of new business opportunities for organizations. In fact, leading organizations now consider sustainability as the new frontier of innovation (Nidumolu et al., 2009). For example, with inputs from customers and working very closely with its suppliers, Unilever, developed a new process to produce margarines lower in calories and saturated animal fat. This resulted in lowering of greenhouse gas emissions and land occupation as compared to processes related to earlier production of margarines.

5. Stakeholder Engagement and Diversity: Freeman (1984, p. 46) defined stakeholders as "any group or individual who can affect or is affected by the achievement of the organization's objectives". Savage, Nix, Whitehead and Blair (1991, p. 61) defined stakeholders as groups or individuals who "have an interest in the actions of an organization and . . . the ability to influence it". A market-oriented extended supply chain consists of various stakeholders – employees, customers, consumers, supply chain partners, competitors, investors, lenders, insurers, nongovernmental organizations, media, the government, and society, with oftentimes "customers" as the most important stakeholder (Hult, 2011). Stakeholder engagement is defined as the process of a closed loop communication and collaboration with various stakeholders of an organization in a way that results in improved decision-making and critical activities of the organization. Beckett and Jonker (2002) note that stakeholder engagement establishes a more balanced conception of the organization as a matrix of human relationships and competencies not necessarily limited to the borders of the organization, and may offer the possibility to create a far wider and more dynamic concept of the sustainable organization. Stakeholder engagement with a focus on customers for developing products which they need results in economic sustainability in the long run. Engaging customers, suppliers, regulators, public groups, policy makers, and investors in the form of discussion and feedback results in economic, environmental and social sustainability. For example, Johnson & Johnson engages in close collaboration with doctors and surgeons, who are the customers, for developing the products they need.

6. Social Initiatives: The stance of leading sustainable companies is that "doing good deeds" also leads to making good money (Pearce & Doh, 2012). These social initiatives go beyond charitable contributions and volunteer work, which are seen by many stakeholders as important but passive contributions. For example, Nissan has created a science foundation whose mission is to create solutions for social progress. This foundation provides grants for advancing research in cognitive science. Unilever has taken various initiatives to improve the nutritional quality of all their food products. These initiatives include reduction in salt, sugar, calories and saturated fats in an economically viable way.

7. Supply Chain Collaboration: Many of the exemplar companies included in our sample pursued supply chain collaboration as a strategy to address market-oriented supply chain sustainability. These collaborative initiatives were not just limited to upstream supplier collaboration but extended to other supply chain members to include customers and even competitors. For example, Johnson and Johnson chose to collaborate rather than compete with multiple generic drug manufacturers to ensure access to its new drug used in the treatment of HIV in developing countries. In order to tackle the problem of world hunger and malnutrition, Kraft Foods collaborated with the ‘World Food Program’ to develop biscuits fortified with essential vitamins and minerals to be sold in Indonesia at an average cost of one to six cents per pack.

Summary and Implications of Strategies

All seven strategies presented in Tables 2.8 to 2.14 make it clear that market-orientation with its extended conceptualization by inclusion of various stakeholders along the supply chain plays an increasingly important role in addressing sustainability in supply chains of firms. All seven strategies resulting from structured content analysis of corporate sustainability reports are centered on stakeholders and customers. Table 2.15 summarizes the seven strategies and their connections to various stakeholders along the supply chains of the firms.

Table 2.15: Proposed Market-oriented Supply Chain Sustainability Strategies

Proposed Market-oriented Sustainability Strategy	Supply Chain Focus	Stakeholder Focus
Product Life Cycle Assessment	Upstream, Downstream, Focal firm	Customers, Suppliers
Supplier Relationships	Upstream, Focal firm	Suppliers
Global Governance and Accountability	Focal firm	Employees, Customers, Society
Innovation	Upstream, Downstream, Focal firm	Suppliers, Customers
Stakeholder Engagement and Diversity	Upstream, Downstream, Focal firm	Employees, Customers, Investors, Competitors, NGOs, Media, Government, Society
Social Initiatives	Focal firm	Society, Customers

Supply Chain Collaboration	Upstream, Downstream, Focal firm	Suppliers, Customers, Competitors, Society

Managerial Implications

While studying firms from different industries, it is quite obvious that firms encounter various difficulties and challenges that need to be overcome in order to move ahead with their SCM strategy-sustainability initiatives. Once stakeholders are brought together, they will need to define a long-term vision for sustainability and corresponding goals in the seven market-oriented supply chain sustainability strategies. The steps between the definition of a long-term market-oriented SCM strategy-sustainability vision and the articulation of general goals will vary with the approach that is used. Some organizations have a strong tradition of working together to build a sustainability vision as the basis for planning, while others may feel the vision can better emerge from establishing and discussing strategy-sustainability goals for organizational development. Stakeholders can play a major role in defining goals based on their understanding of their roles; this is another reason for creating a situation of dialogue around goals, roles and strategies for improvement leading to the achievement of long-term market-oriented sustainability.

The seven strategies that emerged from this research provide a framework for managers to address sustainability in their supply chains that may result in competitive advantage for their firms. From a managerial point of view, an important learning from the strategy framework is that each sustainability strategy of the firm will have to be formulated keeping the important stakeholders in mind. Strategies and initiatives merely involving “green washing” will not be sustainable in the long run for the firm. A good starting point for managers might be implementing those strategies which involve only one stakeholder, e.g. suppliers, and then extending to other strategies involving multiple stakeholders. This stage based approach for implementing various strategies proposed in this research may be a practical approach for managers.

A crucial ingredient in the path of market-oriented sustainability is going to be government involvement. Governments have a crucial supportive role in providing the appropriate enabling environment – such as institutional, policy, legal and regulatory frameworks to sustain investment flows and for effective technology transfer – without which it may be difficult to achieve emission reductions and sustainability at a significant scale. For instance, mobilizing the financing of information and communications technology (ICT) and enabling international technology agreements could help speed up the deployment of the efficient technologies to reduce global warming and achieve sustainability.

Conclusions

Sustainability is becoming part of strategic planning for many organizations. Sustainable and market-oriented supply chain management is bound to become an important integral part of all organizations. Organizations will need to choose specific strategies to achieve balance among competing objectives and be truly sustainability. If more than 70% of corporate managers and executives indicate that their organization has not developed any clear strategy for achieving sustainability (Berns et al., 2009), even though there is a strong consensus that sustainability will continue to have an impact on strategic market-driven decisions, we definitely have a relevant business and academic problem which needs to be addressed. Sustainability in the form of mere "green washing" will not be beneficial and top management needs to seriously reconsider incorporating sustainability within their organizations and extended supply chains. Academicians and practitioners in supply chain must move towards a much broader objective of market-oriented sustainability not only from the traditional profitability point of view, but also to encompass all aspects of the triple bottom line.

The ambition of this research was to understand the market-oriented strategies that leading sustainability-driven firms publicize to address sustainability along their supply chains. As a result of structured content analysis of sustainability reports of these firms, we proposed seven such strategies. As a future research direction, verification of these strategies is required to corroborate the findings of this research. For this, a Delphi study is an appropriate research design. Since academic literature on market-oriented supply chain sustainability is relatively scant when compared to the experience of practitioners and consultants in implementing sustainability strategies in the industry, it would be pragmatic to corroborate the proposed strategies of this research by listening to the viewpoints of industry experts. The Delphi technique is well suited to exploratory theory building (Meredith, Raturi, Amoako-Gyampah, & Kaplan, 1989; Neely, 1993; Akkermans, Bogerd, Yucesan, & Van Wassenhove, 2003).

Further, this research can be used as a starting point to develop survey questionnaires and interview protocols that can be used to measure the seven proposed market-oriented sustainability strategies. The questionnaire development should follow the approach and guidelines set forth by Churchill (1979) and may incorporate questions and items for each strategy. This instrument should be used to test the concept of market-oriented sustainability strategies in a supply chain context.

The objective of this chapter was to develop a strategy framework to address market-oriented sustainability in supply chains of organizations. Once an organization starts addressing this important issue and integrates sustainability goals into its objectives, the next question that arises is how to monitor, measure and track sustainability efforts of the organization. Chapter 3 of this dissertation focuses on finding ways to answer this question.

CHAPTER 3

BENCHMARKING APPROACHES WITH AN INTEGRATED INDEX FOR TRIPLE BOTTOM LINE PERFORMANCE: COMPARISONS OF THE BIG THREE FIRMS IN THE LOGISTICS AND SHIPPING SERVICES INDUSTRY

Introduction

In a globalized economy, competition has shifted from organizations to supply chains (Christopher, 1992; Leuschner, Rogers, & Charvet, 2013). This globalization of competition naturally leads to increased volumes in transportation routes and greater distances; thus, enhancing the criticality of the logistics and shipping services industry in world-wide commerce. The logistics and shipping services industry plays an increasingly important role in facilitating the sourcing of raw materials from suppliers, as well as getting finished products to end-customers. Since many firms now enter into contracts with outside logistics and shipping companies, these transportation-centered firms' environmental and social effects are noticed by their current and prospective supply chain partners and other stakeholders. Various stakeholders are now actively concerned about sustainability performance of firms' operations (Chen & Delmas, 2011). A recent global survey conducted by DHL, a leading logistics and shipping service provider, found climate change to be the most pressing issue of their customers (Appel, 2010). Thus, sustainability in the form of accepting the importance of environmental and social concerns is widely recognized in modern businesses, and sustainability is being integrated as a part of the core strategy of several organizations in the logistics and shipping services industry.

A major concern in the logistics and shipping services industry is how to balance positive wealth generation by supporting movement of goods and services globally (Anderson et al., 2005) and negative impacts on society and environment due to pollution arising from burning of fossil fuels (May et al., 2003). A few statistics from industry sources help establish the importance of this concern. On one hand, this industry accounts for approximately 9% of global gross domestic product (Logistics Today, 2010); whereas, on the other hand, as per 2010 estimates by the Bureau of Transportation Statistics (www.bts.gov), transportation accounted for 28.1% of U.S. energy consumption and 33.6% of carbon dioxide emissions.

Recent trends indicate that shipping and logistics services industry is swiftly embracing sustainability. In 2003, United Parcel Services (UPS), one of the largest logistics and shipping service providers, published its first annual sustainability report on a voluntary basis. By voluntarily publishing annual sustainability reports, companies raise awareness amongst the various stakeholders regarding the emphasis on not only the economic aspects of their business, but also on the environmental and societal impact of conducting business. An essential element of more sustainable logistics and shipping services is the acceptance of green logistics services by business-to-business customers as well as by end consumers (Market Research Service Center, 2010).

There is an old business adage, "If it can be measured, it can be managed. If it can be managed, it can be improved" (Drucker, 1999b). Therefore, in order to manage and monitor sustainability in an organization, it is essential to first measure it. There are numerous sustainability indicators which are used to measure economic, environmental and social sustainability. However, these indicators are often measured in different units across different companies and there is no common baseline. Due to this, it is difficult to make comparisons between aspects of sustainability within and across organizations. Therefore, in order to assess relative economic, environmental and social performance of a company as well as compare different companies on these key dimensions of corporate contributions, it is important to develop standards, which integrate dimensions of sustainability. Such a standard may be an index based on economic, environmental and social measures of an organization. This will enable consistent and concise evaluation of a company's sustainability performance over time and across organizations. Further, an index based on common metrics across more than one organization can be used to assess the relative performance of a company among its industry peers and may enable aggregation and ratios to gauge supply and distribution network sustainability. Given the growing economic, environmental and social importance of the logistics industry, integrated measurement of these various performance aspects of logistics organizations is important for their competitive positioning and decision-making.

A meaningful index should integrate the variety of dimensions in sustainability to assess and benchmark organizational or industrial performance over time and across peers. An ideal approach of integrating three dimensions of sustainability or aggregating different indicators into a sustainability index is difficult owing to the complexity of different dimensions (Sands & Podmore, 2000; Krajnc & Glavič, 2005a). Therefore, a more practical approach towards quantifying sustainability is to start with three dimensions individually and then work towards an integrated index (Sands & Podmore, 2000). Even though there is no consensus regarding how to address the complex problem of measuring sustainability, characterizing sustainability in terms of a set of indicators is emerging as a pragmatic approach adopted by many researchers (Diaz-Balteiro & Romero, 2004).

In recent years, researchers have focused on developing sustainability indices (Krajnc & Glavič, 2005b), but these indices have focused mainly on cross-national or cross-industry comparisons (e.g., Global Reporting Initiative, Dow Jones Sustainability Index) or they have not focused on all three dimensions of sustainability simultaneously. Research on sustainability indicators which focuses on within industry comparison of companies has been very limited (Krajnc & Glavič, 2005a). Specifically, no research has been devoted to measure the sustainability of organizations within the logistics and shipping services industry. Therefore, this chapter addresses the following critical questions:

How can the non-standard sustainability efforts of organizations in the logistics and shipping services industry be measured quantitatively using relative influences of economic, environmental and social dimensions?

How can we identify the specific factors of economic, environmental and social dimensions that need to be improved within a firm?

This research proposes complementary methodologies to develop a sustainability index for organizations in logistics and shipping services industry. This enables comparisons of organizations regarding sustainability performance. The practical applicability of the index will be illustrated using data from secondary sources (e.g. company reports, Bloomberg data) for leading, global logistics organizations.

Next, we discuss the theoretical foundation of sustainability measurement and discuss research methods used to measure sustainability in the logistics industry and to develop the overall sustainability index.

Theoretical Foundation

Complexity within an organization may arise through a diverse set of factors both external and internal. It may arise due to large number of suppliers and customers of the organization, or due to government laws and regulations, and technological advancements (Chakravarthy, 1997; Sarkis et al., 2011). A multitude of factors and stakeholders increase the complexity or turbulence internal and external to the organization, which results in difficulty in planning activities. Proponents of complexity theory view it as a means of identifying patterns underlying complex systems (Manson, 2001). Measurement of sustainability involves numerous economic, environmental and social indicators which together form a system. An increasing number of interacting variables or indicators make a system more complex; and, hence, it becomes difficult to estimate the interaction outcomes of the system (Sarkis et al., 2011).

In order to develop a coherent understanding of complexity theory, Manson (2001) breaks up complexity research into three major divisions – 1) Algorithmic complexity; 2) Deterministic complexity; and 3) Aggregate complexity. Algorithmic complexity deals with mathematical complexity theory and information theory, and posits that complexity of a system lies in the difficulty in describing the characteristics of the system. Deterministic complexity deals with chaos theory and catastrophe theory, and posits that interactions of fewer variables can create stable systems prone to discontinuities. Aggregate complexity is concerned with individual factors working together to create a complex system.

Research in sustainability measurement falls in the domain of aggregate complexity, because it may be posited that various sustainability indicators measuring economic, environmental and social factors together form a complex system. Complexity theory is concerned with how the nature of a system may be characterized with reference to its constituent parts in a holistic manner (Manson, 2001). The focus of complexity theory is on anti-reductionism and holistic appreciation of interconnectedness of various factors in a system (von Bertalanffy, 1968). In this research, our aim is to holistically measure sustainability keeping in view the fact that various indicators of sustainability are interconnected and they cannot capture the holistic nature of sustainability domain if measured in isolation. We essentially try to reduce the complexity of the overall concept of sustainability in logistics and shipping services industry and break it down into comprehensible blocks. We aspire to achieve this by aggregating various sustainability indicators into a single index and formulate a mathematical model using normalization techniques. Furthermore, the ambition of this research is to measure efficiency of companies in logistics and shipping services industry in terms of three dimensions of sustainability – economic, environmental, and social using mathematical techniques.

Research in sustainability in general, and specifically this essay, also has its foundation in resource-based view (RBV), which suggests that the source of sustained competitive advantage for firms lies in its resources that are valuable, rare, inimitable, and organizationally embedded (Barney, 1991). Assets, organizational capabilities and processes can be considered as a firm's resource, because they enable a firm to conceptualize and implement strategies that improve its efficiency for a sustained competitive advantage (Barney, 1991; Daft, 1983; Sarkis et al., 2011). Organizational capabilities can be tracked by measuring and monitoring various organizational performance metrics. This research considers organizational capabilities as inputs, and performance metrics of economic, environmental and social dimensions as outputs of firms. Strengthening the organizational capabilities through sustainability supports the value, rarity, and inimitability of resources (Carter & Carter, 1998; Förstl, Reuter, Hartmann, & Blome, 2010; Sarkis et al., 2011). For example, a logistics and shipping services firm using hybrid or electric vehicle fleet (input) to deliver packages to customers will consume less fuel per package delivered (output).

Research Methodologies

The main aim of this research is to provide insights into sustainability performance measurement (SPM) of firms in the logistics and shipping services industry. In order to achieve this research aim, two complementary mathematical approaches are employed to formulate models which can be used as decision making tools for SPM.

One objective of the research is to develop sub-indices of economic, environmental, and social dimensions which can be finally combined to develop an overall sustainability index for the organization. This is achieved by using a linear aggregation method where equal weights are assigned to individual indicators of economic, environmental, and social dimensions of sustainability resulting in three sub-indices pertaining to each dimension. Finally, the three derived sub-indices are aggregated to an overall sustainability index of the company. Different weights derived by performing structured content analysis on the text contained in sustainability reports of logistics firms using Crawdad software are accorded to each sub-indices. The output of this method is used to illustrate the sustainability performance of three firms in the logistics and shipping services industry. This Linear aggregation methodology is a heuristic approach, which is not guaranteed to be optimal but provides a satisfactory solution to ease the process of decision-making for managers. This methodology is easy to implement and understand from a managerial point of view.

A complementary methodology which is used in this research is data envelopment analysis (DEA). DEA is an optimization approach which is more technical compared to a linear aggregation methodology. DEA is a mathematical programming method for evaluating firms' relative efficiencies. This method uses a firm's multi-factor performance by a composite efficiency index with a value between 0 and 1, with 1 representing efficient firms. A key advantage of DEA over a linear aggregation method is that there is no need for explicit weight specifications for inputs and outputs. Weights are generated through an optimization procedure and the efficiency of firms is measured using these optimal weight values. Another advantage of DEA is that it can be used to compare performance of multiple firms on an efficiency frontier. Development of index models using each of these two methodologies are described and discussed in detail in subsequent sections of this chapter.

Data collection

The data for developing and illustrating the model were collected from multiple secondary sources. The Bloomberg database and sustainability reports were used to obtain data on environmental and social indicators of logistics and shipping services companies. Data on economic indicators were obtained from annual reports and sustainability reports. There are several reasons for choosing Bloomberg database as a data source for this research. First, this database contains data on more than 3,000 public and private companies covering all industry sectors worldwide and is, therefore, considered a comprehensive and reliable data source for conducting research. Second, each firm has multiple data points covering environmental, social and governance (ESG) performance indicators. Third, it provides real-time as well as historical numeric and qualitative key performance indicators (KPIs) data from various sources such as company filings and Bloomberg ESG survey data.

Sustainability reports provide a source of information to companies' activities, strategies and results of economic, environmental and social responsibility (Tate et al., 2010). Many companies are issuing sustainability reports which are easily accessible in order to make stakeholders aware of social and environmental activities (Deegan & Gordan, 1996; Morhardt, Baird, & Freeman, 2002; Kolk, 2003). As per Jose and Lee (2007), about 60% of the top 200 global companies have sustainability reports available on their websites. Based on the various reasons discussed above, use of Bloomberg database and company reports as data sources is well justified for this research.

Regarding the selection of companies, the author focused on the few global competitors in the oligopolistic industry of logistics and shipping services. According to a report by San Jose Consulting Group (2003), the few major competitors in the logistics and shipping services industry are United Parcel Service (UPS), Deutsche Post AG (DHL), United States Postal Service (USPS) and FedEx Corporation (FedEx). In order to be consistent in selection of companies for this research, USPS was excluded as it is not a privately held organization. Data was collected and analyzed for three case companies – UPS, FedEx and DHL, which are leading multinational companies, providing transportation, shipping, logistics, and financial services globally. These three companies were chosen for comparison for several reasons. First, all three companies are listed in the sustainability disclosure database of Global Reporting Initiative (GRI 2011). UPS is featured as the sustainability leader in its sector as per GRI reporting (database.globalreporting.org). Second, as per Armstrong and Associates Inc., a leading supply chain market research and consulting firm, DHL and UPS are market leaders in the logistics sector in terms of gross revenues and freight forwarding volumes in Europe and North America respectively (www.3plogistics.com/top25_ff.htm). Together these two companies accounted for 31% of net revenues among the top 25 firms in the logistics sector worldwide in the year 2010. Third, UPS and DHL have achieved "+" application level of GRI reporting which means that sustainability reporting has been externally assured by a third party auditing firm. UPS has achieved A+ and DHL has achieved B+ application level in their 2012 reporting.

Linear Aggregation Method – Qualitative Numerical Approach

Since one objective of this research is to identify indicators of sustainability performance and then develop a framework for evaluating this performance of an organization, the more descriptive approach of linear aggregation is used to develop a mathematical model to achieve this objective. A lot of research on sustainability measurement has been published in leading management journals which use linear aggregation methodology. Chen and Delmas (2011) summarize 43 publications using aggregation methodologies. However, most of the research summarized by them uses the KLD database which consists of ordinal data. This research differs from previous studies on sustainability measurement with aggregation methods by using actual data from different sources instead of ordinal data to formulate a sustainability index. The numerical model developed in this research produces normalized values of economic, environmental, and social indicators and aggregates them into an overall sustainability index. Weights used in this model are empirically derived by performing structured content analysis using Crawdad software. Structured content analysis has been described in detail in the previous chapter of this dissertation and the weights used stem from this preceding research. To demonstrate experiential relevance, the specification which is developed for calculating this sustainability index is illustrated by calculating sustainability indices of UPS, FedEx and DHL.

Model Development

Development of a linear aggregation model is a step-wise process as illustrated in figure 3.1 and described below.

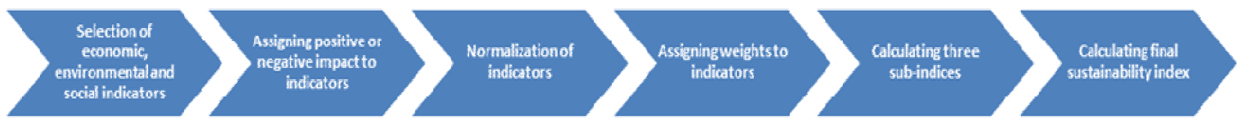


Figure 3.1: Step-wise process of calculating the sustainability index

To assist in describing this process and model formulations, Table 3.1 lists the notations used in the development of the models for this chapter.

Table 3.1: Notations used in this chapter

Variable	Description	
i	indicator	i=1,2,….,n
j	sustainability dimension	j=1,2,3
t	year (time)	t=2011
I_A^+	indicator with positive impact	
I_A^-	indicator with negative impact	
	normalized positive impact indicator	
	normalized negative impact indicator	
	sustainability sub-index of dimension j	
	weight of indicator i	
	overall sustainability index at time period t	

Step 1

The first step involves the selection of appropriate indicators of the economic, environmental and social dimensions where each dimension is represented by *j*. *j*=1 for economic dimension; *j*=2 for environmental dimension; *j*=3 for social dimension.

Step 2

In the second step, all the selected indicators are assigned either a positive or a negative sign. A dimension indicator whose increasing value has a positive impact on the dimension is assigned a positive sign (I_A^+), whereas a dimension indicator whose increasing value has a negative impact on the dimension is assigned a negative sign (I_A^-). For example, the higher the value of revenue and net income, the better (positive) is the impact on the economic dimension of an organization; therefore, both these indicators are assigned a positive sign. An increasing value of operating expense has a negative impact on the economic dimension; therefore, it is assigned a negative sign.

Step 3

This step involves normalizing each indicator *i* of each of the three dimensions *j* for the time (year) *t*. Different indicators are expressed in different units and this causes a problem of aggregating indicators into an sub-index and finally into the sustainability index. One way of solving this problem is to normalize each indicator of each dimension using equations (1) and (2).

$$I_{ijt}^{+*} = \frac{I_{A,ijt}^{+} - I_{min,jt}^{+}}{I_{max,jt}^{+} - I_{min,jt}^{+}} \quad (1)$$

$$I_{ijt}^{-*} = \frac{I_{A,ijt}^{-} - I_{min,jt}^{-}}{I_{max,jt}^{-} - I_{min,jt}^{-}} \quad (2)$$

where I_{ijt}^{+*} represents the normalized value of a positive impact indicator

I_{ijt}^{-*} represents the normalized value of a negative impact indicator.

The objective of normalization of indicators is to make all indicators comparable to each other by offering the possibility of incorporating different types of quantities with different units of measurements irrespective of the units of measurement. Normalization is the process of reducing measurements of different units to a standard scale so that all variables (indicators) are compatible.

Step 4

The next step of calculating the sustainability index involves assigning weights to each indicator *i* and each dimension *j*. Equal weightings were accorded to all indicators *i* within each dimension *j*. The reasons for assigning equal weights to all indicators within a dimension are twofold. First, the top levels of management of an organization who are involved in the decision making process have different views and interests in various indicators, which may change over time depending on factors both internal and external to the organization. For e.g., during a global recession, decision makers within an organization may place higher importance on certain economic indicators than others. This situation may change as the economic conditions improve globally. Second, a standardized weighting scheme for different indicators of sustainability for logistics and shipping services industry is not yet available either in the literature or any database, because reporting of environmental and social indicators is voluntary for organizations which results in different organizations reporting different indicators even within the same industry. Moreover, previous research agrees that it is very difficult to build consensus on universally accepted weights or priorities of environmental and social issues for different stakeholders and different situations (Chen & Delmas, 2011; Bird, Hall, Momente, & Reggiani, 2007; Hillman & Keim, 2001; Mitchell, Agle, & Wood, 1997). Due to the aforementioned reasons, assigning equal weightings to indicators within a sustainability dimension was deemed reasonable.

Step 5

The penultimate step involves grouping all indicators of dimension *j* into a sustainability sub-index ($I_{S,j}$). In this step three sub-indices are calculated for the three dimensions *j*=1, 2, 3 using equation (3).

$$I_{S,jt} = \sum_{jit}^{n} W_{ji} \, . I_{ijt}^{+*} + \sum_{jit}^{n} W_{ji} \, . I_{ijt}^{-*} \qquad (3)$$

subject to $\sum_{ji}^{n} W_{ji} = 1$, $W_{ji} = 1/n$

where $I_{S,jt}$ is the sub-index for three dimensions *j* (where *j* = 1 for economic, *j* = 2 for environmental, j = 3 for social) in time (year) *t*. W_{ji} is the weight of indicator *i* for dimension *j*.

Step 6

In the final step, the three sustainability sub-indices as derived in step 5 are combined to calculate the overall sustainability index I_{OS} as per equation (4).

$$I_{OS,t} = \sum_{jt}^{n} W_{j} \, . I_{S,jt} \qquad (4)$$

where W_j denotes the weight assigned to the sustainability dimension *j* of the organization.

One problem in this final step is regarding the weights to be attached to each dimension of sustainability, i.e., values of W_j. One way is to place equal weightage on each dimension to arrive at the final index. However, in order to be grounded in our approach, we derive weights using text analysis software on sustainability reports of transportation companies listed in

"Global 100 Most Sustainable Corporations of the World" report. This list contains four logistics firms – Mitsui OSK Lines, MTR, Nippon Yusen and TNT. Crawdad text analysis software was employed to discover how three dimensions of sustainability vary in logistics firms. A detailed description of structured content analysis and Crawdad software is presented in Chapter 2. Sustainability reports for the four firms were converted to Crawdad format (.cra file) and all files were analyzed simultaneously. A correlation matrix of 500 most influential words that occurred in at least half of the reports was generated. Next, words in the correlation matrix which were synonyms of *economic, environmental and social*, were identified. These synonyms are listed in Table 3.2.

Table 3.2: Synonyms of Three Dimensions of Sustainability

	Sustainability Dimension		
	Economic	**Environmental**	**Social**
Synonyms	Financial	Ecological	Community
	Fiscal	Conservation	Society
	Commercial	Ecofriendly	Public
	Profit	Green	Group
	Lucrative		Collective
	Efficient		
	Efficiency		
	Cost		

Next, a correlation matrix of synonyms of three dimensions vs. keywords related to market-orientation and supply chain management (SCM) was generated. Out of all synonyms for each dimension, the synonym with maximum correlation value with a keyword was retained for further analysis. This correlation matrix provides coefficients for variables to formulate an assignment optimization problem. This mathematical model is implemented and optimized in MS Excel using a Frontine Solver to match the keywords with the three key dimensions of sustainability. The objective function of the model is to maximize the sum product of correlations with the constraint that each keyword can be matched with a sustainability dimension only once. This resulted in grouping of market-orientation and SCM keywords with each dimension of sustainability for logistics firms. The result is illustrated in Table 3.3. This formulation may be modified easily to accommodate other practical considerations desired by decision-makers.

Table 3.3: Synonyms and Keywords for Each Dimension of Sustainability for Logistics firms

	Economic Dimension				**Environmental Dimension**				**Social Dimension**			
	Synonym	MO & SCM keyword	Influence Value	Correlation value	Synonym	MO & SCM keyword	Influence Value	Correlation value	Synonym	MO & SCM keyword	Influence Value	Correlation value
	economic financial cost efficiency efficient	management customer network market shareholder investor source	0.0329 0.0101 0.0064 0.0059 0.0026 0.0015 0.0010	0.7709 0.8772 0.9928 0.9902 0.9939 0.8513 0.9580	environmental environment greenhouse	employee people society	0.0165 0.0048 0.0044	0.3693 0.9965 0.7049	social community society public	transport stakeholder passenger supply operation quality chain government schedule	0.0149 0.0053 0.0053 0.0033 0.0227 0.0021 0.0013 0.0013 0.0004	0.9120 0.9816 0.9860 0.9769 0.9425 0.9951 0.9906 0.9752 0.9933
Proportion	**0.4237**				**0.1796**				**0.3967**			

Proportion of aggregate influence values for each dimension of sustainability was calculated in order to derive the weightage of each dimension. As per results obtained in Table 3.3, economic dimension has a weightage of 0.4237, environmental dimension has a weightage of 0.1796, and social dimension has a weightage of 0.3967. These weights were used in formulation of overall sustainability index.

Implementation of Linear Aggregation Model

To illustrate this approach, data were gathered for three case companies – UPS, FedEx and DHL. The economic (financial) data for the companies was obtained from annual and sustainability reports for the year 2011. The environmental and social data for the year 2011 was obtained from Bloomberg database and sustainability reports of the companies.

Calculating the economic sub-index

The economic indicators of sustainability for UPS, FedEx and DHL for the year 2011 are given in Table 3.4. Figures for DHL, originally in Euro currency, were converted to Dollar amount using historical exchange rates available at website of Oanda, one of the first companies offering online currency trading (http://www.oanda.com/currency/historical-rates/).

Table 3.4: Economic indicators of case companies

Indicator	+ve / -ve	Notation	Unit	UPS	FedEx	DHL
Net Income	+	NI	US$ bn	3.804	1.452	1.506
Total Shareholder Equity	+	SE	US$ bn	7.108	15.220	14.501
Assets	-	A	US$ bn	34.701	27.385	49.733
Total Liabilities	-	TL	US$ bn	27.593	12.165	35.232

Each indicator of economic dimension was assigned either a positive or negative sign depending on the impact of economic sustainability as follows:

$I_{A,ijt}^{+}$ = NI, SE

$I_{A,ijt}^{-}$ = A, TL

All indicators of economic dimension were normalized using equations (1) and (2). Normalization is the process of reducing measurements of different units to a standard scale so that all variables (indicators) are compatible. Normalized results are presented in Table 3.5.

Table 3.5: Normalized economic indicators of case companies

Indicator	+ve / -ve	Notation	Weight	UPS	FedEx	DHL
Net Income	+	NI	0.25	1.00	0.00	0.02
Total Shareholder Equity	+	SE	0.25	0.00	1.00	0.91
Assets	-	A	0.25	0.67	1.00	0.00
Total Liabilities	-	TL	0.25	0.33	1.00	0.00

Value of weights were accorded as per constraint of equation (3) W_{ji} = 1/n. Since there are four indicators of economic sustainability, therefore, the value of weight = 1/4 = 0.25. Normalized values of indicators were multiplied by their weights to obtain the sub-index for economic dimension. The results are presented in Table 3.6.

Table 3.6: Sustainability sub-index for economic dimension of case companies

UPS	FedEx	DHL
0.501	0.750	0.234

Calculating the environmental sub-index

The indicators of environmental sustainability for UPS, FedEx and DHL for the year 2011 are given in Table 3.7.

Table 3.7: Environmental indicators of case companies

Indicator	+ve / -ve	Notation	Unit	UPS	FedEx	DHL
Package Volume	+	PV	mn	4,010	1,866	3,875
CO2 emissions - Scope 1 +2	-	E12	mn tons	12.768	14.792	5.300
CO2 emissions - Scope 3	-	E3	mn tons	8.742	1.018	22.900

All indicators of environmental dimension were assigned either a positive or a negative sign depending on the impact on sustainability as follows:

$I^{+}_{A,ijt}$ = PV

$I^{-}_{A,ijt}$ = E12, E3

All indicators of environmental dimension were normalized using equations (1) and (2). Normalized results for UPS, FedEx and DHL are presented in Table 3.8.

Table 3.8: Normalized environmental indicators of UPS and DHL

Indicator	+ve / -ve	Notation	Weight	UPS	FedEx	DHL
Package Volume	+	PV	0.33	1.00	0.00	0.94
CO2 emissions - Scope 1 +2	-	E12	0.33	0.21	0.00	1.00
CO2 emissions - Scope 3	-	E3	0.33	0.65	1.00	0.00

Value of weights were accorded as per constraint of equation (3) W_{ji} = 1/n. Since there are three indicators of environmental sustainability, therefore, the value of weight = 1/3 = 0.33. Normalized values of indicators were multiplied by their weights to obtain the sub-index for environmental dimension. The results are presented in Table 3.9.

Table 3.9: Sustainability sub-index for environmental dimension for case companies

UPS	FedEx	DHL
0.614	0.330	0.639

Calculating the social sub-index

The indicators of social sustainability for UPS, FedEx and DHL for the year 2011 are given in Table 3.10.

Table 3.10: Social indicators of case companies

Indicator	+ve / -ve	Notation	Unit	UPS	FedEx	DHL
Dividend to shareholders	+	DS	US$ bn	2.000	0.151	0.846
Charitable Contributions	+	CC	US$ mn	93.500	28.086	22.012
no. of employees	+	E	nos.	398,242	300,000	471,654
Employee compensation	+	EC	US$ bn	27.600	15.276	17.286
Total Expense	-	TE	US$ bn	47.025	39.926	67.906

Each indicator of social dimension was assigned either a positive or negative sign depending on the impact on social sustainability as follows:

$I^{+}_{A,ijt}$ = DS, CC, E, EC

$I^{-}_{A,ijt}$ = TE

All indicators of social dimension were normalized using equations (1) and (2). Normalized results are presented in Table 3.11.

Table 3.11: Normalized social indicators of case companies

Indicator	+ve / -ve	Notation	Weight	UPS	FedEx	DHL
Dividend to shareholders	+	DS	0.20	1.00	0.00	0.38
Charitable Contributions	+	CC	0.20	1.00	0.08	0.00
no. of employees	+	E	0.20	0.57	0.00	1.00
Employee compensation	+	EC	0.20	1.00	0.00	0.16
Total Expense	-	TE	0.20	0.75	1.00	0.00

Value of weights were accorded as per constraint of equation (3) W_{ji} = 1/n. Since there are five indicators of social sustainability, therefore, the value of weight = 1/5 = 0.20. Normalized values of indicators were multiplied by their weights to obtain the sub-index for social dimension. The results are presented in Table 3.12.

Table 3.12: Sustainability sub-index for social dimension for case companies

UPS	FedEx	DHL
0.864	0.217	0.308

Calculating the overall sustainability index

The final step in the calculations involve combining the three sub-indices of economic, environmental and social dimensions into an overall sustainability index, $I_{OS,t}$, of UPS, FedEx and DHL using equation (4). In this final calculation, the sub-indices were multiplied by their respective weights to arrive at the overall sustainability index. The weights used for three sustainability dimensions were derived using Crawdad software as described previously. The results are presented in Table 3.13. The interaction of three dimensions of sustainability for UPS, FedEx and DHL is represented graphically in Figure 3.2.

Table 3.13: Overall sustainability index for case companies

Sub-Index / Index	Weight	UPS	FedEx	DHL
Economic	0.4237	0.501	0.750	0.234
Environmental	0.1796	0.614	0.330	0.639
Social	0.3967	0.864	0.217	0.308
Overall		0.665	0.463	0.336

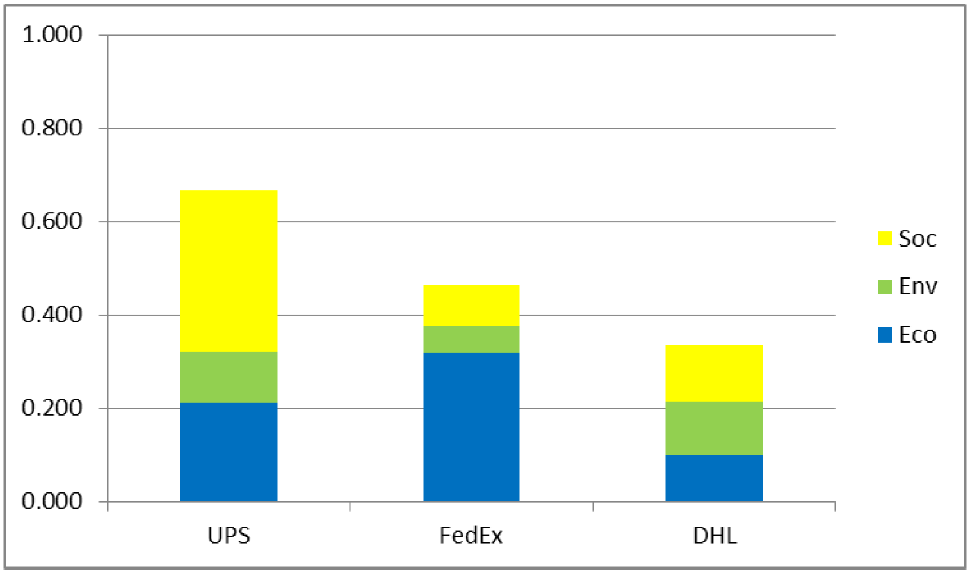


Figure 3.2: The variation of overall sustainability index of case companies

In order to represent sustainability of all companies graphically keeping in view all individual sustainability indicators, the overall sustainability index was illustrated using amoeba indicator technique (Ten Brink, Hosper, & Colijn, 1991). Normalized values of all indicators for the year 2011 have been illustrated in Figures 3.3, 3.4 and 3.5 for UPS, FedEx and DHL respectively. The larger the distance from the center of the circle for an individual indicator, the better is the performance of the company for that indicator as compared to its competitors. For e.g., in Figure 3.3, the indicators net income, package volume, dividend to shareholders, charitable contributions and employee compensation are at the circumference of the circle for UPS, which indicates that UPS outperformed its competitors in these areas for the year 2011. Similarly, looking at the performance of UPS for total shareholder equity reveals that UPS lagged behind its competitors in this area for the year 2011.

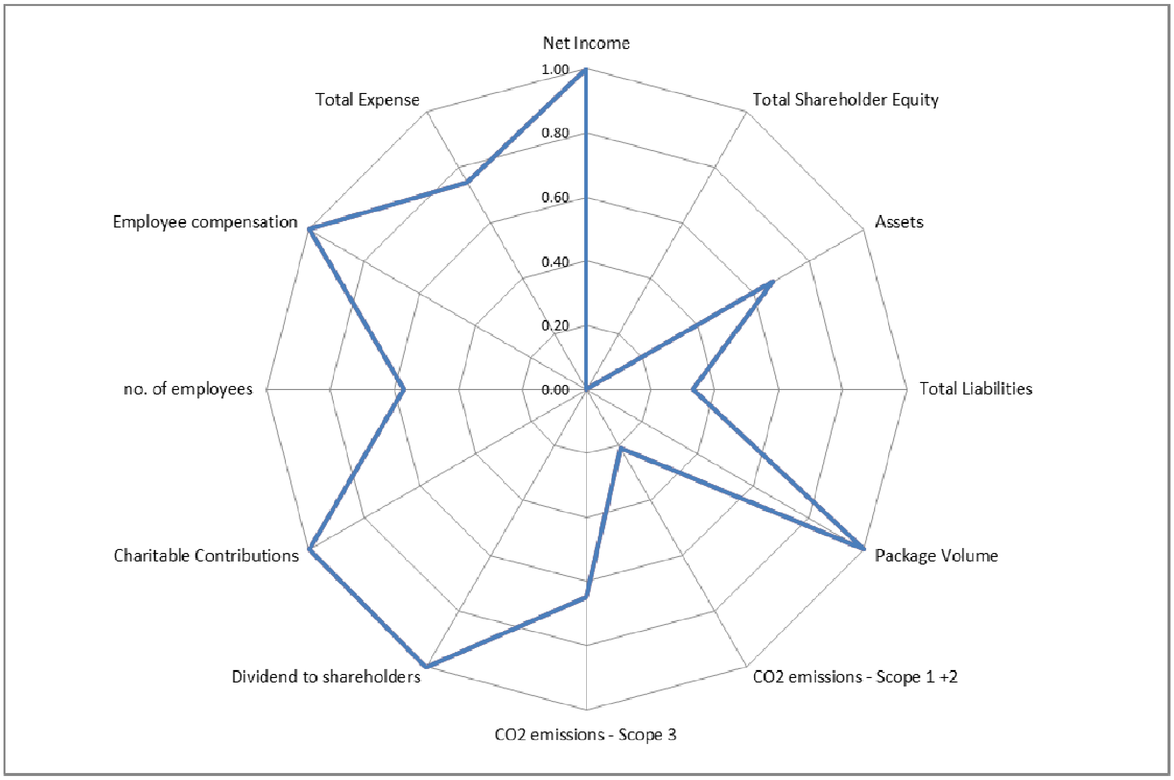


Figure 3.3: Representation of overall sustainability of UPS

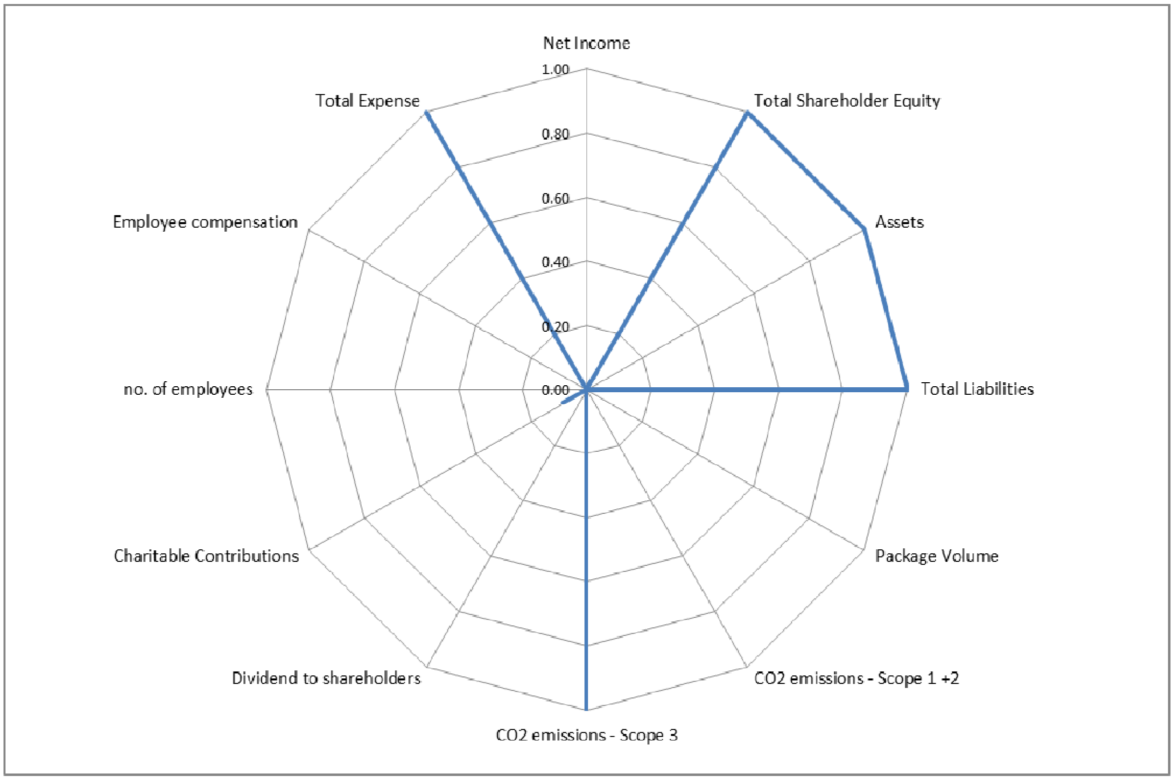


Figure 3.4: Representation of overall sustainability of FedEx

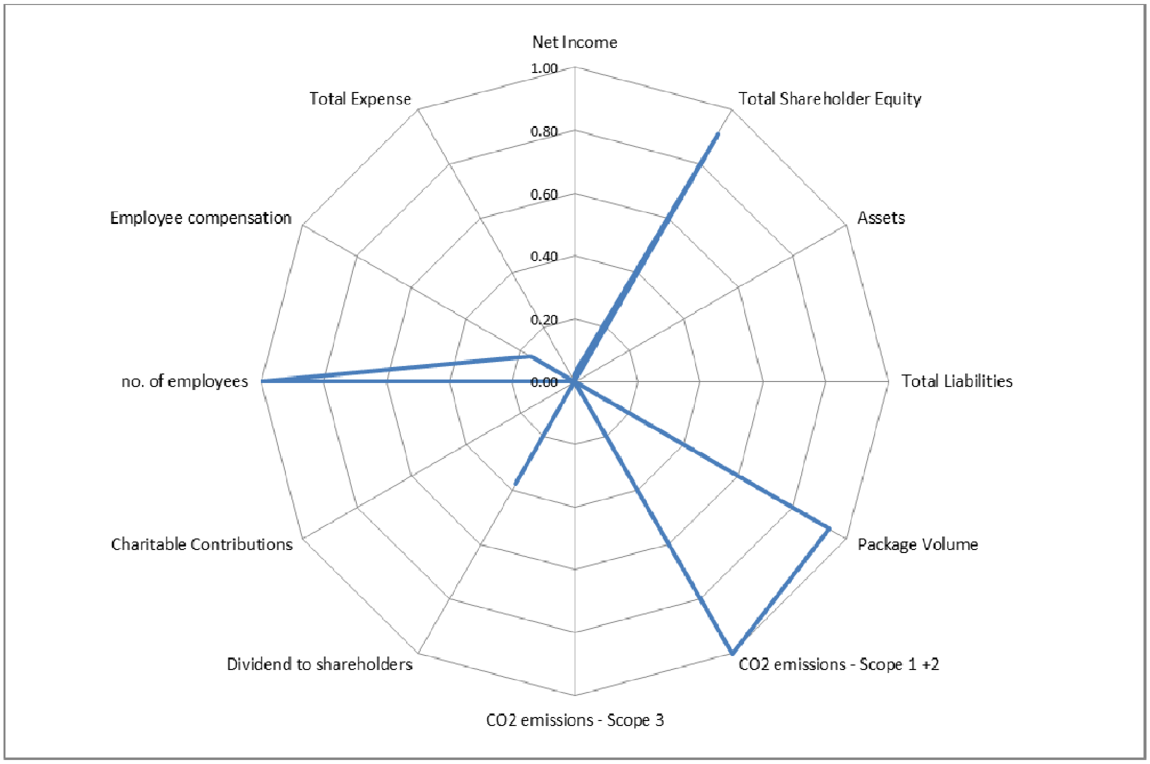


Figure 3.5: Representation of overall sustainability of DHL

Linear aggregation methodology described above provides a way to represent various indicators of sustainability for logistics and shipping services companies in a unique index, which provides managers with a valuable tool in assessing their sustainability efforts over time and also enables them to benchmark their sustainability efforts with industry peers as illustrated in figures 3.3, 3.4 and 3.5. However, a limitation of the above methodology is that it does not take into account the sustainability efficiency ratios, which are useful indicators of self-appraisal and peer appraisal. Moreover, linear aggregation is based on the assumption that in the absence of industry standards for weighting scheme to be accorded to various sustainability indicators, equal weights are accorded to each indicator; thereby, eliminating any managerial biases. In order to address these concerns, this research employs a complementary methodology for a more rigorous analysis of interactions among dimensions of sustainability. The complementary methodology used is data envelopment analysis (DEA) which is described in detail in the next section.

Data Envelopment Analysis – Quantitative Numerical Approach

Data envelopment analysis (DEA) technique is based on a productivity ratio (Golany & Roll, 1989; Doyle & Green, 1994), which involves dividing a weighted sum of multiple outputs by a weighted sum of multiple inputs to compare decision-making units (DMUs). DEA is a non-parametric statistical method, which uses linear programing to arrive at the best possible frontier of a sample of DMUs such as organizations, countries, etc. (Charnes, Cooper, & Rhodes, 1978). Efficiency of each DMU is calculated in terms of scores ranging from zero to one, with efficient units receiving a score of one. Efficiency scores less than one can be interpreted as how much performance should be improved for a DMU to become efficient, i.e., obtain a score of one. DEA has been applied in a number of areas, such as education, healthcare, banking, fast food restaurants, police departments, etc. (Wong & Beasley, 1990). In sustainability research, several studies have estimated environmental performance indices using DEA based techniques. Munksgaard, Christoffersen, Keiding, Pedersen and Jensen (2007) provide a good review of several such articles According to their findings, application of DEA to estimate environmental performance can be divided into three streams of research: various countries, various firms or plants, and environmental management systems. However, most of these studies are focused only on the environmental dimension of sustainability, and have not taken into account the measurement of economic, environment and social aspects of sustainability simultaneously as captured by the triple bottom line concept. Moreover, there is a dearth of literature focusing on measuring sustainability holistically using DEA methodology for logistics and shipping services industry. In the context of this current study, DEA is positioned as a complementary technique to linear aggregation methodology and is propagated as a valuable managerial tool to self-evaluate and peer-evaluate their organization. This study considers inputs as organizational capabilities and outputs as performance metrics corresponding to economic, environmental and social dimensions of sustainability in logistics and shipping services industry.

Model Development

In this study, DEA models are formulated in several ways to index productivities of UPS, FedEx and DHL. These formulations include the basic Charnes, Cooper, and Rhodes (CCR), aggressive cross-efficiency, and benevolent cross-efficiency models proposed by Doyle and Green (1994).

Basic CCR model

Based on the works of Chen and Delmas (2011), Talluri and Narasimhan (2004), and Doyle and Green (1994), performance indices as a DEA model can be defined as:

$$E_{ks} = \sum_y O_{sy} \,.\, v_{ky} / \sum_x I_{sx} \,.\, u_{kx} \qquad (5)$$

where

E_{ks} = efficiency measure of firm *s,* using the weights of firm *k*

O_{sy} = value of output *y* for firm *s*

v_{ky} = value of weight assigned to firm *k* for output *y*

I_{sx} = value of input *x* of firm *s*

u_{kx} = value of weight assigned to firm *k* for input *x*

Equation (5) can be interpreted as a ratio of aggregated outputs and inputs. DEA optimizes weight values in (5) by solving the following decision problem:

maximize

$$E_{kk} = \sum_y O_{ky} . v_{ky} / \sum_x I_{kx} . u_{kx} \quad (6)$$

subject to:

$E_{ks} \leq 1$ for all firms s, including k

$u_{kx}, v_{ky} \geq 0$

In equation (6), each firm k selects optimal weights for inputs and outputs in order to achieve the highest possible efficiency score. This equation is subject to two constraints: a) the weights prevent firms, s, from achieving a score of greater than 1; and b) the weights assigned to inputs and outputs should be non-negative. The above optimization problem can be reformulated as a linear programming problem using Charnes-Cooper transformation and the objective function can be replaced with

maximize

$$E_{kk} = \sum_y O_{ky} . v_{ky}$$

subject to:

$E_{ks} \leq 1$ for all firms s, including k

$\sum_x I_{kx} . u_{kx} = 1$

$u_{kx}, v_{ky} \geq 0$

(7)

This reformulation is achieved by equating the denominator in (6) equal to 1, which is represented by an additional linearizing constraint $\sum_x I_{kx} . u_{kx} = 1$.

The output of model (7) is the optimal efficiency score for firm k which can have any value between 0 and 1. If output = 1, then firm k lies on the efficiency frontier; if output < 1, then firm k is considered to be inefficient and is dominated by at least one other firm. For example, efficiency score of 0.8 for a firm means that it is inefficient by 20% compared to a firm having an efficiency score of 1. For managerial decision making, this means that the firm needs to decrease its inputs by 20% relative to the efficient firm with an efficiency score of 1. This efficiency score is also termed as 'simple efficiency' which can be considered a self-appraisal of the firm (Doyle & Green, 1994). Model (7) is solved s times in order to compute efficiency scores of all firms in the sample. This model is also solved for each of the three dimensions of sustainability as well as for all dimensions put together in a single model.

The result of model (7) is an optimal efficiency score between 0 and 1. If the optimal score is equal to 1, then the firm k is considered to be efficient. On the other hand, if the optimal score is less than 1, then firm k is not considered to be efficient and is dominated by at least one or more firms.

Aggressive cross-efficiency model

The weights u_{kx} and v_{ky} in the CCR model that maximize the objective function of simple efficiency may not be a unique solution. This means that there may be other alternative solutions to the linear programming (LP); however, the results (firm k's evaluation of other firms in the sample) depend upon which set of weights model (7) finds first. Due to this reason, cross-efficiency analysis using CCR model can be somewhat arbitrary and pose a major limitation (Talluri & Narasimhan, 2004). Managerially, this can pose a major problem as there may be better solutions with a different set of weights which model (7) did not arrive at. In order to overcome this, Sexton, Silkman and Hogan (1986), and Doyle and Green (1994) proposed and introduced a cross-efficiency matrix which may be used for more rigorous analysis. This formulation generates a unique set of weights for inputs and outputs and there are no alternative solutions. This formulation is as follows:

minimize

$$\sum_y \left(v_{ky} \sum_{s \neq k} O_{sy}\right)$$

subject to:

$$\sum_x \left(u_{kx} \sum_{s \neq k} I_{sx}\right) = 1$$

$$\sum_y O_{ky}\, v_{ky} - E_{kk} \sum_x I_{kx} u_{kx} = 0 \qquad (8)$$

$E_{ks} \leq 1$ for all firms $s \neq k$

$$u_{kx}, v_{ky} \geq 0$$

The objective function of model (8) is to determine those indicator weights that minimize other firms' output; and, therefore, is defined as an aggressive formulation. The value E_{kk} in model (8) is the optimal simple efficiency score obtained from basic CCR model (7). Model (8) is solved s times in order to compute efficiency score of all firms in the sample. This model is also solved for each of the three dimensions of sustainability as well as for all dimensions put together in a single model.

Benevolent cross-efficiency model

Benevolent cross-efficiency model is formulated by maximizing the objective function in model (8) and is given below:

maximize

$$\sum_y \left(v_{ky} \sum_{s \neq k} O_{sy}\right)$$

subject to:

$$\left.\begin{aligned}
&\sum_x \left(u_{kx} \sum_{s \neq k} I_{sx}\right) = 1 \\
&\sum_y O_{ky}\, v_{ky} - E_{kk} \sum_x I_{kx} u_{kx} = 0 \\
&E_{ks} \leq 1 \text{ for all firms } s \neq k \\
&u_{kx}, v_{ky} \geq 0
\end{aligned}\right\} \quad (9)$$

Model (9) is solved s times in order to compute efficiency score of all firms in the sample. This model is also solved for each of the three dimensions of sustainability as well as for all dimensions put together in a single model.

Data analysis and results of DEA models

Data for UPS, FedEx and DHL provide problem instances of these models. In particular, five inputs and seven outputs pertaining to three sustainability dimensions are shown in Table 3.14.

Table 3.14: Company data with inputs and outputs

	Inputs				
Company	Total Liabilities	Assets	CO2 emissions - Scope 1 + 2	CO2 emissions - Scope 3	Total Expense
UPS	27.593	34.701	12.768	8.742	47.025
FedEx	12.165	27.385	14.972	1.018	39.926
DHL	35.232	49.733	5.300	22.900	67.906

Company	Outputs						
	Total Shareholder Equity	Net Income	Package Volume	Dividend to shareholders	Charitable Contributions	no. of Employees	Employee compensation
UPS	7.108	3.804	4,010.000	2.000	93.500	398,242	27.600
FedEx	15.220	1.452	1,866.000	0.151	28.086	300,000	15.276
DHL	14.501	1.506	3,875.000	0.846	22.012	471,654	17.286

Simple efficiency scores as per basic CCR model (7) were calculated for economic, environmental and social dimensions of sustainability for all three companies with respect to inputs and outputs in Table 3.14. The results are presented in Table 3.15.

Table 3.15: Simple efficiency scores based on CCR model

Company	Simple Efficiency (CCR model)			
	Economic	Environmental	Social	Overall
UPS	1.000	1.000	1.000	1.000
FedEx	1.000	0.465	0.687	1.000
DHL	0.974	0.966	1.000	1.000

CCR model identified UPS to be efficient for all three dimensions of sustainability with a score of 1.0. FedEx was found to be efficient for economic dimension and inefficient for environmental and social dimension with a score of less than 1.0. DHL was identified as efficient for social dimension and inefficient for economic and environmental dimension.

One advantage of a CCR DEA approach over the linear aggregation approach is that each company can specify its own input (u) and output (v) weights to reach its maximum efficiency score. This approach can accommodate multiple inputs and outputs and compares different firms on the basis of ratios of outputs to inputs; thereby, making the comparisons more rigorous as compared to linear aggregation approach which relies on normalized values of various indicators of different firms. However, the linear aggregation approach is more easily comprehensible by managers because of the ease of formulation of the model.

The flexibility of model (7) in terms of specifying optimum weights enables each company to achieve maximum efficiency of 1.0 by various combinations of input and output weights, i.e., u_{kx} and v_{ky} values. However, even with this flexibility, some companies may not necessarily reach the efficiency frontier with value of 1.0 as illustrated in Table 3.15. One bothersome way in which model (7) achieves maximum efficiency score for a company is by according weights on only a single input and output, while according zero weights on all other inputs and outputs. Such a solution may be achieved when a company is very high on one of the outputs or very low on one of the inputs (Doyle & Green, 1994). The optimal weighting scheme accorded to the three companies for all inputs and outputs is presented in Table 3.16.

Table 3.16: Optimal weights based on CCR model

	Input weights				
Company	Total Liabilities	Assets	CO2 emissions - Scope 1 + 2	CO2 emissions - Scope 3	Total Expense
UPS	0.036	0.000	0.078	0.000	0.021
FedEx	0.000	0.037	0.068	0.000	0.025
DHL	0.000	0.020	0.000	0.044	0.015

	Output weights						
Company	Total Shareholder Equity	Net Income	Package Volume	Dividend to shareholders	Charitable Contributions	no. of Employees	Employee compensation
UPS	0.000	0.263	0.000	0.500	0.000	0.000	0.000
FedEx	0.066	0.000	0.000	0.000	0.000	0.000	0.012
DHL	0.049	0.171	0.000	0.000	0.000	0.000	0.000

Table 3.16 reveals that for all companies many input and output weights have been accorded a zero value in order to maximize the objective function in model (7). Sexton et al. (1986) termed the derivation of simple efficiency as primary goal, and minimizing other companies' cross-efficiencies as a secondary goal; and called the model as aggressive

formulation as per model (8). Conversely, a model which maximizes simple efficiency of a company as well as maximizes other companies' cross-efficiencies as a secondary goal is called a benevolent formulation as per model (9). Model (7) is termed as arbitrary formulation due to the reasons discussed above. Since the solution found to model (7) depends on arbitrary factors, Doyle and Green (1994) suggest using the average of aggressive and benevolent formulations as an alternative which leads to more robust results. Models (8) and (9) were solved for all three companies and the averaged results, tabulated as a matrix of cross-efficiencies, are presented and discussed below.

Table 3.17: Matrix of cross-efficiencies for economic dimension

Rating Company	Rated Company			Averaged appraisal of peers
	UPS	FedEx	DHL	
UPS	**1.000**	0.586	0.568	0.577
FedEx	0.470	**1.000**	0.260	0.365
DHL	0.691	0.850	**0.974**	0.771
Averaged appraisal by peers (including self appraisal)	0.720	0.812	0.601	

Table 3.17 presents the matrix of cross-efficiencies for economic dimension of sustainability for three companies. As one moves along the kth row of the matrix in Table 3.17, each entry E_{ks} is the efficiency accorded by company k to other companies in the matrix, given the averaged weighting scheme computed from models (8) and (9). The leading diagonal in bold

represents a special case where *k* rates itself (self-appraisal) and consists of efficiency scores computed from model (7). For example, the value of 0.586 in first row and second column of matrix is interpreted as the cross-efficiency accorded to FedEx using UPS's weights. The value of 1.000 in first row and first column is interpreted as simple efficiency accorded to UPS by itself (self-appraisal). The column 'Averaged appraisal of peers' is averaged without the diagonal element from the overall matrix. For example, the first value of 0.577 in that column represents the averaged appraisal of FedEx and DHL by UPS. The row 'Averaged appraisal by peers' is averaged including the leading diagonal and the values in that row yield company *k*'s averaged appraisal by peers including self-appraisal of *k*. For example, the first value of 0.720 in that row represents the averaged appraisal of UPS by FedEx, DHL and self-appraisal of UPS.

The averaged weighting scheme derived from aggressive and benevolent models is presented in Table 3.18.

Table 3.18: Optimal weights for economic dimension based on averaged aggressive and benevolent cross-efficiency models

	Input weights		Output weights	
Company	Total Liabilities	Assets	Total Shareholder Equity	Net Income
UPS	0.003	0.011	0.034	0.059
FedEx	0.008	0.006	0.006	0.112
DHL	0.013	0.008	0.047	0.094

To summarize the results of the matrix of Table 3.17, it can be concluded that for economic dimension, FedEx has the highest efficiency score of 0.812, followed by UPS with an efficiency score of 0.720, and finally DHL has an efficiency of 0.601.

Table 3.19: Matrix of cross-efficiencies for environmental dimension

Rating Company	Rated Company: UPS	Rated Company: FedEx	Rated Company: DHL	Averaged appraisal of peers
UPS	**1.000**	0.233	0.484	0.358
FedEx	0.425	**0.465**	0.411	0.418
DHL	0.596	0.277	**0.966**	0.437
Averaged appraisal by peers (including self appraisal)	0.674	0.325	0.620	

Table 3.19 presents the matrix of cross-efficiencies for environmental dimension of sustainability for three companies. The averaged weighting scheme derived from aggressive and benevolent models is presented in Table 3.20.

Table 3.20: Optimal weights for environmental dimension based on averaged aggressive and benevolent cross-efficiency models

	Input weights		Output weights
Company	CO2 emissions - Scope 1 +2	CO2 emissions - Scope 3	Package Volume
UPS	0.025	0.021	0.0001
FedEx	0.028	0.016	0.0001
DHL	0.029	0.019	0.0001

To summarize the results of the matrix of Table 3.19, it can be concluded that for environmental dimension, UPS has the highest efficiency score of 0.674, followed by DHL with an efficiency score of 0.620, and finally FedEx has an efficiency of 0.325.

Table 3.21: Matrix of cross-efficiencies for social dimension

Rating Company	Rated Company			Averaged appraisal of peers
	UPS	FedEx	DHL	
UPS	**1.000**	0.181	0.350	0.266
FedEx	0.658	**0.687**	0.491	0.575
DHL	0.830	0.553	**1.000**	0.691
Averaged appraisal by peers (including self appraisal)	0.829	0.474	0.614	

Table 3.21 presents the matrix of cross-efficiencies for social dimension of sustainability for three companies. The averaged weighting scheme derived from aggressive and benevolent models is presented in Table 3.22.

Table 3.22: Optimal weights for social dimension based on averaged aggressive and benevolent cross-efficiency models

	Input weights	Output weights			
Company	Total Liabilities	Dividend to shareholders	Charitable Contributions	no. of employees	Employee compensa tion
UPS	0.009	0.109	0.000	0.000	0.000
FedEx	0.009	0.190	0.000	0.000	0.000
DHL	0.012	0.000	0.000	0.000	0.013

To summarize the results of the matrix of Table 3.21, it can be concluded that for social dimension, UPS has the highest efficiency score of 0.829, followed by DHL with an efficiency score of 0.614, and finally FedEx has an efficiency of 0.474.

Table 3.23: Matrix of cross-efficiencies for all sustainability dimensions

Rating Company	Rated Company			Averaged appraisal of peers
	UPS	FedEx	DHL	
UPS	**1.000**	0.514	0.577	0.546
FedEx	0.508	**1.000**	0.515	0.511
DHL	0.581	0.561	**1.000**	0.571
Averaged appraisal by peers (including self appraisal)	0.696	0.692	0.698	

Table 3.23 presents the matrix of cross-efficiencies for social dimension of sustainability for three companies. The averaged weighting scheme derived from aggressive and benevolent models is presented in Table 3.24.

Table 3.24: Optimal weights for all sustainability dimensions based on averaged aggressive and benevolent cross-efficiency models

	Input weights				
Company	Total Liabilities	Assets	CO2 emissions - Scope 1 + 2	CO2 emissions - Scope 3	Total Expense
UPS	0.000	0.000	0.002	0.013	0.021
FedEx	0.000	0.000	0.000	0.027	0.016
DHL	0.000	0.000	0.000	0.030	0.017

	Output weights						
Company	Total Shareholder Equity	Net Income	Package Volume	Dividend to shareholders	Charitable Contributions	no. of Employees	Employee compensation
UPS	0.031	0.000	0.091	0.000	0.000	0.000	0.000
FedEx	0.026	0.000	0.161	0.000	0.000	0.000	0.000
DHL	0.027	0.000	0.000	0.003	0.000	0.000	0.000

To summarize the results of the matrix of Table 3.23, it can be concluded that for overall sustainability, DHL has the highest efficiency score of 0.698, followed by UPS with an efficiency score of 0.696, and finally FedEx has an efficiency of 0.692.

In the above analysis of different DEA models, we have used average cross-efficiencies of aggressive and benevolent DEA models in order to distinguish between the companies achieving a simple efficiency score of 1.0 using arbitrary DEA model. This resulted in establishing a meaningful ranking among the companies used for analysis. We can now go further in identifying maverick companies (Doyle & Green, 1994), which may be defined as those companies that achieve 100% simple efficiency (or a simple efficiency score of 1.000) by weighting only a single input and output, while other inputs / outputs are accorded a zero weight. Such maverick companies achieve the greatest relative increment in efficiency upon shift from cross-efficiency to simple efficiency. Doyle and Green (1994) suggested a maverick index which is measured as below.

$M_k = (E_{kk} - e_k)/e_k$ (10)

where

$e_k = 1 / (n - 1) \sum_{s \neq k} E_{sk}$

Table 3.25 presents the values of maverick index M_k from (10) along with simple efficiency from (7) and averaged cross-efficiency from (8) and (9) for all three companies and for all sustainability dimensions.

Table 3.25: Simple efficiency, average cross efficiency and maverick index of sustainability

	Company	Simple eff	Average cross eff	Maverick index
Economic	UPS	1.000	0.720	3.889
	FedEx	1.000	0.812	2.315
	DHL	0.974	0.601	6.206
Environmental	UPS	1.000	0.674	4.837
	FedEx	0.465	0.325	4.308
	DHL	0.966	0.620	5.581
Social	UPS	1.000	0.829	2.063
	FedEx	0.687	0.474	4.494
	DHL	1.000	0.614	6.287
All dimensions	UPS	1.000	0.696	4.368
	FedEx	1.000	0.692	4.451
	DHL	1.000	0.698	4.327

The lower the value of maverick index for a company, the less maverick is that company. FedEx is the least maverick company for economic and environmental dimensions with a maverick index of 2.315 and 4.308 respectively; UPS is the least maverick for social dimension with a maverick index of 2.063; and DHL is least maverick overall with a maverick index of 4.327. Results in Table 3.25 also reveal that companies with a high simple efficiency also tend to be high on average cross-efficiency. There is a high positive correlation (R = .8806) between the two parameters. Table 3.25 also identifies best all-round performing companies for each dimension based on the scores achieved for three parameters. FedEx is the best all-round performer for economic dimension as it has the least maverick score with highest simple efficiency and average cross-efficiency. UPS is the best all-round performer for social dimension as it has the lowest maverick score with highest simple efficiency and average cross-efficiency. For the environmental dimension, there is no clear all-round performer; however, it will be fair to conclude that UPS is the best performer with highest simple efficiency and cross-efficiency scores.

Discussion and Conclusions

In this chapter, we have proposed a methodology for measuring sustainability performance of companies in logistics and shipping services industry. A variety of mathematical techniques were utilized to effectively discriminate sustainability performance of companies. Specifically, linear aggregation methodology was used, in which normalizations of various indicators of sustainability were aggregated to create sub-indices of three dimensions of sustainability which were finally aggregated to create an overall sustainability index. This may be the best approach when quick solutions are needed using heuristic rules as this approach assumes equal weights for all indicators. We modified this approach by assigning weights to three dimensions of sustainability for the overall index based upon the sustainability reports of firms in logistics and shipping services industry. However, we assumed equal weights for each indicator within a sustainability dimension. This modified approach can be replicated for other industries to arrive at weights for three sustainability dimensions by extracting information from sustainability reports of a particular industry. As an alternative approach, a DEA methodology was demonstrated by formulating three different DEA models to individually arrive at organizational scores for economic, environmental and social performance. These models also evaluated organizations with integrated formulations to gauge sustainability more comprehensively.

Measuring performance of a firm allows management to assess the success of the firm's adaptation to changing environment (Lynch, 2011). Monitoring the performance of a firm acts as an effective control system. Grant (2008) suggests that apart from just maximizing profits, firms are motivated to achieve other goals also. Many of the world's successful companies tend to be those that are motivated not just to increase profits and shareholder value but also focus on other factors (Lynch, 2011). According to Laszlo (2008), megatrends are emerging which are forcing companies to create business value from a singular profitability focus to one that includes a broader focus based on economic, environmental, and social impacts on stakeholders.

The importance of the *triple bottom line* is evident from the increasing number of companies publishing their sustainability reports on a periodic basis. For these companies that are committed to improving their environmental, social and economic performance, the question is no longer whether to implement sustainability in their corporate strategies, but how to measure the sustainability performance of their company and how to compare sustainability performance longitudinally and with their competitors. In this research, we developed approaches and modeled a sustainability index. This methodology was demonstrated for major competitors in the logistics and shipping services industry. These approaches can provide meaningful competitive comparisons to inform managerial decisions. A basic benefit of modeling sustainability of a firm is to evaluate whether or not the weights derived for each indicator are consistent with an organization's identity, culture and mission. Similarly, a modeling process may illuminate gaps in measurement that can be addressed with directives for targeted reporting. Thus, it can be used for the purposes of internal and external benchmarking. By identifying strengths and weaknesses of organizational performance in regard to sustainability, organizational managers can develop strategies and tactics for continuous improvement. More broadly, an accurate and convenient index that is rich in information can foster healthy competition and encourage collaborative efforts for standardized metrics.

The purpose of an overall sustainability index is to integrate economic, environmental and social indicators into a simplified expression (Krajnc & Glavic, 2005b). This research quantifies a variety of such indicators into a simplified index which can be used as a benchmarking tool for the increasingly important logistics and shipping services sector. We developed a step-wise systematic approach to develop normalized indices to assist management decisions pertaining to sustainability in logistics and shipping services sector. This approach can be replicated for other industries and applied to other comparative projects to support data driven decision-making in these industries.

Our proposed mathematical model to determine a sustainability index framework for the logistics and shipping services industry enhances the understanding of causal relationships between various dimensions of sustainability. The main strength of the model resides in its flexibility and transparency that enables the inclusion and / or deletion of additional indicators, if required. The model can be used to estimate the results of sustainability efforts as a snapshot, which can be re-evaluated if additional information becomes available. At present, there are no standardized sustainability metrics in logistics and shipping services industry which can make comparisons between companies a difficult task. Our proposed model is an attempt to quantify comparisons between companies in this sector and can be used by researchers to provide a unique and objective way of ranking companies in logistics and shipping services industry on the basis of sustainability index. The output of the model, which is the sustainability index, can reveal the driving forces of three dimensions of sustainability.

This research may be extended by probing individual dimensions of sustainability to investigate whether a particular dimension is influenced by the firm, industry or regulatory effects. For example, if on the basis of the developed model, specific indicators of environmental sustainability are found to be more dominant and important in the overall sustainability of a company, then researchers can investigate the environmental performance by decomposing the performance into firm, industry, and regulatory effects, i.e., whether the environmental performance is influenced more by the activities of the company itself, the industry to which the firm belongs, or the regulatory environment in which the company or industry operates. Also, overall patterns of sustainability performance can be studied over time and across industries to evaluate relationships of indicators and identify trends or paths of improvement. These directions for future research may help practitioners and academics more fully comprehend drivers of sustainability in particular companies and industries.

CHAPTER 4

ENVIRONMENTAL RISK PERFORMANCE OF MANUFACTURING FACILITIES: PLANT, FIRM, INDUSTRY AND STATE REGULATORY EFFECTS

Introduction

Previous research has studied the relationship between environmental performance and profitability of a firm (e.g., Rivera, 2004; Clemens and Douglas, 2004; Zhu and Sarkis, 2007; Vachon and Klassen, 2006; Carter and Carter, 1998; Förstl, Blome, Henke, & Schönherr, 2010). A recent meta-analysis by Golicic et al. (2013) concluded that environmental performance of a firm has a positive relationship with a firm's economic performance. However, extant literature has largely ignored analysis of factors contributing to environmental performance. The role of industry and other factors may be important sources of variation affecting a firm's environmental performance. Apart from industry effects, there may be other factors contributing to the environmental performance of a firm such as the geographical location of the firm. The state or county where a firm is located may have a direct influence on the environmental performance of the firm due to the variability of environmental laws in different regions. Thus gaining understanding of the interplay between various factors affecting environmental performance may provide vital information for mitigating environmental risks.

The purpose of this research is to examine the variation in a firm's environmental performance over time and partition this variability into facility, firm, industry, and geographical location. In order to achieve this purpose, we formulate a multilevel cross-classified model consisting of facility, firm, industry, state, county and year as the different levels of the model. State and county levels serve as a proxy for environmental laws and regulations which govern a particular geographical location. The specific research question that this research seeks to answer is:

What is the extent to which facility, firm, industry and regulatory effects explain the environmental performance differences across manufacturing facilities?

Theoretical Foundation

This research draws from three different theoretical bases to investigate the effect of facility, firm, industry and regulatory effects on differential environmental performance of firms. Specifically we consider resource based view, industrial organization theory and institutional theory. Below we provide a brief discussion of these theories in order to position our research within the context of these theories.

Resource-based view (RBV) explains that valuable, rare, inimitable, and organizationally embedded resources and capabilities provide the key sources of competitive advantage for a firm (Barney, 1991; Wenerfelt, 1984; Dierickx and Cool, 1989). These resources may include financial capital, assets, technical know-how and human capital. Managers of a firm should bundle these resources in unique ways so that they provide a sustained competitive advantage to the firm (Sirmon, Hitt, & Ireland, 2007; Connelly, Ketchen, & Slater, , 2011). Hence, RBV focuses on the individual firm, its resources and developed capabilities, and firm level strategies as a source of firm performance. Since previous research has indicated that environmental performance leads to firm performance, RBV may be used to explain the source of differential environmental performance at the firm level leading to its competitive advantage.

Industrial organization (IO) theory suggests industry structure is the central determinant of firm performance (Porter, 1980). IO theorists argue that a firm’s success is dependent on its external environment, i.e., the industry in which it operates. IO theory differs from RBV in the locus. While RBV approach emphasizes the 'firm' level, IO theory focuses on the 'industry' level (Maijoor and Witteloostuijn, 1996). Therefore, this theory seems to suggest that environmental performance of a firm will depend on the performance of its industry.

Institutional theory examines the effects of external pressure on a company (Hirsh, 1975). Societies have many institutionalized roles that create a set of guidelines or frameworks under which organizations make their decisions (Meyer and Rowan, 1977). Failure of a firm to conform to critical, institutionalized norms of acceptability can threaten the firm's legitimacy, resources and, ultimately, its survival (DiMaggio and Powell, 1983; Oliver, 1991; Scott, 1987; Bansal, 2005). Within institutional theory, 'coercion' is an important form of external driver that influences the performance of firms. (DiMaggio and Powell, 1983). For example, government is a powerful institution that coercively influences the environmental actions of a firm through penalties and fines in cases of non-compliance. Government plays a powerful role in influencing environmental sustainable development (Bansal, 2005) and in order to avoid fines and penalties, firms subscribe to higher standards of environmental performance. Previous research has shown that coercive pressures, in the form of environmental laws and regulations enacted by the government, are core elements driving environmental management (e.g., Kilbourne, Beckmann, & Thelen, 2002) and promoting environmental management practices (Rivera, 2004). Therefore, this theory seems to suggest that environmental performance of a firm will depend on the intensity of regulatory pressures on the firm.

Based on the above discussion of RBV, IO theory and institutional theory, we may argue that the explanation of differential environmental performance of firms may be attributed to either the facility or its parent firm, or the industry, or the environmental laws and regulations that govern a particular geographical location, namely, the state or county. Previous research has studied the relationship between environmental performance and firm performance based on each of these theories individually (e.g., Rivera, 2004; Clemens and Douglas, 2006; Zhu and Sarkis, 2007; Vachon and Klassen, 2006; Carter and Carter, 1998; Förstl et al. 2010). However, to the best of our knowledge, there has been no empirical research conducted which provides evidence regarding relative effects of proxies for each of these theories on the environmental performance of a firm. In this research, our endeavor is to partition the variability of environmental performance of firms into facility, firm, industry and regulatory effects. In doing so, we also explain how much of the differential environmental performance can be explained by each theory discussed above.

Data Source and Variables

In order to partition the environmental risk performance of firms into firm, industry and location effects, this research focuses on the environmental pollution data extracted from Risk Screening Environmental Indicators (RSEI) database. This database consists of scientifically estimated air pollution data that is calculated based on toxicity-weighted concentration of air pollutants emitted from every facility in US in a calendar year which is listed in the Environmental Protection Agency's (EPA) Toxics Release Inventory (TRI). It is a publicly available database available for download for any number of available years of TRI data. A more comprehensive discussion of TRI data is provided by Ash and Fetter (2004). The RSEI database estimates each air pollutant using a 101 square-kilometers plume model made up of grid cells of one square-kilometer each (Downey, Dubois, Hawkins, & Walker, 2008). While estimating the pollutants, the model takes into account various external factors such as wind speed, direction, turbulence, and rate of chemical decay and deposition for each grid cell which are aggregated to create toxicity-weighted air pollutant concentration grids for neighborhoods, counties and states.. Thus, RSEI data provides researchers with accurate micro level estimates of environmental risks in various locations for the entire nation (see Bowen, 2002). The vast scope of this data makes RSEI a very valuable research tool that is being increasingly used by researchers interested in studying environmental risks. It has been maintained since 1996 and fully updated through 2010. Further technical details on the RSEI model can be found at US EPA (2010).

For the purpose of sustainability research, this database has been used by a number of management scholars (e.g., Klassen and Whybark, 1999; King and Shaver, 2001; King and Lennox, 2002; Russo and Harrison, 2005; Clelland, Douglas, & Henderson, 2006; Walker, 2011). Toffel and Marshall (2004) conducted a comprehensive review of 13 weighted environmental databases and they recommend the RSEI as one of the most comprehensive database for analyzing environmental risk arising from toxic releases in the atmosphere. For our research, we used RSEI 2.3.1 which is the latest version currently available on the EPA website.

Variables used in the research are listed below. More information regarding the variables can be found in the RSEI manual (US EPA, 2012).

Table 4.1: List of variables and their description

Variable	Description
Facility ID	Unique TRI identifier for facility.
Parent DUNS	The 9-digit number assigned by Dun & Bradstreet for the parent company of the facility.
State	State in which the facility is located.
FIPS	Federal Information Processing Standard code which identifies the county in which the facility is located.
NAICS	North American Industry Classification System code for the facility.
Year	Calendar year for which the pollutant estimates are calculated.
Pounds-based results	Number of pounds released or transferred that are reported to TRI.
Hazard-based results	TRI pounds multiplied by the toxicity weight of the chemical appropriate for the exposure pathway selected.
*Modeled Hazard*Pop*	Number of modeled pounds multiplied by the toxicity weight of the chemical appropriate for the exposure pathway selected and by the population potentially exposed.
Risk-related results	Product of the surrogate dose (estimated using exposure models), the chemical's toxicity weight, and the population.

The last four variables in the above table are used as dependent variables in each of the four models formulated respectively in this research. The variables *modeled hazard*pop* and *risk-related results* provide the most microscopic estimates of pollutants. However, the pounds used in the two variables differ from each other. Calculations to estimate the pounds in *risk-related results* include the fate and transport of the pollutant pounds and exposure risk assumptions.

Fifteen years of environmental risk data were downloaded from RSEI model for the years 1996-2010. This is the whole data population currently available in the RSEI model. We restricted our data to manufacturing industries only while excluding other industries such as services, retail, etc. Downloaded data was screened for invalid or missing values pertaining to DUNS number, NAICS, zip codes, and hazard and such observations were deleted from the data. The screening process yielded 74,593 observations nested within 9530 facilities that were cross-classified with 1464 firms and 449 industries.

We estimated four models using TRIPounds, Hazard, Modeled Hazard*Pop, and Risk-related results, as the dependent variable for each model respectively. Our objective was to decompose the dependent variable in each model in seven classifications – facility, firm, industry, state, county, year and error (unknown).

Non-hierarchical data structures

Clustered data structures are most commonly analyzed using multilevel models, also known as hierarchical linear models (Chung and Beretvas, 2012). Examples of pure hierarchical data structures include students that are nested within schools, facilities that are nested within firms, or firms that are nested within industries. Such data structures may be analyzed by formulating a traditional multilevel model in which each data entity (e.g., students) belongs to only one higher-level data entity (e.g., schools) (Chung and Beretvas, 2012). However, real world situations entail multilevel data that are not purely hierarchical in nature. Our RSEI data structure is an example of non-hierarchical model in which each facility has simultaneous multiple memberships in firm, industry or state (geographical location). Figure 4.1 depicts our multiple membership data structure in which a facility is nested within a firm, industry, and state.

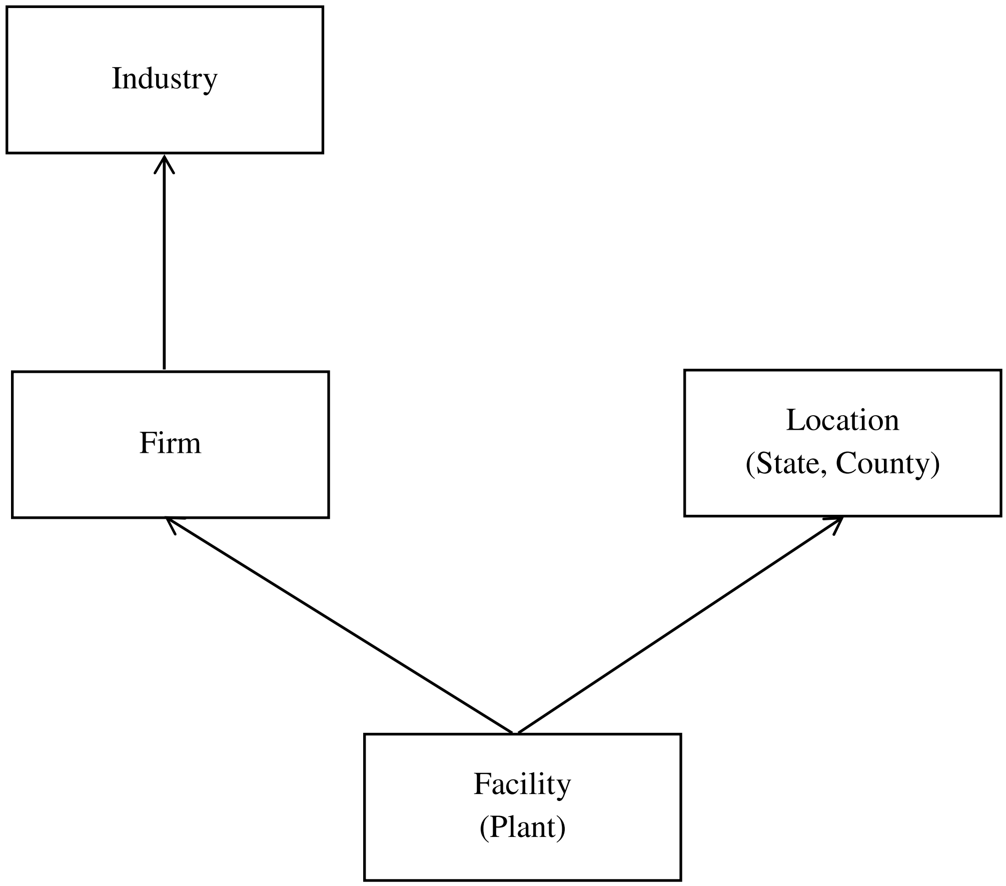


Figure 4.1: Cross classified model for facility simultaneously nested within firm, industry and location (state and county)

This multiple membership multiple classification (MMMC) model is formulated to handle the complex data structure associated with multiple membership. We analyze this MMMC utilizing Markov Chain Monte Carlo (MCMC) estimation procedures, which are described in detail in the next section.

Markov Chain Monte Carlo Estimation Procedures

The multilevel model illustrated in figure 4.1 was analyzed using MCMC (Browne, 2009; Rasbash, Steele, Browne, & Goldstein, 2009) procedures. To be consistent with previous studies (e.g. Mollick, 2012), our model was estimated using MCMC methods by employing MLwiN

2.26 multilevel modeling software, developed by the Center for Multilevel Modeling at the University of Bristol in the U.K. (Browne, 2009; Hough, 2006).

For Bayesian modeling, MLwiN software uses two types of sampling estimation procedures: Gibbs, and Metropolis-Hastings. Our analysis was conducted utilizing Gibbs Sampling algorithm in MCMC (Geman and Geman, 1984) which is the most widely used algorithm. MCMC methods are simulation-based procedures, which are run for many iterations (Browne, 2012). Each iteration produces an estimate for each unknown parameter and the estimates from the last iteration are used to predict the new estimate. However, it is important that before running MCMC estimation, the method has good starting values. This is achieved in two ways: First, by running Iterative Generalized Least Squares (IGLS) prior to actual MCMC estimation. Second, allowing the estimation a burn-in period which allows the chains to settle down (Browne, 2009). We utilized the default value of 500 iteration burn-in period which is used to reduce the overall number of iterations required to reach a stable solution (Browne, Goldstein, & Rasbash, 2001). The estimated model is shown below. This model was run for each of the four dependent variables as defined in equation (1).

$$y_i = X_i\beta + u^{(7)}_{year(i)} + u^{(6)}_{county(i)} + u^{(5)}_{state(i)} + u^{(4)}_{industry(i)} + u^{(3)}_{firm(i)} + u^{(2)}_{facility(i)} + e_{(i)} \quad (1)$$

where y_i is TRI pounds, hazard, modeled hazard*pop, and risk-related results

$X_i\beta$ is the matrix of predictors

$u^{(7)}_{year(i)}$ is the random effect for the year

$u^{(6)}_{county(i)}$ is the random effect for the county

$u^{(5)}_{state(i)}$ is the random effect for the state

$u^{(4)}_{industry(i)}$ is the random effect for the industry

$u^{(3)}_{firm(i)}$ is the random effect for the firm

$u^{(2)}_{facility(i)}$ is the random effect for the facility

$e_{(i)}$ is the unexplained (error) random effect.

The performance of MCMC algorithms is related to the speed at which Markov chain navigates multiple levels in the model. High autocorrelation in the data requires long time periods to navigate the parameter space fully (Rossi, Allenby, & McCulloch, 2009) and such situations are common. In these situations, it may take days of computing to properly navigate the posterior. If autocorrelation is a problem, a technique called 'thinning' can be applied to improve mixing and reduce required chain length. Thinning is a technique that stores every *k*th iteration of the chain. This technique offers only slight speed gains, but has the added attractions of reduced storage requirements and less autocorrelation in the thinned chain (von Sanden, 2004). In our case, each of the four models was initially estimated for 100,000 iterations per the recommendations of Link, Emmanuelle, Nichols, & Cooch (2002) and Gardner, Lawler, Ver Hoef, Magoun, & Kellie, K.A. (2010). In order to reach a stable solution, various combinations of number of iterations and thinning were employed. Finally, a stable solution, indicated by convergence of each model, was achieved with a monitoring chain length of 1,000,000 iterations with no thinning (thinning = 1). Convergence of a model involves iterating between two deterministic steps until two consecutive estimates for each parameter specified in the model are sufficiently close together (Browne, 2012). Convergence of a model indicates that the model chains have run long enough to produce a stable solution. Two important MCMC diagnostics – Raftery-Lewis and Brook-Draper – are considered to determine the convergence of the model. These diagnostics are discussed in the next section.

Diagnosis and Results

The purpose of this study was to decompose the variability of four dependent variables – tripounds, hazard, modeled hazard*pop, and risk-related results, into facility, firm, industry, state, county and unexplained (error) components. Four models as per equation (1) were estimated using MLwiN 2.26 software. Tables 4.2 – 4.5 illustrate the summary statistics as well as the accuracy diagnostics of all four models related to environmental risk performance specified in equation (1).

Table 4.2: Summary statistics and accuracy diagnostics of seven levels of model having tripound as dependent variable

	Summary Statistics (in pounds)				Accuracy Diagnostics		% variance explained
	Posterior Mean Variance	2.5% quantile	97.5% quantile	Effective Sample Size	Raftery-Lewis diagnostic (2.5%, 97.5%)	Brooks-Draper diagnostic (mean)	
Facility	1.275	1.231	1.321	118611	(4462, 8102)	2	**48.15**
Firm	0.114	0.090	0.142	23983	(14831, 12153)	452	**4.31**
Industry	0.295	0.240	0.358	62798	(5980, 10046)	507	**11.14**
State	0.007	0.001	0.016	23388	(38959, 8562)	276292	**0.26**
County	0.023	0.006	0.046	6560	(66062, 49430)	199972	**0.87**
Year	0.006	0.003	0.012	231093	(4034, 8560)	21242	**0.23**
Error	0.928	0.918	0.938	799341	(3910, 3891)	5	**35.05**

Table 4.3: Summary statistics and accuracy diagnostics of seven levels of model having mhp as dependent variable

	Summary Statistics (in pounds*toxicity wt.*population)				Accuracy Diagnostics		% variance explained
	Posterior Mean Variance	2.5% quantile	97.5% quantile	Effective Sample Size	Raftery-Lewis Diagnostic (2.5%, 97.5%)	Brooks-Draper diagnostic (mean)	
Facility	8.03E20	7.71E20	8.35E20	414799	(4492, 4448)	84	**24.36**
Firm	5.03E18	3.30E16	1.34E19	21633	(10446, 22368)	839711	**0.15**
Industry	2.24E19	9.80E18	3.67E19	48229	(21577, 10739)	12263	**0.68**
State	4.64E17	4.97E14	2.24E18	114126	(4094, 10486)	539579	**0.01**
County	1.57E18	2.42E15	6.17E18	36267	(4836, 17232)	130306	**0.05**
Year	1.43E17	1.53E14	7.12E17	468942	(3875, 4973)	13987	**0.00**
Error	2.46E21	2.43E21	2.48E21	833796	(3876, 3879)	1	**74.74**

Table 4.4: Summary statistics and accuracy diagnostics of seven levels of model having hazard as dependent variable

	Summary Statistics (in pounds*toxicity wt.)				Accuracy Diagnostics		% variance explained
	Posterior Mean Variance	2.5% quantile	97.5% quantile	Effective Sample Size	Raftery-Lewis Diagnostic (2.5%, 97.5%)	Brooks-Draper diagnostic (mean)	
Facility	1.86E13	1.79E13	1.94E13	466641	(4530, 4525)	5	**35.59**
Firm	6.40E11	4.15E11	8.88E11	41568	(17341, 18306)	45018	**1.22**
Industry	7.73E11	5.34E11	1.05E12	73800	(10910, 8513)	25456	**1.47**
State	2.48E10	7.83E07	8.61E10	49533	(5678, 10092)	120946	**0.05**
County	3.73E10	8.69E07	1.28E11	23418	(5887, 20365)	831285	**0.07**
Year	6.21E09	2.74E07	2.30E10	345965	(4576, 4984)	171866	**0.01**
Error	3.23E13	3.19E13	3.26E13	778454	(3916, 3918)	1	**61.58**

Table 4.5: Summary statistics and accuracy diagnostics of seven levels of model having risk-related as dependent variable

	Summary Statistics (in pounds*toxicity wt.*population)				Accuracy Diagnostics		% variance explained
	Posterior Mean Variance	2.5% quantile	97.5% quantile	Effective Sample Size	Raftery-Lewis Diagnostic (2.5%, 97.5%)	Brooks-Draper diagnostic (mean)	
Facility	2.86E11	2.78E11	2.94E11	997945	(7500, 7572)	3	**62.72**
Firm	6.92E10	6.43E10	7.44E10	1002531	(7464, 7462)	101	**15.17**
Industry	9.43E10	8.27E10	1.07E11	1001101	(7576, 7588)	615	**20.68**
State	4.64E07	3.17E07	6.79E07	1000273	(7502, 7490)	1333	**0.01**
County	2.85E09	2.68E09	3.05E09	999771	(7498, 7530)	14	**0.63**
Year	3.63E09	1.71E09	7.54E09	1009248	(7504, 7504)	3688	**0.80**
Error	1.403E01	1.388	1.419	776693	(3931, 3927)	1	**0.00**

In order to confirm whether each of the four models had converged and, hence, produced a stable solution, two important MCMC diagnostics – Raftery-Lewis and Brook-Draper – were considered. The Raftery-Lewis diagnostic (Raftery and Lewis, 1992; Browne, 2012) is used to estimate the length of the Markov chain required to estimate 2.5% and 97.5% quantiles to a given accuracy that forms a central interval estimate. All seven parameters in all four models as specified in equation (1) satisfied this diagnostic, as each model chain was run for 1 million iterations, which is well above the estimated chain length as seen in tables 4.1 – 4.4. The highest value for 2.5% quantile for Raftery-Lewis diagnostic was 66062 in table 4.1, which is well below the actual number of iterations (1 million) for which each model was run. Likewise, the highest value for 97.5% quantile for Raftery-Lewis diagnostic was 49430 in table 4.1, which is again well below the actual number of iterations (1 million) for which each model was run.

The Brooks-Draper diagnostic is a contrasting diagnostic, which is based on the mean of the distribution (Browne, 2012). This diagnostic is used to estimate the length of the Markov chain required to produce a mean estimate to k significant figures to a given accuracy. As tables 4.1 – 4.4 show, it was necessary to run the chain for a maximum of 839711 iterations (refer table 4.3) to produce estimates with the required level of accuracy with two significant figures. This is less than the actual number of iterations (1 million) for which all four models were run. Thus, both diagnostics were satisfied for all parameters in all four models. Hence, it can be reasonably concluded that: 1) all four models converged and produced a stable solution, and 2) the percentage variation of environmental risk explained by each level (parameter) in all four models has a high degree of reliability.

As per table 4.2, the first model with *tripounds* as the dependent variable attributes 52.46% of variation of environmental risk to the facility and firm level. 11.14% of variation of environmental risk can be attributed to the industry, and 1.13% of variation of environmental risk can be attributed to environmental laws and regulations that govern a particular geographical area, namely, the state and county.

As per table 4.3, the third model with *mhp* as the dependent variable attributes 24.51% of variation of environmental risk to the facility and firm level. 0.68% of variation of environmental risk can be attributed to the industry, and 0.06% of variation of environmental risk can be attributed to environmental laws and regulations that govern a state and county.

As per table 4.4, the third model with *hazard* as the dependent variable attributes 36.81% of variation of environmental risk to the facility and firm level. 1.47% of variation of environmental risk can be attributed to the industry, and 0.12% of variation of environmental risk can be attributed to environmental laws and regulations that govern a state and county.

As per table 4.5, the second model with *risk-related* as the dependent variable attributes 77.89% of variation of environmental risk to the facility and firm level. 20.68% of variation of environmental risk can be attributed to the industry, and 0.64% of variation of environmental risk can be attributed to environmental laws and regulations that govern a state and county.

Figure 4.2 illustrates and compares the % variance explained by facility and firm, industry, and location, for all the four models with four dependent variables.

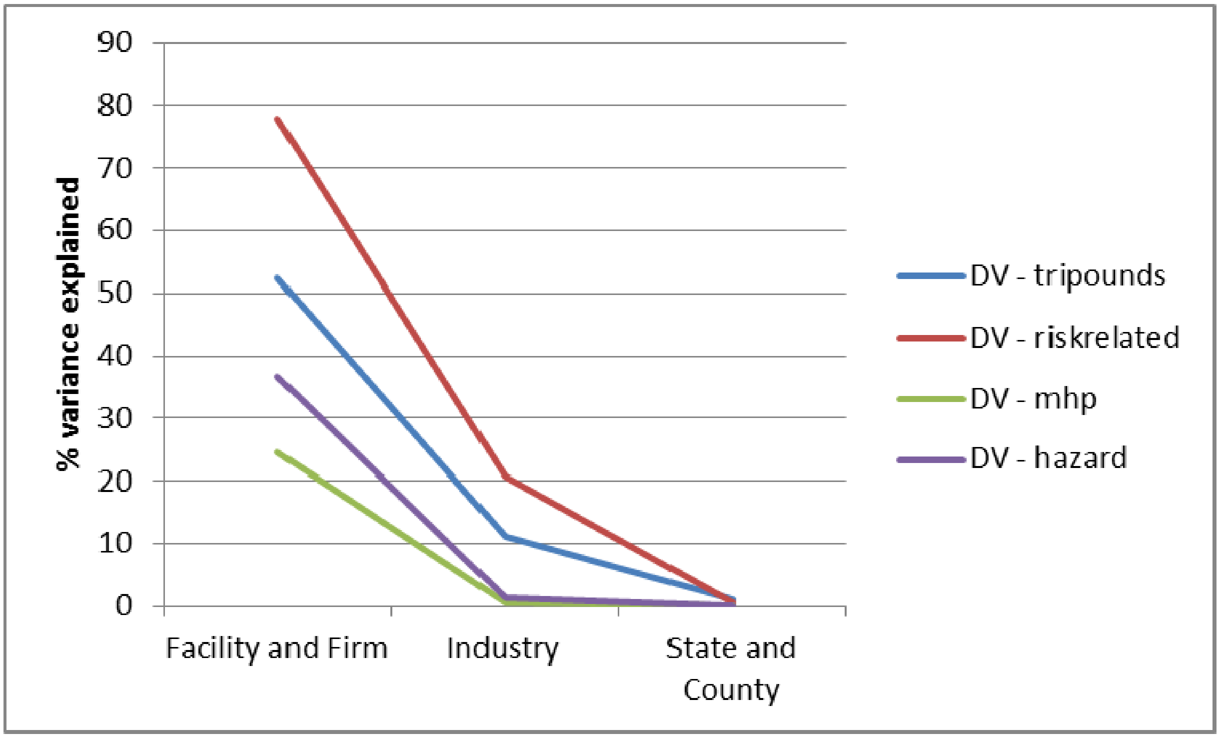


Figure 4.2: Comparison of % variance explained by the levels of four models

Implications and Conclusions

In this chapter, we strived to answer a fundamental question in environmental strategy about the relative importance of firm, industry, and environmental laws and regulations enacted by government as external factors, on environmental risk performance using comprehensive data covering manufacturing industries drawn from RSEI database for 1996 through 2010. In order to answer this question, four separate multiple membership cross-classified multilevel models with four different dependent variables were estimated. The results indicate that for each model, the variation in firm effects account for 52.46%, 77.89%, 24.51% and 36.81% respectively. The variation in industry effects account for 11.14%, 20.68%, 0.68% and 1.47% respectively. Finally, the variation in location effects account for 1.13%, 0.64%, 0.06% and 0.12% respectively. These results have important managerial and theoretical implications which are discussed below.

In terms of environmental risk performance, the analysis strongly indicates that firm resources and capabilities matter more than the industry structure or the institutional pressures. Theoretically, these results provide strong evidence that most of the differential environmental performance of firms can be attributed to internal resources, as advocated by the RBV. IO theory explains the remainder of the differential environmental performance. Institutional theory has negligible effect on environmental performance. Another important finding from the analyses is that the year effects are negligible and account for merely 0.23%, 0.80%, 0% and 0.01%, respectively, in the four models. This supports the assertion that rapid changes in economy over the years have negligible effect on environmental risk performance of firms.

The results have important strategic implications for managers. Since our results indicate that environmental risk performance is mainly dependent on firm resources and capabilities, managers should have higher investment of available resources at the firm level. As far as the environmental risk performance is considered, the firm activities matter more that the industry in which the firm is embedded. The results also imply that environmental risk performance does not depend much on the environmental laws and regulations of a state or county in which the firm is located. This may be due to the reason most states and counties in the United States not having strict environmental laws and regulations. Since our analyses were at an aggregated level covering the entire country, it would be interesting to analyze the four models at each state level to find out whether in some states environmental laws and regulation effects are more that the firm or industry effects.

CHAPTER 5

SUMMARY AND CONCLUSIONS

The purpose of this chapter is twofold: a) to discuss the linkages of chapters 2, 3, and 4; and b) to discuss the contributions of the three essays of this dissertation, managerial and theoretical implications of the dissertation, and discuss the research limitations.

Chapters 2, 3, and 4 of this dissertation fall under the important domain of strategic sustainable supply chain management. In chapter 1 we provided an overview and discussed the linkage between the four Ms (measure, manage, mitigate, market) of sustainability. In this context, chapter 2 specifically focuses on the 'market' aspect of the four Ms of sustainability and objectively examines the sustainability reports (which are a medium of communication for customers and stakeholders) of top, sustainable corporations in order to analyze the market-oriented strategies employed by the organizations to address sustainability in their supply chains. The main focus of chapter 3 is on 'measure' and 'manage' aspects of sustainability. Chapter 3 contains development demonstration of complementary methodologies to measure and benchmark sustainability efforts of organizations within an industry. Chapter 4 focuses on 'measure', 'manage' and 'mitigate' aspects of sustainability while examining the sources of differential environmental risk performance of firms. These three chapters also traverse nodes and arcs of supply chain networks. The scope of chapter 2 contains focal firms (often manufacturers) as well as upstream and downstream sides of their supply chains. Chapter 3 focuses on major firms that link the various nodes of a supply chain; i.e., firms in the logistics and shipping services industry. Chapter 4 focuses solely on focal firms and more specifically on manufacturing companies. Thus, this dissertation examines contemporary topics that are relevant to supply chain managers and also captures perspectives of key supply chain entities: logistics service providers and manufacturers. Furthermore, results from a qualitative analysis in chapter 2 inform quantitative modeling performed in chapter 3. Likewise, the emphasis of environmental concerns demonstrated in chapters 2 and 3 motivate the deeper examination of environmental performance in chapter 4.

One major contribution of this dissertation to logistics and supply chain literatures is the use of secondary data sources in all three essays. Rabinovich and Cheon (2011) have stressed the importance of using secondary data sources in logistics and supply chain studies while moving away from over-reliance on primary data sources. Specifically, the authors argued in favor of using six secondary data methodologies – meta analyses, event studies, use of archival data sources, content analysis, geographical information systems, and simulation and numerical applications. Out of the six recommended, this dissertation utilizes three methodologies in each of the three essays: structured content analysis using Crawdad software and linear programming techniques in chapter 2, numerical application of linear aggregation and data envelopment analysis using secondary data in chapter 3, and Markov chain Monte Carlo estimation procedures using MLwiN in chapter 4.

This dissertation also contributes to the discipline of sustainable supply chain management, which has progressed in the last twenty years "from a fringe topic to the mainstream" (Pagell and Shevchenko, 2014, p.44). Specifically, chapter 2 proposed a strategy framework to address market-oriented sustainability across supply chains; chapter 3 focused on measuring and standardizing sustainability efforts of organizations in logistics and shipping services industry; and chapter 4 explored the firm, industry and regulatory effects on environmental performance differences across manufacturing facilities.

The next sections of this chapter summarize the major contributions of chapters two, three and four respectively. The final section identifies a few research limitations of the dissertation.

Key Results and Contributions of Chapter 2

The primary contribution of chapter 2 was to propose market-oriented sustainability strategies that address sustainability across the supply chains of organizations. This was achieved by objectively coding and analyzing sustainability reports of leading sustainable organizations. In the process of achieving our objective, we devised a novel methodology that identified key influential words found in the vicinity of keywords related to market-orientation and supply chain management using Crawdad, a text analysis software, and linear programming techniques. This methodology resulted in the emergence of seven proposed strategies based upon the extended conceptualization of market-orientation to include customers and stakeholders along the supply chain. In a recent article, Pagell and Shevchenko (2014) raise the concern that how to create truly sustainable supply chains remains unanswered. Chapter 2 of this dissertation strives to answer this question by proposing seven market-oriented sustainability strategies.

Key Results and Contributions of Chapter 3

The primary contribution of chapter 3 was to illustrate how two complementary methodologies – linear aggregation and data envelopment analysis, can be utilized to create a unique index consisting of sustainability indicators. These unique indices form a basis for sustainability performance measurement of companies in logistics and shipping services industry. The mathematical models formulated in this chapter are flexible to include or exclude any number of sustainability indicators and provide an easy-to-comprehend tool for the managers to evaluate their sustainability efforts over a period of time. The model formulated using DEA technique can be used to benchmark the sustainability efforts of a firm against the competition and can be utilized as a decision making tool to decide which areas of sustainability need additional resources to gain competitive advantage.

One problem in SPM of logistics and shipping services industry is that unlike the economic indicators, there is no standardized reporting of social and environmental sustainability indicators. This chapter also contributes to practice by aligning social and environmental indicators on the same scale and comparing the performance of companies using the ratios of these indicators.

Key Results and Contributions of Chapter 4

The key contribution of chapter 4 was to partition the variability of environmental performance into facility, firm, industry and location effects. Essentially, we tested which theory can provide the maximum explanation regarding differential environmental performance of firms. Our results provide reasonable evidence that facility and firm effects account for 52.46%, 77.89%, 24.51% and 36.81% of variation in four dependent variables respectively. This highlights the preeminent role of the resource-based view in explaining the differential environmental performance of firms in the manufacturing sector when compared with industrial organization theory and institutional theory. These results were achieved by formulating a multilevel cross-classified model consisting of facility, firm, industry, state, county, year and error as the seven levels of the model. This model was analyzed using MCMC methods and employing MLwiN multilevel modeling software. The results have important strategic implications for managers in deciding the proportion of resources which need to be deployed for increasing the environmental performance of the firm.

Table 5.1 provides a summary of data sources, methodologies, and contributions of the dissertation.

Table 5.1: Summary of data sources, methodologies, and contributions of the dissertation

	Data Source(s)	Methodologies and data analysis	Methodological contribution	Contribution to practice	Contribution to literature
Chapter 2	Textual data from sustainability reports	Structured content analysis using Crawdad text analysis software and linear programming techniques.	Demonstration of objectively coding textual data by combining the output of textual analysis using a software and linear programming techniques. This resulted in objective identification of market-oriented strategies.	As per Berns et al. (2009), majority of managers surveyed agree that sustainability will have an impact on strategic market-driven decisions but have not developed clear strategies to achieve sustainability. This chapter proposes that sustainability strategies need to include customers and stakeholders in order to have competitive advantage for an organization.	Strives to answer a call to address the question posed by Pagell and Shevchenko (2014) on how to create truly sustainable supply chains.
Chapter 3	Sustainability indicators data from Bloomberg database and sustainability reports	Linear aggregation and data envelopment analysis (DEA)	Demonstration of two complementary methodologies – linear aggregation (heuristic approach) and DEA (comprehensive approach), to formulate models which can be used as decision making tools for sustainability performance measurement (SPM).	Provides managers in logistics and shipping services industry with a SPM tool representing various indicators of sustainability, collected from multiple data sources, in a unique index. The index may be used for benchmarking purpose.	This chapter is an attempt to introduce mathematical modeling techniques in logistics and supply chain literature for the purpose of creating SPM tools.

	Data Source(s)	Methodologies and data analysis	Methodological contribution	Contribution to practice	Contribution to literature
Chapter 4	Risk Screening Environmental Indicators database consisting of 74,593 observations nested within 9530 manufacturing facilities cross-classified with 1464 firms and 449 industries.	Markov Chain Monte Carlo estimation procedures using MLwiN multilevel modeling software.	Demonstration of formulation of multilevel cross-classified model and use of MCMC estimation methods to partition the firm, industry, and location effects on environmental performance.	Provides managers with an understanding of the sources of variation of environmental performance. This may help managers in deciding the allocation of resources to improve environmental performance.	A recent meta-analysis by Golicic and Smith (2013) concludes that environmental performance leads to firm performance. This chapter provides insights on sources of differential environmental performance which have been ignored by previous researchers. We provide sufficient evidence that RBV as opposed to IO and institutional theory can explain much of this variation.

Research Limitations

Every research effort has its strengths and limitations and, as such, this dissertation is also subject to limitations. Since the data source for all three essays of this dissertation is from secondary sources, it is worthwhile to discuss the general limitations associated with secondary data. A few unknown factors, such as the personal and external biases of the person collecting and compiling the data, need consideration while utilizing secondary data sources for conducting research (Tate et al., 2010). Further, archival data reveals a snapshots of what has occurred in the past (Snow and Thomas, 1994; Tate et al., 2010) and, therefore, does not take into account the changes that may have occurred in the most recent time. Since the source of data utilized in this dissertation is from different companies, therefore, different reporting measures and different time frames used in collecting data may be a source of variation.

Since sustainability reports are published voluntarily, it is not imperative for companies to report everything and they may be biased towards reporting what the companies perceive as most favorable. Further, definitions and interpretations of sustainability may differ by firm, industry and country, so it may be difficult to substantiate what companies are actually doing in terms of addressing sustainability (Tate et al., 2010).

Large databases, such as RSEI database utilized in Chapter 4, requires extensive data cleaning which can be an arduous and time-consuming task. Data cleaning involves inspecting data for errors, ambiguity, and standardizing the data in order to prepare it for analysis (Tate et al., 2010). RSEI also has some specific limitations. Several assumptions are made to simplify pollution estimates for such a large number of firms and facilities across the country (Bouwes and Hassur, 1999; EPA, 2004; Downey et al., 2008).

In spite of these limitations, secondary data provides immense practical value to the results obtained from analysis of such data. Since the data is obtained directly from company sources and government agencies, it provides practitioners with insights that may be directly targeted to address managerial applications (Rabinovich and Cheon, 2011). Since, it is the same data that managers use in their periodic reporting, therefore, the results obtained from such data is more easily translated into tangible implications for their operations (Rabinovich and Cheon, 2011). This makes the value of academic research more relevant for the managers.

REFERENCES

2010 Global 100 Project (2011), *Global 100 Most Sustainable Corporations of the World*, Corporate Knights Research Group, http://www.corporateknights.ca, Accessed July 19, 2011.

Akkermans, H. A., Bogerd, P., Yücesan, E., & Van Wassenhove, L. N. (2003). The impact of ERP on supply chain management: Exploratory findings from a European Delphi study. *European Journal of Operational Research*, *146*(2), 284-301.

Ameer, R., & Otham, R. (2012). Sustainability practices and corporate financial performance: A study based on the top global corporations. *Journal of Business Ethics*, *108*, 61-79.

Anderson, S., Allen, J., & Browne, M. (2005). Urban logistics - How can it meet policy makers' sustainability objectives? *Journal of Transport Geography*, *13*(1), 71–81.

Appel, F. (2010). *Delivering tomorrow: Towards sustainable logistics*. Duetsche Post AG, Bonn, Germany.

Ash, M., & Fetter, T.R. (2004). Who lives on the wrong side of the environmental tracks? Evidence from the EPA's risk-screening environmental indicators model. *Social Science Quarterly, 8*5*,* 441-462.

Awaysheh, A., & Klassen, R.D. (2010). The impact of supply chain structure on the use of supplier socially responsible practices. *International Journal of Operations & Production Management, 30*(12), 1246-1268.

Azadegan, A. (2011). Benefiting from supplier operational innovativeness: the influence of supplier evaluations and absorptive capacity. *Journal of Supply Chain Management*, *47*(2), 49-64.

Azzone, G. and G. Noci. "Identifying effective PMSs for the deployment of "green" manufacturing strategies," *International Journal of Operations & Production Management*, 18 (4), 1998, pp. 308 – 335.

Bansal, P. (2005). Evolving sustainably: a longitudinal study of corporate sustainable development. *Strategic Management Journal*, *26*(3), 197-218.

Barney, J. B. (2012). Purchasing, Supply Chain Management and Sustained Competitive Advantage: The Relevance of Resource-based Theory. *Journal of Supply Chain Management*, *48*(2), 3-6.

Barney, J. B. (1991). Firm resources and sustained competitive advantage. *Journal of management*, *17*(1), 99-120.

Basu, K. & Palazzo, G. (2008). Corporate Social Responsibility: a Process Model of Sensemaking. *The Academy of Management Review*, *33*(1), 122-136.

Beckett, R., & Jonker, J. (2002). AccountAbility 1000: A New Social Standard for Building Sustainability. *Managerial Auditing Journal, 17*(1/2), 36 – 42.

Berns, M., Townend, A., Khayat, Z., Balagopal, B., Reeves, M., & Hopkins, M.S. (2009). The Business of Sustainability: What it Means to Managers Now. *Sloan Management Review*, Fall, 20–26.

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

Bird, R., Hall, A. D., Momentè, F., & Reggiani, F. (2007). What corporate social responsibility activities are valued by the market?. *Journal of Business Ethics*,*76*(2), 189-206.

Bluhm, D. J., Harman, W., Lee, T. W., & Mitchell, T. R. (2011). Qualitative Research in Management: A Decade of Progress. *Journal of Management Studies, 48*, 1866–1891.

Bouwes, N., & Hassur, S. (1999). Estimates of stack heights and exit gas velocities for TRI facilities in OPPT's Risk-Screening Environmental Indicators Model. *Washington, DC: Environmental Protection Agency.*

Bowen, W. (2002). An analytical review of environmental justice research: what do we really know?. *Environmental management, 29*(1), 3-15.

Brown, C. (2007). *Borders and identity in international political theory*. University of Minnesota Press.

Browne, W.J. (2012). *MCMC Estimation in MLwiN, Version 2.26.* Bristol, UK: Centre for Multilevel Modeling, University of Bristol.

Browne, W.J. (2009). *MCMC Estimation in MLwiN, Version 2.13.* Bristol, UK: Centre for Multilevel Modeling, University of Bristol.

Browne, W. J., Goldstein, H., & Rasbash, J. (2001). Multiple membership multiple classification (MMMC) models. *Statistical Modelling, 1*(2), 103-124.

Buysse, K., & Verbeke, A. (2003). Proactive Environmental Strategies: a Stakeholder Management Perspective. *Strategic Management Journal, 24*, 453–470.

Carter, C.R., & Carter, J.R. (1998). Interorganizational determinants of environmental purchasing: Initial evidence from the consumer products industries. *Decision Sciences*, *29*(3), 659–685.

Carter, C. R., & Easton, P. L. (2011). Sustainable supply chain management: evolution and future directions. *International Journal of Physical Distribution & Logistics Management*, *41*(1), 46-62.

Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chain management: moving toward new theory. *International journal of physical distribution & logistics management*, *38*(5), 360-387.

Chaabane, A., Ramudhin, A., & Paquet, M. (2012). Design of sustainable supply chains under the emission trading scheme. *International Journal of Production Economics, 135*(1), 37-49.

Chakravarthy, B. (1997). A new strategy framework for coping with turbulence. *Sloan Management Review, 38*(4), 69-82.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, *2*(6), 429-444.

Chen, C. C., Shih, H. S., Shyur, H. J., & Wu, K. S. (2012). A business strategy selection of green supply chain management via an analytic network process. *Computers & Mathematics with Applications*, *64*(8), 2544-2557.

Chen, C. M., & Delmas, M. (2011). Measuring corporate social performance: An efficiency perspective. *Production and Operations Management*, *20*(6), 789-804.

Chichilnisky, G. (1997). What is sustainable development. *Available at SSRN 1375216*.

Choi, T.Y., & Hong, Y. (2002). Unveiling the structure of supply networks: case studies in Honda, Acura and Daimler Chrysler. *Journal of Operations Management*, 20 (5), 469–493.

Christopher, J. (1992). Logistics and Supply Chain Management: Strategies for Reducing Cost and Improving Cost and Improving Services. *MA: Pitman, Boston*.

Chung, H., & Beretvas, S.N. (2012). The impact of ignoring multiple membership data structures in multilevel models. *British Journal of Mathematical and Statistical Psychology, 65*, 185-200.

Churchill, G. A., Jr. (1979). A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research*, 16, 64–73.

Ciliberti, F., Pontrandolfo, P., & Scozzi, B. (2008). Investigating corporate social responsibility in supply chains: a SME perspective. *Journal of cleaner production*, *16*(15), 1579-1588.

Clelland, I.J., Douglas, T.J., & Henderson, D.A. (2006). Testing resource-based and industry factors in a multi-level model of competitive advantage creation. *Academy of Strategic Management Journal, 5*(1), 1-24.

Clemens, B., & Douglas, T.J. (2006). Does coercion drive firms to adopt 'voluntary' green initiatives? Relationships among coercion, superior firm resources, and voluntary green initiatives. *Journal of Business Research, 59*(4), 483-491.

Closs, D.J., Speier, C., & Meacham, N. (2011). Sustainability to support end-to-end value chains: the role of supply chain management. *Journal of the Academy of Marketing Science*, 39: 101-116.

Connelly, B. L., Ketchen Jr, D. J., & Slater, S. F. (2011). Toward a "theoretical toolbox" for sustainability research in marketing. *Journal of the Academy of Marketing Science*, *39*(1), 86-100.

Corbett, C. J., & Klassen, R. D. (2006). Extending the horizons: environmental excellence as key to improving operations. *Manufacturing & Service Operations Management*, *8*(1), 5-22.

Corman, S., & Dooley, K., 2006. *Crawdad Text Analysis System.* Crawdad Technologies, LLC, Chandler, Arizona.

Corman, S.R., Kuhn, T., McPhee, R.D., & Dooley, K.J. (2002). Studying Complex Discursive Systems. *Human communication research*, *28*(2), 157-206.

Costanza, R., Daly, H. E., Bartholomew, J. (1991). Goals, agenda and policy recommendations for ecological economics. In *Ecological Economics*, Costanza R (ed.). Columbia University Press: New York; 1–20.

Crittenden, V. L., Crittenden, W. F., Ferrel, L. K., Ferrel, O. C., & Pinney, C. C. (2011). Market-oriented sustainability: a conceptual framework and propositions. *Journal of the Academy of Marketing Science*, 39: 71-85.

Curkovic, S., Melnyk, S. A., Handfield, R. B., & Calantone, R. (2000). Investigating the linkage between total quality management and environmentally responsible manufacturing. *IEEE Transactions on Engineering Management*, 47(4), 444-464.

Daft, R. (1983). *Organization Theory and Design.* New York: West.

Deegan, C., & Gordon, B. (1996). A Study of the Environmental Disclosure Practices of Australian Corporations. *Accounting and Business Research*, *26*(3), 187-199.

Deshpande, R., Farley, J. U., & Webster, F. E. (1993). Corporate culture, customer orientation, and innovativeness in Japanese firms: A quadrad analysis. *Journal of Marketing*, 57(1), 23–27.

Deshpande, R., & Webster, F. E. (1989). Organizational culture and marketing: Defining the research agenda. *Journal of Marketing*, 53(1), 3–15.

Diaz-Balteiro, L., and Romero, C. (2004), "In search of a natural systems sustainability index," *Ecological Economics*, 49, pp. 401–5.

Dierickx, I., & Cool, K. (1989). Asset stock accumulation and sustainability of competitive advantage. *Management Science*, *35*(12), 1504-1511.

DiMaggio, P. J., & Powell, W. W. (Eds.). (1991). *The new institutionalism in organizational analysis* (Vol. 17). Chicago: University of Chicago Press.

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, 147-160.

Dou, Y., & Sarkis, J. (2010). A joint location and outsourcing sustainability analysis for a strategic offshoring decision. *International Journal of Production Research*, 48(2), 567.

Downey, L., Dubois, S., Hawkins, B., & Walker, M. (2008). Environmental inequality in metropolitan America. *Organization Environment 21*, 270-294.

Doyle, J., & Green, R. (1994). Efficiency and cross-efficiency in DEA: Derivations, meanings and uses. *Journal of the Operational Research Society*, 567-578.

Drucker, P.F. (1999a). Knowledge-worker productivity: The biggest challenge. *California Management Review, 41*(2), 79-94.

Drucker, P. F. (1999b). *Management—Tasks, responsibilities, practices*. Oxford: Butterworth-Heinemann.

Elkington, J. (1998). Partnerships from cannibals with forks: The triple bottom line of 21st century business. *Environmental Quality Management*, 8(1), 37-51.

Epstein, M. J. (2008). *Making sustainability work: Best practices in managing and measuring corporate social, environmental, and economic impacts*. Berrett-Koehler Store.

Epstein, M. J., & Roy, M. J. (2003). Making the business case for sustainability. *Journal of Corporate Citizenship*, *2003*(9), 79-96.

Fisher, M. L. (1997). What is the right supply chain for your product?. *Harvard business review*, *75*, 105-117.

Fisher, M.L. (2007). Strengthening the empirical base of operations management. *Manufacturing and Service Operations Management*, 9 (4), 368–382.

Flynn, B. B., Schroeder, R. G., & Flynn, E. J. (1999). World class manufacturing: an investigation of Hayes and Wheelwright's foundation. *Journal of operations management*, *17*(3), 249-269.

Förstl, K., Blome, C., Henke, M., & Schönherr, T. (2011). Towards a Supply Risk Management Capability Process Model: An Analysis of What Constitutes Excellence in Supply Risk Management Across Different Industry Sectors. In *Quantitative Financial Risk Management* (pp. 265-280). Springer Berlin Heidelberg.

Föerstl, K., Reuter, C., Hartmann, E., & Blome, C. (2010). Managing supplier sustainability risks in a dynamically changing environment – sustainable supplier management in the chemical industry. *Journal of Purchasing and Supply Management, 16*(2), 118-130.

Freeman, R. E. (1984). *Strategic Management: A Stakeholder Approach*, Prentice-Hall, Englewood Cliffs, NJ.

Gardner, C.L., Lawler, J.P., Ver Hoef, J.M., Magoun, A.J., & Kellie, K.A. (2010). Coarse-scale distribution surveys and occurrence probability modeling for wolverine in interior Alaska. *The Journal of Wildlife Management, 78*(8), 1894-1903.

Geman, S., & Geman, D. (1984). Stochastic relaxation, gibbs distributions and the bayesian restoration of images. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 6*, 721-741.

Golany, B., & Roll, Y. (1989). An application procedure for DEA. *Omega*, *17*(3), 237-250.

Golicic, S. L., & Smith, C. D. (2013). A Meta-Analysis of Environmentally Sustainable Supply Chain Management Practices and Firm Performance. *Journal of Supply Chain Management*, *49*(2), 78-95.

Goodland, R. (1995). The concept of environmental sustainability. *Annual Review of Ecology and Systematics*, 1-24.

Grant, R. M. (2008), *Contemporary Strategy Analysis (6th ed.)*. United Kingdom: Blackwell Publishing Ltd.

Global Reporting Initiative (2011), *The Global Reporting Initiative—An Overview*, Global Reporting Initiative, Boston, USA. Available at www.globalreporting.org

Grindle, M. S. (2002). Good enough governance: poverty reduction and reform in developing countries. *Governance*, 17(4), 525–548.

Hart, S. L. (1995). A natural-resource-based view of the firm. *Academy of management review*, *20*(4), 986-1014.

Hartmann, E., & De Grahl, A. (2011). The flexibility of logistics service providers and its impact on customer loyalty: an empirical study. *Journal of Supply Chain Management*, *47*(3), 63-85.

He, W, Hee, B, Lu, Wen Fen, Ming, X, & Ni, Q. (2006). A unified product structure management for enterprise business process integration throughout the product lifecycle. *International Journal of Production Research*, *44*(9), 1757-1776.

Hiede, J. B. (1994). Interorganizational governance in marketing channels. *Journal of Marketing*, 58(1), 71-85.

Hill, C. W. (1995). National institutional structures, transaction cost economizing and competitive advantage: The case of Japan. *Organization Science*, *6*(1), 119-131.

Hillman, A.J., & Keim, G.D. (2001). Shareholder value, stakeholder management, and social issues: what's the bottom line?. *Strategic Management Journal*, *22*(2), 125-139.

Hirsch, P. M. (1975). Organizational effectiveness and the institutional environment. *Administrative Science Quarterly*, 327-344.

Hofer, C., Cantor, D. E., & Dai, J. (2012). The competitive determinants of a firm's environmental management activities: Evidence from US manufacturing industries. *Journal of Operations Management*, *30*(1), 69-84.

Homburg, C., & Pflesser, C. (2000). A multiple-layer model of market-oriented organizational culture: measurement issues and performance outcomes. *Journal of Marketing Research*, 449-462.

Hough, J.R. (2006). Business segment performance redux: a multilevel approach. *Strategic Management Journal, 27*, 45-61.

Hult, G. T. M. (2011). Market-focused sustainability: market orientation plus! *Journal of the Academy of Marketing Science*, 39: 1-6.

Hunt, S. D., & Morgan, R. M. (1995). The comparative advantage theory of competition. *Journal of Marketing*, 59(2), 1-15.

Intergovernmental Panel on Climate Change (IPCC) (2007),Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, edited by S. Solomon et al., Cambridge Univ. Press, Cambridge, U. K., available at http://ipcc-wg1.ucar.edu/wg1/wg1-report.html.

Iyer, A., Seshadri, S., & Vasher, R. (2009). *Toyota Supply Chain Management: A Strategic Approach to the Principles of Toyota's Renowned System,* McGraw Hill Education, New York

Jaworski, B. J., & Kohli, A. K. (1993). Market orientation: antecedents and consequences. *The Journal of marketing*, 53-70.

Johnson, M. E., (2006). Supply Chain Management: Technology, Globalization, and Policy at a Crossroads. *Interfaces, 36*(3), 191–193.

Jose, A., & Lee, S. M. (2007). Environmental reporting of global corporations: a content analysis based on website disclosures. *Journal of Business Ethics, 72*(4), 307-321.

Kapner, S., Mukherji, B., & Banjo, S. (2013, May 3). Before Dhaka collapse, some firms fled risk, *Wall Street Journal,* p. A7.

Kilbourne, W. E., Beckmann, S. C., & Thelen, E. (2002). The role of the dominant social paradigm in environmental attitudes: A multinational examination. *Journal of Business Research*, *55*(3), 193-204.

King, A., & Lennox, M. (2002). Exploring the locus of profitable pollution reduction. *Management Science, 48* (2), 289-299.

King, A.A., & Shaver, J.M. (2001). Are aliens green? Assessing foreign establishments' environmental conduct in the United States. *Strategic Management Journal, 22* (11), 1069-1084.

Kiron, D., Kruschwitz, N., Haanaes, K., & Fuisz-Kehrbach, S.K. (2013). How serious is climate change to business?. *MIT Sloan Management Review, 55*(1), 75-76.

Klassen, R. D., & McLaughlin, C. P. (1996). The impact of environmental management on firm performance. *Management Science*, *42*(8), 1199-1214.

Klassen, R.D., & Whybark, D.C. (1999). The impact of environmental technologies on manufacturing performance. *The Academy of Management Journal, 42* (6), 599-615.

Kleindorfer, P. R., Singhal, K., & Wassenhove, L. N. (2005). Sustainable operations management. *Production and operations management*, *14*(4), 482-492.

Kohli, A. K., & Jaworski, B. J. (1990). Market orientation: The construct, research propositions, and managerial implications. *Journal of Marketing*, 54(2), 1–18.

Kolk, A. (2003), “Trends in Sustainability Reporting by the Fortune Global 250,” *Business Strategy and the Environment*, 12(5), pp. 279-291.

Krajnc, D., and Glavič, P. (2005a), “How to compare companies on relevant dimensions of sustainability,” *Ecological Economics*, 55(4), pp. 551-563.

Krajnc, D., and Glavič, P. (2005b), “A model for integrated assessment of sustainable development,” *Resources, Conservation and Recycling*, 43(2), pp. 189-208.

Krause, D.R., Vachon, S., & Klassen, R.D. (2009). Special topic forum on sustainable supply chain management: introduction and reflections on the role of purchasing management. *Journal of Supply Chain Management, 45*(4), 18-25.

Kuei, C. H., Madu, C. N., & Lin, C. (2001). The relationship between supply chain quality management practices and organizational performance. *International Journal of Quality & Reliability Management*, *18*(8), 864-872.

Kumar, S., Teichman, S., & Timpernagel, T. (2012). A green supply chain is a requirement for profitability. *International Journal of Production Research*, *50*(5), 1278-1296.

Kuosmanen, T., & Kuosmanen, N. (2009). How not to measure sustainable value (and how one might). *Ecological Economics*, 69(2), 235-243.

Lai, K. H., & Cheng, T. E. (2009). *Just-in-time logistics*. Gower Publishing, Ltd.

Laszlo, C. (2008), *Sustainable Value: How the World’s Leading Companies are Doing Well by Doing Good*, Stanford, CA: Stanford University Press.

Layton, R. A. (2007). Marketing systems—A core macromarketing concept. *Journal of Macromarketing*, *27*(3), 227-242.

Lee, P. M., & James, E. H. (2007). She'-e-os: gender effects and investor reactions to the announcements of top executive appointments. *Strategic Management Journal*, *28*(3), 227-241.

Leppelt, T., Kai F., Carsten R., & Evi H. (2013). Sustainability management beyond organizational boundaries–sustainable supplier relationship management in the chemical industry. *Journal of Cleaner Production, 56*(1), 94-102.

Leuschner, R., Rogers, D. S., & Charvet, F. F. (2013). A Meta-Analysis of Supply Chain Integration and Firm Performance. *Journal of Supply Chain Management*, *49*(2), 34-57

Li, S., Ragu-Nathan, B., Ragu-Nathan, T. S., & Subba Rao, S. (2006). The impact of supply chain management practices on competitive advantage and organizational performance. *Omega*, *34*(2), 107-124.

Link, W. A., Emmanuelle, C., Nichols, J. D., & Cooch, E. G. (2002). Of bugs and birds: Markov chain Monte Carlo for hierarchical modeling in wildlife research. *The Journal of Wildlife Management, 66*, 277–291.

Linton, J. D., Klassen, R., & Jayaraman, V. (2007). Sustainable supply chains: an introduction. *Journal of Operations Management*, 25 (6), 1075–1082.

Logistics Today (2010), *Global Logistics Market Hits Bottom, Could Rise to $4 Trillion by 2013*, Available at: http://logisticstoday.com/global_markets/global-logistics-hit-bottom-could-rise-0419, Accessed 11 December 2011.

Luo, J. and Hamlin, K. (2013) Bloomberg News Jun 30. http://www.bloomberg.com/news/2013-06-30/xi-says-gdp-not-officials-sole-focus-in-signal-on-growth.html

Lynch, K. D. (2011), *Measuring Corporate Sustainability Performance: Influences and Issues to Consider in Metric Conceptualization*, Doctoral Dissertation, Benedictine University.

Maignan, I., Ferrell, O. C., & Ferrell, L. (2005). A stakeholder model for implementing social responsibility in marketing. *European Journal of Marketing*,*39*(9/10), 956-977.

Maijoor, S., & Witteloostuijn, A. V. (1996). An empirical test of the resource-based theory: strategic regulation in the Dutch audit industry. *Strategic Management Journal*, *17*(7), 549-569.

Makower, Joel. "State of Green Business Report 2012" GreenBiz.com - Daily News on Green Business, Business and Climate Change and Sustainable Business Practices. 2 Aug. 2009. 2 Aug. 2009 <http://www.greenbiz.com>.

Manson, S. M. (2001). Simplifying complexity: a review of complexity theory. *Geoforum*, *32*(3), 405-414.

Market Research Service Center (2010), *Green Trends Survey*, Deutsche Post DHL, Available at: http://www.dpdhl.com/en/logistics_around_us/sustainable_logistics/global_green_trends_survey.html, Accessed 11 December 2011.

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.

Matsuno, K., & Mentzer, J. T. (2000). The effects of strategy type on the market orientation-performance relationship. *Journal of Marketing*, 64(4), 1–16.

Maxwell, J. A. (1992). Understanding and validity in qualitative research. *Harvard educational review*, *62*(3), 279-301.

May, A. D., Jopson, A., and Matthews, B. (2003), “Research challenges in urban transport policy,” *Transport Policy*, 10(3), 157–164.

McPhee, R.D., Corman, S.R., & Dooley, K. (2002). Organizational knowledge expression and management. *Management Communication Quarterly, 16*(2), 274–281.

McWilliams, A., & Siegel, D. (2001). Corporate social responsibility: A theory of the firm perspective. *Academy of Management Review*, 26: 117-127.

Meredith, J. R., Raturi, A., Amoako-Gyampah, K., & Kaplan, B. (1989). Alternative research paradigms in operations. *Journal of Operations Management*, *8*(4), 297-326.

Meyer, J. W., & Rowan, B. (1977). Institutionalized organizations: Formal structure as myth and ceremony. *American Journal of Sociology*, *83*(2), 340.

Mitchell, R.K., Agle, B.R., & Wood, D.J. (1997). Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. *Academy of Management Review*, *22*(4), 853-886.

Mollick, E. (2012). People and process, suits and innovators: The role of individuals in firm performance. *Strategic Management Journal*, *33*(9), 1001-1015.

Morali, O., & Searcy, C. (2013). A Review of Sustainable Supply Chain Management Practices in Canada. *Journal Of Business Ethics*, *117*(3), 635-658.

Morhardt, J. E., Baird, S., and Freeman, K. (2002). Scoring Corporate Environmental and Sustainability Reports Using GRI 2000, ISO 14031 and Other Criteria. *Corporate Social Responsibility and Environmental Management, 9*(4), 215-233.

Munksgaard, J., Christoffersen, L. B., Keiding, H., Pedersen, O. G., & Jensen, T. S. (2007). An environmental performance index for products reflecting damage costs. *Ecological Economics*, *64*(1), 119-130.

Nagurney, A., Liu, Z., & Woolley, T. (2007). Sustainable supply chain and transportation networks. *International Journal of Sustainable Transportation*,*1*(1), 29-51.

Narasimhan, R., Kim, S. W., & Tan, K. C. (2008). An empirical investigation of supply chain strategy typologies and relationships to performance. *International Journal of Production Research*, *46*(18), 5231-5259.

Narver, J. C., & Slater, S. F. (1990). The effect of a market orientation on business profitability. *Journal of Marketing*, 54(4), 20–35.

Neely, A. (1993). Production/operations management: research process and content during the 1980s. *International Journal of Operations & Production Management, 13*(1), 5-18.

Neuman, W.L. (2000). *Social Research Methods,* Allyn and Bacon, London.

Nidumolu, R., Prahalad, C. K., & Rangaswami, M. R. (2009). Why sustainability is now the key driver of innovation. *Harvard Business Review, 87*(9), 56–64.

Oliver, C. (1997). Sustainable competitive advantage: Combining institutional and resource-based views. *Strategic Management Journal*, *18*(9), 697-713.

Oliver, C. (1991). Strategic responses to institutional processes. *Academy of Management Review*, *16*(1), 145-179.

Oracle Report (2013), The Shape of Tomorrow's Supply Chains, The Science of Sustainability, www.oracle.com/us/products/applications/green/051300.pdf

Palay, T. M. (1984). Comparative institutional economics: the governance of rail freight contracting. *Journal of Legal Studies*, 13(2), 265-287.

Paulraj, A. (2011). Understanding the relationships between internal resources and capabilities, sustainable supply management and organizational sustainability. *Journal of Supply Chain Management*, 47(1), 19-37.

Pagell, M. & Shevchenco, A. (2014). Why research in sustainable supply chain management should have no future. *Journal of Supply Chain Management, 50*(1), 44-55.

Pagell, M. & Wu, Z. (2009). Building a more complete theory of sustainable supply chain management using case studies of 10 exemplars. *Journal of Supply Chain Management*, *45*: 37–56.

Pearce, J. A., & Doh, J. P. (2012). The high impact of collaborative social initiatives. *Sloan Management Review, 46*(2).

Porter, M. E. (2008). The five competitive forces that shape strategy. *Harvard business review*, *86*(1), 25-40.

Porter, M. E. (1992). Capital choices: Changing the way America invests in industry. *Journal of Applied Corporate Finance*, *5*(2), 4-16.

Porter, M. E. (1985). Technology and competitive advantage. *Journal of Business Strategy*, *5*(3), 60-78.

Porter, M. E. (1981). The contributions of industrial organization to strategic management. *Academy of Management Review*, *6*(4), 609-620.

Porter, M. E. (1980). Industry structure and competitive strategy: keys to profitability. *Financial Analysts Journal*, 30-41.

Porter, M. E., & Van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *The journal of economic perspectives*, *9*(4), 97-118.

Preuss, L. (2005). Rhetoric and reality of corporate greening: a view from the supply chain management function. *Business Strategy and the Environment*, 14: 123–139.

Qi, Y., Zhao, X., & Sheu, C. (2011). The Impact of Competitive Strategy and Supply Chain Strategy on Business Performance: The Role of Environmental Uncertainty*. *Decision Sciences*, *42*(2), 371-389.

Rabinovich, E., & Cheon, S. (2011). Expanding horizons and deepening understanding via the use of secondary data sources. *Journal of Business Logistics*, *32*(4), 303-316.

Raftery, A.E. & Lewis, S.M. (1992). How many iterations in the Gibbs sampler? In J.M. Bernado, J.O. Berfer, A.P. Dawid & A.F.M. Smith, eds., *Bayesian Statistics 4*, 765-776. Oxford: Oxford University Press.

Rao, P., & Holt, D. (2005). Do green supply chains lead to competitiveness and economic performance?. *International Journal of Operations & Production Management*, 25 (9), 898 – 916.

Rasbash, J., Steele, F., Browne, W.J., & Goldstein, H. (2009). *A user's guide to MLwiN, v2.10.* Centre for Multilevel Modeling, University of Bristol.

Reuter, C., Foerstl, K. A. I., Hartmann, E. V. I., & Blome, C. (2010). Sustainable global supplier management: the role of dynamic capabilities in achieving competitive advantage. *Journal of Supply Chain Management*, *46*(2), 45-63.

Rivera, J. (2004). Institutional pressures and voluntary environmental behavior in developing countries: Evidence from the Costa Rican hotel industry. *Society and Natural Resources*, *17*(9), 779-797.

Rosen, M. A. (2001). Design for energy efficiency and selection. *Greener Manufacturing and Operations: From Design to Delivery and Back*, *1*(34), 161-177.

Rossetti, C. L., & Dooley, K. J. (2010). Job types in the supply chain management profession. *Journal of Supply Chain Management*, *46*(3), 40-56.

Rossetti, C. L., Handfield, R., & Dooley, K. J. (2011). Forces, trends, and decisions in pharmaceutical supply chain management. *International Journal of Physical Distribution & Logistics Management*, *41*(6), 601-622.

Rossi, P.E., Allenby, G.M., & McCulloch, R. (2009). *Bayesian Statistics and Marketing,* Wiley & Sons, England.

Roy, S., Sivakumar, K., & Wilkinson, I. F. (2004). Innovation generation in supply chain relationships: a conceptual model and research propositions. *Journal of the Academy of Marketing Science*, *32*(1), 61-79.

Russo, M. V., & Fouts, P. A. (1997). A resource-based perspective on corporate environmental performance and profitability. *Academy of Management Journal*, *40*(3), 534-559.

Russo, M.V., & Harrison, N.S. (2005). Organizational design and environmental performance: clues from the electronics industry. *The Academy of Management Journal, 48* (4), 582-593.

San Jose Consulting Group (2003). *FedEx Corporation: Strategic Management Project.* Eds. Crane, B., Landthorn, B., Miri, B., Relph, J., Sanchez, C., & Vernerova, A.

Sands, G. R. and Podmore, T. H. (2000). "A generalized environmental sustainability index for agricultural systems." *Agriculture, Ecosystems and Environment*, 79, pp. 29-41.

Sarkis, J., Zhu, Q., & Lai, K. H. (2011). An organizational theoretic review of green supply chain management literature. *International Journal of Production Economics*, *130*(1), 1-15.

Savage, G.T., Nix, T.W., Whitehead, C.J., & Blair, J.D. (1991). Strategies for assessing and managing organisational stakeholders. *Academy of Management Executive*, 5(2), 61-75.

Savitz, A. (2013). *The triple bottom line: how today's best-run companies are achieving economic, social and environmental success-and how you can too*. John Wiley & Sons.

Schaltegger, S., & Wagner, M. (2006). Managing and measuring the business case for sustainability. *Managing the Business Case for Sustainability: The Integration of Social, Envir*, *1*(62), 1-28

Schiele, H. (2007). Supply-management maturity, cost savings and purchasing absorptive capacity: testing the procurement-performance link. *Journal of Purchasing & Supply Management, 13*(4), 274-293.

Scott, W. R. (1987). The adolescence of institutional theory. *Administrative science quarterly*, 493-511.

Seuring, S., & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of cleaner production*, *16*(15), 1699-1710.

Seuring, S., Sarkis, J., Müller, M., & Rao, P. (2008). Sustainability and supply chain management–an introduction to the special issue. *Journal of Cleaner Production*, *16*(15), 1545-1551.

Sexton, T.R., Silkman, R.H., & Hogan, A. (1986). Data envelopment analysis: Critique and extensions, In: Richard H., Silkman (Eds.), *Measuring Efficiency: An Assessment of Data Envelopment Analysis*, Publication no. 32in the series New Directions of Program Evaluation, Jossey Bass, San Francisco.

Sheth, J. N., Sethia, N. K., & Srinivas, S. (2011). Mindful consumption: a customer-centric approach to sustainability. *Journal of the Academy of Marketing Science*, 39: 21-39.

Shrivastava, P. (1995). The role of corporations in achieving ecological sustainability. *Academy of management review*, *20*(4), 936-960.

Shultz, C. (2004). Staying the macromarketing course and expanding boundaries. *Journal of Macromarketing*, *24*(1), 3-5.

Siegel, D. S. (2009). Green management matters only if it yields more green: an economic/strategic perspective. *Academy of Management Perspectives*, 5–16.

Sirkin, H.L. (2013). *A Sustainable Business Model Pays off.* Retrieved http://www.businessweek.com/articles/2013-11-26/a-sustainable-business-model-pays-off

Sirmon, D. G., Hitt, M. A., & Ireland, R. D. (2007). Managing firm resources in dynamic environments to create value: Looking inside the black box. *Academy of Management Review*, *32*(1), 273-292.

Slater, S. F., & Narver, J. C. (1995). Market orientation and the learning organization. *Journal of Marketing*, 59(3), 63–74.

Snow, C.C., & Thomas, J.B. (1994). Field research methods in strategic management: contributions to theory building and testing. *Journal of Management Studies, 31*(4), 458-480.

Strong, C. (1997). The role of fair trade principles within sustainable development. *Sustainable Development*, 5: 1–10.

Sueyoshi, T., & Goto, M. (2010). Measurement of a linkage among environmental, operational, and financial performance in Japanese manufacturing firms: A use of Data Envelopment Analysis with strong complementary slackness condition. *European Journal of Operational Research*, *207*(3), 1742-1753.

Talluri, S., & Narasimhan, R. (2004). A methodology for strategic sourcing. *European Journal of Operational Research*, *154*(1), 236-250.

Tate, W. L., Ellram, L. M., and Kirchoff, J. F. (2010). Corporate Social Responsibility Reports: A Thematic Analysis Related to Supply Chain Management. *Journal of Supply Chain Management, 46*(1), pp. 19-44.

Ten Brink, B. J. E., Hosper, S. H., & Colijn, F. (1991). A quantitative method for description & assessment of ecosystems: The AMOEBA-approach. *Marine pollution bulletin*, *23*, 265-270.

Toffel, M.W., & Marshall, J.D. (2004). Improving environmental performance assessment – a comparative analysis of weighting methods used to evaluate chemical release inventories. *Journal of Industrial Ecology, 8*(1-2), 143-172.

United States Environmental Protection Agency (2012). *User's manual for RSEI version 2.3.1* [1996-2010 TRI data].

United Nations Global Compact (2010). *Supply Chain Sustainability: A Practical Guide for Continuous Improvement*. UN Global Compact Office and Business for Social Responsibility.

Vachon, S., & Klassen, R. D. (2008). Environmental management and manufacturing performance: the role of collaboration in the supply chain. *International Journal of Production Economics*, *111*(2), 299-315.

Vachon, S., & Klassen, R.D. (2006). Extending green practices across the supply chain: The impact of upstream and downstream integration. *International Journal of Operations & Production Management, 26*(7), 795 - 821.

Van Dam, Y. K., & Apeldoorn, P. A. (1996). Sustainable marketing. *Journal of Macromarketing*, *16*(2), 45-56.

Varadarajan, P. R. (1992). Marketing's contribution to strategy: the view from a different looking glass. *Journal of the Academy of Marketing Science*, *20*(4), 335-343.

von Sanden, N.D. (2004). *Interviewer effects in household surveys: estimation and design,* PhD thesis, University of Wollongong.

Von Bertalanffy, L. (1968). *General system theory: Foundations, development, applications* (Revised Ed.). New York: George Braziller.

Waddock, S., Bodwell, C., & Leigh, J. (2007). Total responsibility management. *Sheffield: Greenleaf*.

Wagner, S. M., Grosse-Ruyken, P. T., & Erhun, F. (2012). The link between supply chain fit and financial performance of the firm. *Journal of Operations Management*, *30*(4), 340-353.

Walker, Kent (2011). *Deviation from Predictions in Corporate Environmental Performance: Antecedents and Financial Consequences,* PhD Thesis, University of Manitoba.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, *5*(2), 171-180.

Wheeler, D., Colbert, B., & Freeman, R. E. (2003). Focusing on value: Reconciling corporate social responsibility, sustainability and a stakeholder approach in a network world. *Journal of General Management*, *28*(3), 1-28.

Williamson, O., & Ouchi, W. (1981). The markets and hierarchies perspective: origins, implications, prospects. in A. van de Ven and W. F. Joyce (eds.), *Assessing Organizational Design and Performance*, Wiley, New York.

Wong, Y. H., & Beasley, J. E. (1990). Restricting weight flexibility in data envelopment analysis. *Journal of the Operational Research Society*, 829-835.

World Commission on Environment and Development. (1987). *Our common future*. Oxford: Oxford University Press.

Wyatt, J. (2013). *Sustainability: A 3PL's Role in Your Green Supply Chain,* Retrieved http://www.manufacturing.net/articles/2013/12/sustainability-a-3pl%E2%80%99s-role-in-your-green-supply-chain

Young, A. (2013) Automobile Manufacturing Has Been Consistently Outpacing Average Global Industrial Output. International Business Times http://www.ibtimes.com/automobile-manufacturing-has-been-consistently-outpacing-average-global-industrial-output-1404255

Zhu, Q., & Sarkis, J. (2007). The moderating effects of institutional pressures on emergent green supply chain practices and performance. *International Journal of Production Research, 45*(18), 4333 - 4355.

APPENDIX 1:

Solution to LP Model Used to Generate 22 Highest Correlated Keyword Pairs

Correlation Matrix

	employee	people	supplier	managem	customer	market	quality	operation	governme	supply	stakehold	chain	society	transport	source	sharehold	network	competiti	investor	media	staff	purchase
employee	0	-0.2568	0.07862	-0.10534	0.05329	-0.19433	-0.03222	-0.21068	-0.39257	5.47E-04	-0.52374	-0.07466	-0.13725	-0.44651	-0.50247	0.459447	-0.27916	-0.31053	0.234506	-0.22213	-0.23315	0.05119
people	-0.2568	0	-0.06448	-0.51657	-0.24288	-0.05412	-0.16753	-0.26642	-0.27933	-0.28776	-0.19913	0.345437	-0.17852	0.856291	0.528414	-0.2454	-0.16565	-0.26792	-0.20511	-0.23066	-0.22697	0.100797
supplier	0.07862	-0.06448	0	-0.31539	0.09973	0.091156	-0.01117	-0.22923	-0.26282	0.389413	-0.33302	0.050626	-0.0957	-0.07848	0.609253	-0.49373	0.302936	-0.17363	-0.21481	-0.45097	-0.13084	0.648289
managem	-0.10534	-0.51657	-0.31539	0	0.099015	-0.21846	0.417934	0.040726	0.127416	0.015433	0.17651	-0.45848	0.273883	-0.42204	-0.35523	0.647913	-0.07932	0.141802	0.177861	0.493556	0.345524	-0.03202
customer	0.05329	-0.24288	0.09973	0.099015	0	0.638279	0.33419	-0.24057	-0.52313	-0.51596	0.085373	-0.35448	0.281337	-0.10636	-0.12164	0.114353	0.205495	-0.12984	0.426604	-0.48859	0.025633	-0.46344
market	-0.19433	-0.05412	0.091156	-0.21846	0.638279	0	-0.02272	0.069606	-0.07516	-0.39516	0.418876	-0.12547	-0.02374	-0.03083	0.200379	-0.30069	-0.03321	-0.05829	-0.10361	-0.09297	-0.29662	-0.39323
quality	-0.03222	-0.16753	-0.01117	0.417934	0.33419	-0.02272	0	0.097804	0.010034	-0.44205	0.099105	-0.63854	0.910633	0.074984	-0.1747	0.430359	-0.29301	0.100061	0.721493	-0.27277	0.412854	0.153062
operation	-0.21068	-0.26642	-0.22923	0.040726	-0.24057	0.069606	0.097804	0	0.712528	0.154786	0.779112	-0.02785	0.256292	-0.259	-0.151	-0.07212	-0.06408	0.788669	0.165407	0.438146	-0.1886	-0.07266
governme	-0.39257	-0.27933	-0.26282	0.127416	-0.52313	-0.07516	0.010034	0.712528	0	0.411456	0.571549	0.184699	0.220034	-0.11543	-0.15497	-0.25767	-0.03785	0.654893	-0.11138	0.565161	0.098481	0.091014
supply	5.47E-04	-0.28776	0.389413	0.015433	-0.51596	-0.39516	-0.44205	0.154786	0.411456	0	-0.12457	0.607554	-0.3224	-0.28304	0.113741	-0.41124	0.482653	0.362325	-0.41496	0.286525	-0.22006	0.490088
stakehold	-0.52374	-0.19913	-0.33302	0.17651	0.085373	0.418876	0.099105	0.779112	0.571549	-0.12457	0	-0.16961	0.153545	-0.21199	-0.07796	-0.15488	-0.13894	0.724013	-0.04533	0.380604	0.041969	-0.24277
chain	-0.07466	0.345437	0.050626	-0.45848	-0.35448	-0.12547	-0.63854	-0.02785	0.184699	0.607554	-0.16961	0	-0.40732	0.327679	0.152548	-0.57722	0.461767	0.237315	-0.36745	0.027101	-0.51817	0.078041
society	-0.13725	-0.17852	-0.0957	0.273883	0.281337	-0.02374	0.910633	0.256292	0.220034	-0.3224	0.153545	-0.40732	0	0.199903	-0.22253	0.25911	-0.04309	0.258916	0.827538	-0.24812	0.332373	-0.01304
transport	-0.44651	0.856291	-0.07848	-0.42204	-0.10636	-0.03083	0.074984	-0.259	-0.11543	-0.28304	-0.21199	0.327679	0.199903	0	0.475788	-0.29738	0.094909	-0.21066	0.080985	-0.30268	-0.0568	-0.01884
source	-0.50247	0.528414	0.609253	-0.35523	-0.12164	0.200379	-0.1747	-0.151	-0.15497	0.113741	-0.07796	0.152548	-0.22253	0.475788	0	-0.56562	0.209498	-0.24383	-0.45729	-0.08856	-0.25274	0.409386
sharehold	0.459447	-0.2454	-0.49373	0.647913	0.114353	-0.30069	0.430359	-0.07212	-0.25767	-0.41124	-0.15488	-0.57722	0.25911	-0.29738	-0.56562	0	-0.41849	-0.23217	0.48908	0.243323	0.150318	-0.24137
network	-0.27916	-0.16565	0.302936	-0.07932	0.205495	-0.03321	-0.29301	-0.06408	-0.03785	0.482653	-0.13894	0.461767	-0.04309	0.094909	0.209498	-0.41849	0	0.158275	0.065074	-0.12066	-0.15982	-0.18384
competiti	-0.31053	-0.26792	-0.17363	0.141802	-0.12984	-0.05829	0.100061	0.788669	0.654893	0.362325	0.724013	0.237315	0.258916	-0.21066	-0.24383	-0.23217	0.158275	0	0.120506	0.209031	-0.02409	0.063352
investor	0.234506	-0.20511	-0.21481	0.177861	0.426604	-0.10361	0.721493	0.165407	-0.11138	-0.41496	-0.04533	-0.36745	0.827538	0.080985	-0.45729	0.48908	0.065074	0.120506	0	-0.34925	0.15065	-0.31029
media	-0.22213	-0.23066	-0.45097	0.493556	-0.48859	-0.09297	-0.27277	0.438146	0.565161	0.286525	0.380604	0.027101	-0.24812	-0.30268	-0.08856	0.243323	-0.12066	0.209031	-0.34925	0	-0.18969	-0.13304
staff	-0.23315	-0.22697	-0.13084	0.345524	0.025633	-0.29662	0.412854	-0.1886	0.098481	-0.22006	0.041969	-0.51817	0.332373	-0.0568	-0.25274	0.150318	-0.15982	-0.02409	0.15065	-0.18969	0	0.067605
purchase	0.05119	0.100797	0.648289	-0.03202	-0.46344	-0.39323	0.153062	-0.07266	0.091014	0.490088	-0.24277	0.078041	-0.01304	-0.01884	0.409386	-0.24137	-0.18384	0.063352	-0.31029	-0.13304	0.067605	0

	employee	people	supplier	managem	customer	market	quality	operation	governme	supply	stakehold	chain	society	transport	source	sharehold	network	competiti	investor	media	staff	purchase	
employee	0	0	0	0	0	0	0	0	0	0.00E+00	0	0	0	0	0	0	0	0	0	0	0	0	0
people	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
supplier	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2
managem	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
customer	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
market	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
quality	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	2
operation	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	3
governme	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
supply	0.00E+00	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2
stakehold	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
chain	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
society	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2
transport	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
source	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
sharehold	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
network	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
competiti	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
investor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
media	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
staff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
purchase	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22

Microsoft Excel 14.0 Sensitivity Report
Worksheet: [Matrix - 22 Keywords by 22 keywords_12_firms_04_09_2013.xlsx]22 x 22 Keywords x keywords
Report Created: 4/9/2013 3:00:21 PM
Engine: Gurobi Solver

Objective Cell (Max)

Cell	Name	Final Value
B54	employee	15.04380139

Decision Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
B29	employee employee	0	-0.459447363	0	0.459447363	1E+100
C29	employee people	0	-1.113090962	-0.256799597	1.113090962	1E+100
D29	employee supplier	0	-0.569668493	0.07862023	0.569668493	1E+100
E29	employee management	0	-0.75324938	-0.105336467	0.75324938	1E+100
F29	employee customer	0	-0.584989438	0.053289733	0.584989438	1E+100
G29	employee market	0	-0.832610921	-0.19433175	0.832610921	1E+100
H29	employee quality	0	-0.942857758	-0.032224974	0.942857758	1E+100
I29	employee operation	0	-0.999349324	-0.21068079	0.999349324	1E+100
J29	employee government	0	-1.105102081	-0.392573693	1.105102081	1E+100

K29	employee supply	0.00E+00	-6.07E-01	0.000547	0.607006698	1E+100
L29	employee stakeholder	0	- 1.302852723	- 0.523740465	1.302852723	1E+100
M29	employee chain	0	- 0.682211969	- 0.074658271	0.682211969	1E+100
N29	employee society	0	- 1.047884204	-0.13725142	1.047884204	1E+100
O29	employee transport	0	- 1.302801024	- 0.446509659	1.302801024	1E+100
P29	employee source	0	- 1.111724938	-0.50247206	1.111724938	1E+100
Q29	employee shareholder	0	-0.18846555	0.459447363	0.18846555	1E+100
R29	employee network	0	- 0.761807972	- 0.279155181	0.761807972	1E+100
S29	employee competition	0	- 1.099198579	- 0.310530045	1.099198579	1E+100
T29	employee investor	0	- 0.593032668	0.234505514	0.593032668	1E+100
U29	employee media	0	-0.78729192	- 0.222131171	0.78729192	1E+100
V29	employee staff	0	- 0.646009048	- 0.233154646	0.646009048	1E+100
W29	employee purchase	0	- 0.597098634	0.051190089	0.597098634	1E+100
B30	people employee	0	-0.71624696	- 0.256799597	0.71624696	1E+100
C30	people people	0	- 0.856291365	0	0.856291365	1E+100
D30	people supplier	0	- 0.712772608	- 0.064483885	0.712772608	1E+100
E30	people management	0	-	-	1.164486486	1E+100

			1.164486486	0.516573573		
F30	people customer	0	-0.881154244	-0.242875073	0.881154244	1E+100
G30	people market	0	-0.692403682	-0.054124511	0.692403682	1E+100
H30	people quality	0	-1.078167163	-0.167534379	1.078167163	1E+100
I30	people operation	0	-1.055085205	-0.266416671	1.055085205	1E+100
J30	people government	0	-0.991862055	-0.279333667	0.991862055	1E+100
K30	people supply	0	-0.895317092	-0.287763394	0.895317092	1E+100
L30	people stakeholder	0	-0.978245525	-0.199133267	0.978245525	1E+100
M30	people chain	0	-0.262116683	0.345437015	0.262116683	1E+100
N30	people society	0	-1.089157139	-0.178524355	1.089157139	1E+100
O30	people transport	1	0	0.856291365	1E+100	0.380503079
P30	people source	0	-0.080838678	0.5284142	0.080838678	1E+100
Q30	people shareholder	0	-0.893313493	-0.24540058	0.893313493	1E+100
R30	people network	0	-0.64830171	-0.165648919	0.64830171	1E+100
S30	people competition	0	-1.056584218	-0.267915684	1.056584218	1E+100
T30	people investor	0	-1.032648105	-0.205109923	1.032648105	1E+100
U30	people media	0	-	-	0.795818303	1E+100

			0.795818303	0.230657554		
V30	people staff	0	- 0.639819981	- 0.226965579	0.639819981	1E+100
W30	people purchase	0	- 0.547491991	0.100796732	0.547491991	1E+100
B31	supplier employee	0	- 0.380827133	0.07862023	0.380827133	1E+100
C31	supplier people	0	-0.92077525	- 0.064483885	0.92077525	1E+100
D31	supplier supplier	0	- 0.648288723	0	0.648288723	1E+100
E31	supplier management	0	- 0.963305054	- 0.315392141	0.963305054	1E+100
F31	supplier customer	0	-0.53854918	0.099729991	0.53854918	1E+100
G31	supplier market	0	- 0.547123653	0.091155518	0.547123653	1E+100
H31	supplier quality	0	- 0.921798116	- 0.011165332	0.921798116	1E+100
I31	supplier operation	0	- 1.017898612	- 0.229230078	1.017898612	1E+100
J31	supplier government	0	- 0.975352631	- 0.262824243	0.975352631	1E+100
K31	supplier supply	0	- 0.218140474	0.389413224	0.218140474	1E+100
L31	supplier stakeholder	0	- 1.112134311	- 0.333022053	1.112134311	1E+100
M31	supplier chain	0	- 0.556927578	0.05062612	0.556927578	1E+100
N31	supplier society	0	- 1.006327784	-0.095695	1.006327784	1E+100
O31	supplier transport	0	-	-0.07848498	0.934776345	1E+100

			0.934776345			
P31	supplier source	1	0	0.609252878	1E+100	0.080838678
Q31	supplier shareholder	0	-1.141641153	-0.49372824	1.141641153	1E+100
R31	supplier network	0	-0.179717244	0.302935547	0.179717244	1E+100
S31	supplier competition	0	-0.96230094	-0.173632406	0.96230094	1E+100
T31	supplier investor	0	-1.042343521	-0.214805339	1.042343521	1E+100
U31	supplier media	0	-1.016134968	-0.450974219	1.016134968	1E+100
V31	supplier staff	0	-0.543689679	-0.130835277	0.543689679	1E+100
W31	supplier purchase	1	0	0.648288723	1E+100	0.158200573
B32	management employee	0	-0.56478383	-0.105336467	0.56478383	1E+100
C32	management people	0	-1.372864938	-0.516573573	1.372864938	1E+100
D32	management supplier	0	-0.963680864	-0.315392141	0.963680864	1E+100
E32	management management	0	-0.647912913	0	0.647912913	1E+100
F32	management customer	0	-0.539264462	0.099014709	0.539264462	1E+100
G32	management market	0	-0.85674077	-0.218461599	0.85674077	1E+100
H32	management quality	0	-0.492698303	0.417934481	0.492698303	1E+100
I32	management operation	0	-0.747942821	0.040725713	0.747942821	1E+100

J32	management government	0	-0.585112598	0.12741579	0.585112598	1E+100
K32	management supply	0	-0.592120997	0.015432701	0.592120997	1E+100
L32	management stakeholder	0	-0.602602594	0.176509664	0.602602594	1E+100
M32	management chain	0	-1.066034972	-0.458481274	1.066034972	1E+100
N32	management society	0	-0.636750086	0.273882698	0.636750086	1E+100
O32	management transport	0	-1.278327804	-0.422036439	1.278327804	1E+100
P32	management source	0	-0.964486446	-0.355233568	0.964486446	1E+100
Q32	management shareholder	1	0	0.647912913	1E+100	0.158832475
R32	management network	0	-0.561967923	-0.079315132	0.561967923	1E+100
S32	management competition	0	-0.646866553	0.141801981	0.646866553	1E+100
T32	management investor	0	-0.649676801	0.177861381	0.649676801	1E+100
U32	management media	0	-0.071604743	0.493556006	0.071604743	1E+100
V32	management staff	0	-0.067330666	0.345523736	0.067330666	1E+100
W32	management purchase	0	-0.680307597	-0.032018874	0.680307597	1E+100
B33	customer employee	0	-0.40615763	0.053289733	0.40615763	1E+100
C33	customer people	0	-1.099166438	-0.242875073	1.099166438	1E+100
D33	customer supplier	0	-	0.099729991	0.548558732	1E+100

			0.548558732			
E33	customer management	0	- 0.548898204	0.099014709	0.548898204	1E+100
F33	customer customer	0	- 0.638279171	0	0.638279171	1E+100
G33	customer market	1	0	0.638279171	1E+100	0.219402773
H33	customer quality	0	- 0.576442541	0.334190243	0.576442541	1E+100
I33	customer operation	0	- 1.029233834	-0.2405653	1.029233834	1E+100
J33	customer government	0	- 1.235659762	- 0.523131374	1.235659762	1E+100
K33	customer supply	0	- 1.123516114	- 0.515962416	1.123516114	1E+100
L33	customer stakeholder	0	- 0.693739343	0.085372915	0.693739343	1E+100
M33	customer chain	0	- 0.962030732	- 0.354477034	0.962030732	1E+100
N33	customer society	0	- 0.629295286	0.281337498	0.629295286	1E+100
O33	customer transport	0	- 0.962649709	- 0.106358344	0.962649709	1E+100
P33	customer source	0	- 0.730895722	- 0.121642844	0.730895722	1E+100
Q33	customer shareholder	0	- 0.533559456	0.114353457	0.533559456	1E+100
R33	customer network	0	- 0.277157648	0.205495143	0.277157648	1E+100
S33	customer competition	0	- 0.918512714	-0.12984418	0.918512714	1E+100
T33	customer investor	0	-	0.426604408	0.400933774	1E+100

			0.400933774			
U33	customer media	0	-1.053749772	-0.488589023	1.053749772	1E+100
V33	customer staff	0	-0.387221566	0.025632836	0.387221566	1E+100
W33	customer purchase	0	-1.111723848	-0.463435125	1.111723848	1E+100
B34	market employee	0	-0.653779113	-0.19433175	0.653779113	1E+100
C34	market people	0	-0.910415876	-0.054124511	0.910415876	1E+100
D34	market supplier	0	-0.557133205	0.091155518	0.557133205	1E+100
E34	market management	0	-0.866374512	-0.218461599	0.866374512	1E+100
F34	market customer	1	0	0.638279171	1E+100	0.211674763
G34	market market	0	-0.638279171	0	0.638279171	1E+100
H34	market quality	0	-0.933353546	-0.022720762	0.933353546	1E+100
I34	market operation	0	-0.719062713	0.069605821	0.719062713	1E+100
J34	market government	0	-0.787688787	-0.075160399	0.787688787	1E+100
K34	market supply	0	-1.002715666	-0.395161968	1.002715666	1E+100
L34	market stakeholder	0	-0.36023586	0.418876398	0.36023586	1E+100
M34	market chain	0	-0.73302192	-0.125468222	0.73302192	1E+100
N34	market society	0	-0.934376289	-0.023743505	0.934376289	1E+100

O34	market transport	0	-0.887125136	-0.030833771	0.887125136	1E+100
P34	market source	0	-0.408874311	0.200378567	0.408874311	1E+100
Q34	market shareholder	0	-0.948599971	-0.300687058	0.948599971	1E+100
R34	market network	0	-0.515859688	-0.033206897	0.515859688	1E+100
S34	market competition	0	-0.846955891	-0.058287357	0.846955891	1E+100
T34	market investor	0	-0.931150795	-0.103612613	0.931150795	1E+100
U34	market media	0	-0.65813388	-0.092973131	0.65813388	1E+100
V34	market staff	0	-0.709474472	-0.29662007	0.709474472	1E+100
W34	market purchase	0	-1.041516017	-0.393227294	1.041516017	1E+100
B35	quality employee	0	-0.491672337	-0.032224974	0.491672337	1E+100
C35	quality people	0	-1.023825744	-0.167534379	1.023825744	1E+100
D35	quality supplier	0	-0.659454055	-0.011165332	0.659454055	1E+100
E35	quality management	0	-0.229978432	0.417934481	0.229978432	1E+100
F35	quality customer	0	-0.304088928	0.334190243	0.304088928	1E+100
G35	quality market	0	-0.660999933	-0.022720762	0.660999933	1E+100
H35	quality quality	0	-	0	0.910632784	1E+100

			0.910632784			
I35	quality operation	0	-0.690864424	0.09780411	0.690864424	1E+100
J35	quality government	0	-0.702494732	0.010033656	0.702494732	1E+100
K35	quality supply	0	-1.049606052	-0.442052354	1.049606052	1E+100
L35	quality stakeholder	0	-0.680007159	0.099105099	0.680007159	1E+100
M35	quality chain	0	-1.24609017	-0.638536472	1.24609017	1E+100
N35	quality society	1	0	0.910632784	1E+100	0.083094602
O35	quality transport	0	-0.781307015	0.07498435	0.781307015	1E+100
P35	quality source	0	-0.783956619	-0.174703741	0.783956619	1E+100
Q35	quality shareholder	0	-0.217553774	0.430359139	0.217553774	1E+100
R35	quality network	0	-0.775660054	-0.293007263	0.775660054	1E+100
S35	quality competition	0	-0.688608002	0.100060532	0.688608002	1E+100
T35	quality investor	0	-0.106045491	0.721492691	0.106045491	1E+100
U35	quality media	0	-0.837933394	-0.272772645	0.837933394	1E+100
V35	quality staff	1	0	0.412854402	1E+100	0.067330666
W35	quality purchase	0	-0.495226416	0.153062307	0.495226416	1E+100
B36	operation employee	0	-0.670128153	-0.21068079	0.670128153	1E+100

C36	operation people	0	-1.122708036	-0.266416671	1.122708036	1E+100
D36	operation supplier	0	-0.877518801	-0.229230078	0.877518801	1E+100
E36	operation management	0	-0.6071872	0.040725713	0.6071872	1E+100
F36	operation customer	0	-0.878844471	-0.2405653	0.878844471	1E+100
G36	operation market	0	-0.56867335	0.069605821	0.56867335	1E+100
H36	operation quality	0	-0.812828674	0.09780411	0.812828674	1E+100
I36	operation operation	0	-0.788668534	0	0.788668534	1E+100
J36	operation government	1	0	0.712528388	1E+100	0.05763529
K36	operation supply	0	-0.452767537	0.154786161	0.452767537	1E+100
L36	operation stakeholder	1	0	0.779112258	1E+100	0.055098797
M36	operation chain	0	-0.63540356	-0.027849862	0.63540356	1E+100
N36	operation society	0	-0.654341053	0.256291731	0.654341053	1E+100
O36	operation transport	0	-1.115290692	-0.258999327	1.115290692	1E+100
P36	operation source	0	-0.760255778	-0.1510029	0.760255778	1E+100
Q36	operation shareholder	0	-0.720035572	-0.072122659	0.720035572	1E+100
R36	operation network	0	-0.54673002	-0.064077229	0.54673002	1E+100
S36	operation competition	1	0	0.788668534	1E+100	0.064655073
T36	operation investor	0	-0.662131267	0.165406915	0.662131267	1E+100

U36	operation media	0	-0.127014928	0.438145821	0.127014928	1E+100
V36	operation staff	0	-0.60145688	-0.188602478	0.60145688	1E+100
W36	operation purchase	0	-0.72094426	-0.072655537	0.72094426	1E+100
B37	government employee	0	-0.852021056	-0.392573693	0.852021056	1E+100
C37	government people	0	-1.135625032	-0.279333667	1.135625032	1E+100
D37	government supplier	0	-0.911112966	-0.262824243	0.911112966	1E+100
E37	government management	0	-0.520497123	0.12741579	0.520497123	1E+100
F37	government customer	0	-1.161410545	-0.523131374	1.161410545	1E+100
G37	government market	0	-0.71343957	-0.075160399	0.71343957	1E+100
H37	government quality	0	-0.900599128	0.010033656	0.900599128	1E+100
I37	government operation	0	-0.076140146	0.712528388	0.076140146	1E+100
J37	government government	0	-0.712528388	0	0.712528388	1E+100
K37	government supply	0	-0.196097274	0.411456424	0.196097274	1E+100
L37	government stakeholder	0	-0.207562898	0.57154936	0.207562898	1E+100
M37	government chain	0	-0.422854608	0.18469909	0.422854608	1E+100
N37	government society	0	-	0.220034111	0.690598673	1E+100

			0.690598673			
O37	government transport	0	-0.971717836	-0.115426471	0.971717836	1E+100
P37	government source	0	-0.764225188	-0.15497231	0.764225188	1E+100
Q37	government shareholder	0	-0.905586496	-0.257673583	0.905586496	1E+100
R37	government network	0	-0.520499865	-0.037847074	0.520499865	1E+100
S37	government competition	0	-0.133775436	0.654893098	0.133775436	1E+100
T37	government investor	0	-0.938921763	-0.111383581	0.938921763	1E+100
U37	government media	1	0	0.565160749	1E+100	0.071604743
V37	government staff	0	-0.314373877	0.098480525	0.314373877	1E+100
W37	government purchase	0	-0.557274489	0.091014234	0.557274489	1E+100
B38	supply employee	0.00E+00	-4.59E-01	0.000547	0.458900363	1E+100
C38	supply people	0	-1.144054759	-0.287763394	1.144054759	1E+100
D38	supply supplier	0	-0.258875499	0.389413224	0.258875499	1E+100
E38	supply management	0	-0.632480212	0.015432701	0.632480212	1E+100
F38	supply customer	0	-1.154241587	-0.515962416	1.154241587	1E+100
G38	supply market	0	-1.033441139	-0.395161968	1.033441139	1E+100
H38	supply quality	0	-1.352685138	-0.442052354	1.352685138	1E+100

I38	supply operation	0	-0.633882373	0.154786161	0.633882373	1E+100
J38	supply government	0	-0.301071964	0.411456424	0.301071964	1E+100
K38	supply supply	0	-0.607553698	0	0.607553698	1E+100
L38	supply stakeholder	0	-0.90367917	-0.124566912	0.90367917	1E+100
M38	supply chain	1	0	0.607553698	1E+100	0.145786982
N38	supply society	0	-1.233036517	-0.322403733	1.233036517	1E+100
O38	supply transport	0	-1.139332108	-0.283040743	1.139332108	1E+100
P38	supply source	0	-0.495511593	0.113741285	0.495511593	1E+100
Q38	supply shareholder	0	-1.059151575	-0.411238662	1.059151575	1E+100
R38	supply network	1	0	0.482652791	1E+100	0.020886075
S38	supply competition	0	-0.42634392	0.362324614	0.42634392	1E+100
T38	supply investor	0	-1.242495089	-0.414956907	1.242495089	1E+100
U38	supply media	0	-0.278636242	0.286524507	0.278636242	1E+100
V38	supply staff	0	-0.632918173	-0.220063771	0.632918173	1E+100
W38	supply purchase	0	-0.158200573	0.49008815	0.158200573	1E+100
B39	stakeholder employee	0	-0.983187828	-0.523740465	0.983187828	1E+100
C39	stakeholder people	0	-1.055424632	-0.199133267	1.055424632	1E+100

D39	stakeholder supplier	0	-0.981310776	-0.333022053	0.981310776	1E+100
E39	stakeholder management	0	-0.471403249	0.176509664	0.471403249	1E+100
F39	stakeholder customer	0	-0.552906256	0.085372915	0.552906256	1E+100
G39	stakeholder market	0	-0.219402773	0.418876398	0.219402773	1E+100
H39	stakeholder quality	0	-0.811527685	0.099105099	0.811527685	1E+100
I39	stakeholder operation	0	-0.009556276	0.779112258	0.009556276	1E+100
J39	stakeholder government	0	-0.140979028	0.57154936	0.140979028	1E+100
K39	stakeholder supply	0	-0.73212061	-0.124566912	0.73212061	1E+100
L39	stakeholder stakeholder	0	-0.779112258	0	0.779112258	1E+100
M39	stakeholder chain	0	-0.77716623	-0.169612532	0.77716623	1E+100
N39	stakeholder society	0	-0.757087461	0.153545323	0.757087461	1E+100
O39	stakeholder transport	0	-1.068282143	-0.211990778	1.068282143	1E+100
P39	stakeholder source	0	-0.687210136	-0.077957258	0.687210136	1E+100
Q39	stakeholder shareholder	0	-0.802796221	-0.154883308	0.802796221	1E+100
R39	stakeholder network	0	-0.621588759	-0.138935968	0.621588759	1E+100
S39	stakeholder competition	0	-	0.724013461	0.064655073	1E+100

			0.064655073			
T39	stakeholder investor	0	-0.872867915	-0.045329733	0.872867915	1E+100
U39	stakeholder media	0	-0.184556296	0.380604453	0.184556296	1E+100
V39	stakeholder staff	0	-0.370885454	0.041968948	0.370885454	1E+100
W39	stakeholder purchase	0	-0.891061048	-0.242772325	0.891061048	1E+100
B40	chain employee	0	-0.534105634	-0.074658271	0.534105634	1E+100
C40	chain people	0	-0.51085435	0.345437015	0.51085435	1E+100
D40	chain supplier	0	-0.597662603	0.05062612	0.597662603	1E+100
E40	chain management	0	-1.106394187	-0.458481274	1.106394187	1E+100
F40	chain customer	0	-0.992756205	-0.354477034	0.992756205	1E+100
G40	chain market	0	-0.763747393	-0.125468222	0.763747393	1E+100
H40	chain quality	0	-1.549169256	-0.638536472	1.549169256	1E+100
I40	chain operation	0	-0.816518396	-0.027849862	0.816518396	1E+100
J40	chain government	0	-0.527829298	0.18469909	0.527829298	1E+100
K40	chain supply	1	0	0.607553698	1E+100	0.117465548
L40	chain stakeholder	0	-0.94872479	-0.169612532	0.94872479	1E+100
M40	chain chain	0	-0.607553698	0	0.607553698	1E+100

N40	chain society	0	-1.317949685	-0.407316901	1.317949685	1E+100
O40	chain transport	0	-0.528612782	0.327678583	0.528612782	1E+100
P40	chain source	0	-0.456704756	0.152548122	0.456704756	1E+100
Q40	chain shareholder	0	-1.225137387	-0.577224474	1.225137387	1E+100
R40	chain network	0	-0.020886075	0.461766716	0.020886075	1E+100
S40	chain competition	0	-0.551353617	0.237314917	0.551353617	1E+100
T40	chain investor	0	-1.19498388	-0.367445698	1.19498388	1E+100
U40	chain media	0	-0.538060204	0.027100545	0.538060204	1E+100
V40	chain staff	0	-0.931025929	-0.518171527	0.931025929	1E+100
W40	chain purchase	0	-0.570247725	0.078040998	0.570247725	1E+100
B41	society employee	0	-0.596698783	-0.13725142	0.596698783	1E+100
C41	society people	0	-1.03481572	-0.178524355	1.03481572	1E+100
D41	society supplier	0	-0.743983723	-0.095695	0.743983723	1E+100
E41	society management	0	-0.374030215	0.273882698	0.374030215	1E+100
F41	society customer	0	-0.356941673	0.281337498	0.356941673	1E+100
G41	society market	0	-	-	0.662022676	1E+100

			0.662022676	0.023743505		
H41	society quality	1	0	0.910632784	1E+100	0.189140093
I41	society operation	0	-0.532376803	0.256291731	0.532376803	1E+100
J41	society government	0	-0.492494277	0.220034111	0.492494277	1E+100
K41	society supply	0	-0.929957431	-0.322403733	0.929957431	1E+100
L41	society stakeholder	0	-0.625566935	0.153545323	0.625566935	1E+100
M41	society chain	0	-1.014870599	-0.407316901	1.014870599	1E+100
N41	society society	0	-0.910632784	0	0.910632784	1E+100
O41	society transport	0	-0.656388324	0.199903041	0.656388324	1E+100
P41	society source	0	-0.831782251	-0.222529373	0.831782251	1E+100
Q41	society shareholder	0	-0.388802965	0.259109948	0.388802965	1E+100
R41	society network	0	-0.525743047	-0.043090256	0.525743047	1E+100
S41	society competition	0	-0.529752108	0.258916426	0.529752108	1E+100
T41	society investor	1	0	0.827538182	1E+100	0.106045491
U41	society media	0	-0.813285717	-0.248124968	0.813285717	1E+100
V41	society staff	0	-0.080481267	0.332373135	0.080481267	1E+100
W41	society purchase	0	-0.661326801	-0.013038078	0.661326801	1E+100

B42	transport employee	0	-0.905957022	-0.446509659	0.905957022	1E+100
C42	transport people	1	0	0.856291365	1E+100	0.327877165
D42	transport supplier	0	-0.726773703	-0.07848498	0.726773703	1E+100
E42	transport management	0	-1.069949352	-0.422036439	1.069949352	1E+100
F42	transport customer	0	-0.744637515	-0.106358344	0.744637515	1E+100
G42	transport market	0	-0.669112942	-0.030833771	0.669112942	1E+100
H42	transport quality	0	-0.835648434	0.07498435	0.835648434	1E+100
I42	transport operation	0	-1.047667861	-0.258999327	1.047667861	1E+100
J42	transport government	0	-0.827954859	-0.115426471	0.827954859	1E+100
K42	transport supply	0	-0.890594441	-0.283040743	0.890594441	1E+100
L42	transport stakeholder	0	-0.991103036	-0.211990778	0.991103036	1E+100
M42	transport chain	0	-0.279875115	0.327678583	0.279875115	1E+100
N42	transport society	0	-0.710729743	0.199903041	0.710729743	1E+100
O42	transport transport	0	-0.856291365	0	0.856291365	1E+100
P42	transport source	0	-0.133464592	0.475788286	0.133464592	1E+100
Q42	transport shareholder	0	-0.945292649	-0.297379736	0.945292649	1E+100

R42	transport network	0	-0.387743509	0.094909282	0.387743509	1E+100
S42	transport competition	0	-0.99932591	-0.210657376	0.99932591	1E+100
T42	transport investor	0	-0.746552713	0.080985469	0.746552713	1E+100
U42	transport media	0	-0.867841028	-0.302680279	0.867841028	1E+100
V42	transport staff	0	-0.469655955	-0.056801553	0.469655955	1E+100
W42	transport purchase	0	-0.667132087	-0.018843364	0.667132087	1E+100
B43	source employee	0	-0.961919423	-0.50247206	0.961919423	1E+100
C43	source people	0	-0.327877165	0.5284142	0.327877165	1E+100
D43	source supplier	0	-0.039035845	0.609252878	0.039035845	1E+100
E43	source management	0	-1.003146481	-0.355233568	1.003146481	1E+100
F43	source customer	0	-0.759922015	-0.121642844	0.759922015	1E+100
G43	source market	0	-0.437900604	0.200378567	0.437900604	1E+100
H43	source quality	0	-1.085336525	-0.174703741	1.085336525	1E+100
I43	source operation	0	-0.939671434	-0.1510029	0.939671434	1E+100
J43	source government	0	-0.867500698	-0.15497231	0.867500698	1E+100
K43	source supply	0	-	0.113741285	0.493812413	1E+100

			0.493812413			
L43	source stakeholder	0	-0.857069516	-0.077957258	0.857069516	1E+100
M43	source chain	0	-0.455005576	0.152548122	0.455005576	1E+100
N43	source society	0	-1.133162157	-0.222529373	1.133162157	1E+100
O43	source transport	0	-0.380503079	0.475788286	0.380503079	1E+100
P43	source source	0	-0.609252878	0	0.609252878	1E+100
Q43	source shareholder	0	-1.213528503	-0.56561559	1.213528503	1E+100
R43	source network	0	-0.273155166	0.209497625	0.273155166	1E+100
S43	source competition	0	-1.032497198	-0.243828664	1.032497198	1E+100
T43	source investor	0	-1.284828608	-0.457290426	1.284828608	1E+100
U43	source media	0	-0.653719899	-0.08855915	0.653719899	1E+100
V43	source staff	0	-0.665599096	-0.252744694	0.665599096	1E+100
W43	source purchase	0	-0.238902611	0.409386112	0.238902611	1E+100
B44	shareholder employee	1	0	0.459447363	1E+100	0.224941849
C44	shareholder people	0	-1.101691945	-0.24540058	1.101691945	1E+100
D44	shareholder supplier	0	-1.142016963	-0.49372824	1.142016963	1E+100
E44	shareholder management	1	0	0.647912913	1E+100	0.154356907

F44	shareholder customer	0	-0.523925714	0.114353457	0.523925714	1E+100
G44	shareholder market	0	-0.938966229	-0.300687058	0.938966229	1E+100
H44	shareholder quality	0	-0.480273645	0.430359139	0.480273645	1E+100
I44	shareholder operation	0	-0.860791193	-0.072122659	0.860791193	1E+100
J44	shareholder government	0	-0.970201971	-0.257673583	0.970201971	1E+100
K44	shareholder supply	0	-1.01879236	-0.411238662	1.01879236	1E+100
L44	shareholder stakeholder	0	-0.933995566	-0.154883308	0.933995566	1E+100
M44	shareholder chain	0	-1.184778172	-0.577224474	1.184778172	1E+100
N44	shareholder society	0	-0.651522836	0.259109948	0.651522836	1E+100
O44	shareholder transport	0	-1.153671101	-0.297379736	1.153671101	1E+100
P44	shareholder source	0	-1.174868468	-0.56561559	1.174868468	1E+100
Q44	shareholder shareholder	0	-0.647912913	0	0.647912913	1E+100
R44	shareholder network	0	-0.901143009	-0.418490218	0.901143009	1E+100
S44	shareholder competition	0	-1.020842241	-0.232173707	1.020842241	1E+100
T44	shareholder investor	0	-0.338457744	0.489080438	0.338457744	1E+100
U44	shareholder media	0	-0.32183798	0.243322769	0.32183798	1E+100

V44	shareholder staff	0	- 0.262536614	0.150317788	0.262536614	1E+100
W44	shareholder purchase	0	- 0.889654978	- 0.241366255	0.889654978	1E+100
B45	network employee	0	- 0.738602544	- 0.279155181	0.738602544	1E+100
C45	network people	0	- 1.021940284	- 0.165648919	1.021940284	1E+100
D45	network supplier	0	- 0.345353176	0.302935547	0.345353176	1E+100
E45	network management	0	- 0.727228045	- 0.079315132	0.727228045	1E+100
F45	network customer	0	- 0.432784028	0.205495143	0.432784028	1E+100
G45	network market	0	- 0.671486068	- 0.033206897	0.671486068	1E+100
H45	network quality	0	- 1.203640047	- 0.293007263	1.203640047	1E+100
I45	network operation	0	- 0.852745763	- 0.064077229	0.852745763	1E+100
J45	network government	0	- 0.750375462	- 0.037847074	0.750375462	1E+100
K45	network supply	0	- 0.124900907	0.482652791	0.124900907	1E+100
L45	network stakeholder	0	- 0.918048226	- 0.138935968	0.918048226	1E+100
M45	network chain	0	- 0.145786982	0.461766716	0.145786982	1E+100
N45	network society	0	-0.95372304	- 0.043090256	0.95372304	1E+100
O45	network transport	0	-	0.094909282	0.761382083	1E+100

			0.761382083			
P45	network source	0	-0.399755253	0.209497625	0.399755253	1E+100
Q45	network shareholder	0	-1.066403131	-0.418490218	1.066403131	1E+100
R45	network network	0	-0.482652791	0	0.482652791	1E+100
S45	network competition	0	-0.630393734	0.1582748	0.630393734	1E+100
T45	network investor	0	-0.762464034	0.065074148	0.762464034	1E+100
U45	network media	0	-0.685818587	-0.120657838	0.685818587	1E+100
V45	network staff	0	-0.572673602	-0.1598192	0.572673602	1E+100
W45	network purchase	0	-0.83213055	-0.183841827	0.83213055	1E+100
B46	competition employee	0	-0.769977408	-0.310530045	0.769977408	1E+100
C46	competition people	0	-1.124207049	-0.267915684	1.124207049	1E+100
D46	competition supplier	0	-0.821921129	-0.173632406	0.821921129	1E+100
E46	competition management	0	-0.506110932	0.141801981	0.506110932	1E+100
F46	competition customer	0	-0.768123351	-0.12984418	0.768123351	1E+100
G46	competition market	0	-0.696566528	-0.058287357	0.696566528	1E+100
H46	competition quality	0	-0.810572252	0.100060532	0.810572252	1E+100

I46	competition operation	1	0	0.788668534	1E+100	0.009556276
J46	competition government	0	-0.05763529	0.654893098	0.05763529	1E+100
K46	competition supply	0	-0.245229084	0.362324614	0.245229084	1E+100
L46	competition stakeholder	0	-0.055098797	0.724013461	0.055098797	1E+100
M46	competition chain	0	-0.370238781	0.237314917	0.370238781	1E+100
N46	competition society	0	-0.651716358	0.258916426	0.651716358	1E+100
O46	competition transport	0	-1.066948741	-0.210657376	1.066948741	1E+100
P46	competition source	0	-0.853081542	-0.243828664	0.853081542	1E+100
Q46	competition shareholder	0	-0.88008662	-0.232173707	0.88008662	1E+100
R46	competition network	0	-0.324377991	0.1582748	0.324377991	1E+100
S46	competition competition	0	-0.788668534	0	0.788668534	1E+100
T46	competition investor	0	-0.707032377	0.120505805	0.707032377	1E+100
U46	competition media	0	-0.356130182	0.209030567	0.356130182	1E+100
V46	competition staff	0	-0.436947148	-0.024092746	0.436947148	1E+100
W46	competition purchase	0	-0.58493704	0.063351683	0.58493704	1E+100
B47	investor employee	0	-0.224941849	0.234505514	0.224941849	1E+100
C47	investor people	0	-1.061401288	-0.205109923	1.061401288	1E+100

D47	investor supplier	0	-0.863094062	-0.214805339	0.863094062	1E+100
E47	investor management	0	-0.470051532	0.177861381	0.470051532	1E+100
F47	investor customer	0	-0.211674763	0.426604408	0.211674763	1E+100
G47	investor market	0	-0.741891784	-0.103612613	0.741891784	1E+100
H47	investor quality	0	-0.189140093	0.721492691	0.189140093	1E+100
I47	investor operation	0	-0.623261619	0.165406915	0.623261619	1E+100
J47	investor government	0	-0.823911969	-0.111383581	0.823911969	1E+100
K47	investor supply	0	-1.022510605	-0.414956907	1.022510605	1E+100
L47	investor stakeholder	0	-0.824441991	-0.045329733	0.824441991	1E+100
M47	investor chain	0	-0.974999396	-0.367445698	0.974999396	1E+100
N47	investor society	0	-0.083094602	0.827538182	0.083094602	1E+100
O47	investor transport	0	-0.775305896	0.080985469	0.775305896	1E+100
P47	investor source	0	-1.066543304	-0.457290426	1.066543304	1E+100
Q47	investor shareholder	0	-0.158832475	0.489080438	0.158832475	1E+100
R47	investor network	0	-0.417578643	0.065074148	0.417578643	1E+100
S47	investor competition	0	-	0.120505805	0.668162729	1E+100

			0.668162729			
T47	investor investor	0	-0.827538182	0	0.827538182	1E+100
U47	investor media	0	-0.914408072	-0.349247323	0.914408072	1E+100
V47	investor staff	0	-0.262204727	0.150649675	0.262204727	1E+100
W47	investor purchase	0	-0.958576888	-0.310288165	0.958576888	1E+100
B48	media employee	0	-0.681578534	-0.222131171	0.681578534	1E+100
C48	media people	0	-1.086948919	-0.230657554	1.086948919	1E+100
D48	media supplier	0	-1.099262942	-0.450974219	1.099262942	1E+100
E48	media management	0	-0.154356907	0.493556006	0.154356907	1E+100
F48	media customer	0	-1.126868194	-0.488589023	1.126868194	1E+100
G48	media market	0	-0.731252302	-0.092973131	0.731252302	1E+100
H48	media quality	0	-1.183405429	-0.272772645	1.183405429	1E+100
I48	media operation	0	-0.350522713	0.438145821	0.350522713	1E+100
J48	media government	0	-0.147367639	0.565160749	0.147367639	1E+100
K48	media supply	0	-0.321029191	0.286524507	0.321029191	1E+100
L48	media stakeholder	0	-0.398507805	0.380604453	0.398507805	1E+100

M48	media chain	0	- 0.580453153	0.027100545	0.580453153	1E+100
N48	media society	0	- 1.158757752	- 0.248124968	1.158757752	1E+100
O48	media transport	0	- 1.158971644	- 0.302680279	1.158971644	1E+100
P48	media source	0	- 0.697812028	-0.08855915	0.697812028	1E+100
Q48	media shareholder	0	- 0.404590144	0.243322769	0.404590144	1E+100
R48	media network	0	- 0.603310629	- 0.120657838	0.603310629	1E+100
S48	media competition	0	- 0.579637967	0.209030567	0.579637967	1E+100
T48	media investor	0	- 1.176785505	- 0.349247323	1.176785505	1E+100
U48	media media	0	- 0.565160749	0	0.565160749	1E+100
V48	media staff	0	- 0.602542564	- 0.189688162	0.602542564	1E+100
W48	media purchase	0	- 0.781325287	- 0.133036564	0.781325287	1E+100
B49	staff employee	0	- 0.692602009	- 0.233154646	0.692602009	1E+100
C49	staff people	0	- 1.083256944	- 0.226965579	1.083256944	1E+100
D49	staff supplier	0	-0.779124	- 0.130835277	0.779124	1E+100
E49	staff management	0	- 0.302389177	0.345523736	0.302389177	1E+100
F49	staff customer	0	-	0.025632836	0.612646335	1E+100

			0.612646335			
G49	staff market	0	-0.934899241	-0.29662007	0.934899241	1E+100
H49	staff quality	0	-0.497778382	0.412854402	0.497778382	1E+100
I49	staff operation	0	-0.977271012	-0.188602478	0.977271012	1E+100
J49	staff government	0	-0.614047863	0.098480525	0.614047863	1E+100
K49	staff supply	0	-0.827617469	-0.220063771	0.827617469	1E+100
L49	staff stakeholder	0	-0.73714331	0.041968948	0.73714331	1E+100
M49	staff chain	0	-1.125725225	-0.518171527	1.125725225	1E+100
N49	staff society	0	-0.578259649	0.332373135	0.578259649	1E+100
O49	staff transport	0	-0.913092918	-0.056801553	0.913092918	1E+100
P49	staff source	0	-0.861997572	-0.252744694	0.861997572	1E+100
Q49	staff shareholder	0	-0.497595125	0.150317788	0.497595125	1E+100
R49	staff network	0	-0.642471991	-0.1598192	0.642471991	1E+100
S49	staff competition	0	-0.81276128	-0.024092746	0.81276128	1E+100
T49	staff investor	0	-0.676888507	0.150649675	0.676888507	1E+100
U49	staff media	0	-0.754848911	-0.189688162	0.754848911	1E+100
V49	staff staff	0	-	0	0.412854402	1E+100

			0.412854402			
W49	staff purchase	0	-0.580683629	0.067605094	0.580683629	1E+100
B50	purchase employee	0	-0.408257274	0.051190089	0.408257274	1E+100
C50	purchase people	0	-0.755494633	0.100796732	0.755494633	1E+100
D50	purchase supplier	1	0	0.648288723	1E+100	0.039035845
E50	purchase management	0	-0.679931787	-0.032018874	0.679931787	1E+100
F50	purchase customer	0	-1.101714296	-0.463435125	1.101714296	1E+100
G50	purchase market	0	-1.031506465	-0.393227294	1.031506465	1E+100
H50	purchase quality	0	-0.757570477	0.153062307	0.757570477	1E+100
I50	purchase operation	0	-0.861324071	-0.072655537	0.861324071	1E+100
J50	purchase government	0	-0.621514154	0.091014234	0.621514154	1E+100
K50	purchase supply	0	-0.117465548	0.49008815	0.117465548	1E+100
L50	purchase stakeholder	0	-1.021884583	-0.242772325	1.021884583	1E+100
M50	purchase chain	0	-0.5295127	0.078040998	0.5295127	1E+100
N50	purchase society	0	-0.923670862	-0.013038078	0.923670862	1E+100
O50	purchase transport	0	-0.875134729	-0.018843364	0.875134729	1E+100
P50	purchase source	0	-0.199866766	0.409386112	0.199866766	1E+100

Q50	purchase shareholder	0	-0.889279168	-0.241366255	0.889279168	1E+100
R50	purchase network	0	-0.666494618	-0.183841827	0.666494618	1E+100
S50	purchase competition	0	-0.725316851	0.063351683	0.725316851	1E+100
T50	purchase investor	0	-1.137826347	-0.310288165	1.137826347	1E+100
U50	purchase media	0	-0.698197313	-0.133036564	0.698197313	1E+100
V50	purchase staff	0	-0.345249308	0.067605094	0.345249308	1E+100
W50	purchase purchase	0	-0.648288723	0	0.648288723	1E+100

Constraints

Cell	**Name**	**Final Value**	**Shadow Price**	**Constraint R.H. Side**	**Allowable Increase**	**Allowable Decrease**
B51	employee	1	0.459447363	1	0	1
C51	people	1	0.856291365	1	0	1
D51	supplier	1	0.648288723	1	0	1
E51	management	1	0.647912913	1	0	1
F51	customer	1	0.638279171	1	0	1
G51	market	1	0.638279171	1	0	1
H51	quality	1	0.910632784	1	0	1
I51	operation	1	0.788668534	1	0	1
J51	government	1	0.712528388	1	0	1
K51	supply	1	0.607553698	1	0	1
L51	stakeholder	1	0.779112258	1	0	1

M51	chain	1	0.607553698	1	0	1
N51	society	1	0.910632784	1	0	1
O51	transport	1	0.856291365	1	0	1
P51	source	1	0.609252878	1	0	1
Q51	shareholder	1	0.647912913	1	0	1
R51	network	1	0.482652791	1	0	1
S51	competition	1	0.788668534	1	0	1
T51	investor	1	0.827538182	1	0	1
U51	media	1	0.565160749	1	0	1
V51	staff	1	0.412854402	1	0	1
W51	purchase	1	0.648288723	1	0	1

APPENDIX 2:

Solution to LP Model Used to Generate 7 Clusters of Keywords and Influential Words having Maximum Correlation

	31.86030495						
						operation	
						government	
		supplier	management		quality	stakeholder	supply
	people	source	shareholder	customer	society	competition	chain
	transport	purchase	employee	market	investor	media	network
	Average 1	Average 2	Average 3	Average 4	Average 5	Average 6	Average 7
product	0.75968611	0.209747901	-0.15589081	-0.233413637	-0.331340897	-0.352185057	-0.033981958
company	-0.453968656	-0.167755342	0.335856027	0.063215733	0.096988554	0.464463411	-0.359578319
business	-0.567773266	-0.003905594	0.165540661	0.433523797	-0.110677747	0.315816756	-0.199965503
program	-0.582723793	0.087016505	0.307891378	0.007850562	-0.0314524	-0.004292772	-0.035263967
water	0.662041121	0.141933008	-0.408036943	-0.225167821	-0.337076019	0.236499651	0.147335939
global	-0.377622521	0.123575336	0.195322255	0.347977528	0.344784463	0.175287614	-0.404116795
health	0.111988738	0.115104562	0.257570993	-0.416230458	-0.288824514	-0.127087769	-0.078720443
system	-0.359478265	-0.128356999	0.013753883	0.49324854	0.609100627	0.307511522	-0.133155923
energy	-0.142735412	0.388857403	-0.218240092	0.600324536	-0.290934163	-0.301463607	0.182333289
new	-0.294124923	-0.154110462	-0.129039161	0.630670316	0.163654441	0.089890691	0.037647615
world	0.681884282	0.283931925	-0.357484694	0.114970363	-0.299226428	-0.016668048	-0.0909718
year	-0.41314973	0.115056097	-0.017638867	0.728552489	-0.1076853	-0.109769887	-0.163364555
consumer	0.837552091	0.410417354	-0.293341832	-0.228999516	-0.232827401	-0.286437955	-0.030987804
information	0.054373589	-0.22903195	-0.040407693	0.075859644	0.130124728	-0.008629269	0.454309234
technology	-0.409145684	0.113533803	-0.062011421	0.641242296	0.084328143	-0.065766686	0.186569719
material	0.753725727	-0.073544114	-0.036387606	-0.292650094	-0.102147473	-0.319802335	0.138282683
development	0.16983594	-0.33960798	0.011721482	-0.037774693	0.242624561	0.42939164	-0.122885642
sustainable	0.925963766	0.228894278	-0.371572984	-0.07316499	-0.209101254	-0.2665344	0.029574127

community	-0.236492189	0.218912653	-0.021450761	-0.275529448	-0.164611511	0.305367997	-0.130413731
food	0.061833539	0.684197057	-0.025304582	-0.303700418	0.020147194	-0.230470266	-0.152987426
corporate	-0.509687427	-0.008931969	0.356360366	0.133060352	0.145529197	0.015221375	-0.136200762
report	-0.324641603	-0.320941024	0.179899842	-0.191996897	0.015927518	0.430739826	-0.080095313
country	0.786289481	0.353060649	-0.562770192	-0.261807834	-0.276519767	-0.029324963	0.11631826
waste	0.644445357	0.518232492	-0.175911881	-0.328041841	-0.148995159	-0.471184161	-0.061287779
performance	-0.444367335	0.282838277	-0.105860109	0.640730951	-0.203095723	-0.116908334	-0.007843677
facility	0.035587722	0.625861524	-0.015621331	0.124171407	-0.19611662	-0.31135214	-0.055683748
service	-0.475360057	-0.169213618	0.138501619	0.625784856	0.101484338	-0.108908914	-0.004996164
safety	-0.264763781	-0.121696369	0.437581995	-0.207196073	0.256143711	-0.180630506	-0.332268009
goal	0.633133576	0.147851718	-0.149822058	-0.304802326	-0.366819889	0.051412387	0.121586201
data	-0.173635094	-0.039597955	-0.134406619	-0.220783025	-0.276019485	-0.064214894	0.577189302
activity	-0.102854078	-0.417962367	0.311927464	0.176055926	0.860510715	0.028489305	-0.366041178
local	-0.295419735	0.338516562	0.001294593	-0.361142697	-0.085698351	0.263321118	-0.060988607
policy	-0.454076905	0.053758918	0.379307439	-0.463671715	-0.269035985	0.160249576	0.159013977
group	-0.302416347	-0.32567024	0.189737272	0.077142042	0.497126133	0.295799774	0.033966432
area	0.308341612	0.024008334	-0.112000953	-0.184860741	0.190161392	0.278359094	0.402970815
emission	-0.003988467	0.033410426	0.189695936	0.100279232	0.373081927	-0.22864514	0.034780771
part	0.234828471	0.158603594	-0.036520292	0.107199939	0.787718073	0.135887657	-0.219660682
packaging	0.860234125	0.370563254	-0.376955091	-0.230244356	-0.24702131	-0.141260948	0.01593868
initiative	-0.342521579	-0.07796296	-0.024306501	-0.25033807	-0.200518766	0.445753456	0.154011999
standard	-0.444748907	0.153719275	0.377489659	-0.488427015	-0.176939669	-0.080075608	0.002718624
organization	-0.433838694	0.153954323	0.22600718	-0.284106723	0.04280848	-0.057046959	0.357750141
work	-0.264434269	-0.064189802	0.067450807	-0.366423985	-0.116004394	0.411113595	-0.096480243
high	-0.2677092	-0.223815134	0.258776989	0.184898384	0.053324777	-0.265886529	-0.161020609
number	0.860275754	0.157113052	-0.48040625	-0.094817288	-0.226346306	-0.158819203	0.19227715
site	-0.331986938	-0.298139961	0.116177554	-0.131432721	-0.131569095	-0.106405443	0.108246926
project	-0.563117141	-0.172829968	0.006296407	0.064295294	-0.21290028	0.40703116	0.181093865
total	-0.198039753	-0.319721739	0.226361297	-0.285648425	-0.160161445	0.154980517	0.041774828

change	0.256714386	0.0015994	-0.29365714	0.395053871	-0.120016422	-0.137568572	0.08446638
environment	-0.314316408	-0.410280165	0.408831921	0.333225367	0.721935921	-0.061937513	-0.216307463
industry	-0.346690371	0.635895596	-0.262335264	0.018233049	-0.192811313	0.062464676	0.384547206
education	-0.448631427	-0.059784844	0.150325858	-0.154395713	-0.048964456	0.225404488	0.199625336
effort	-0.262025613	0.061920036	0.390531698	-0.302028713	0.489288534	0.286940073	-0.260748641
approach	0.884385106	0.115374827	-0.241154039	-0.259001817	-0.178179286	-0.341477582	0.097714911
process	-0.474196668	-0.393994015	0.32082383	-0.322274306	0.002873753	0.205119941	0.106190959
resource	-0.315696901	0.137046143	0.040752235	-0.149012632	0.448244957	0.52717949	0.175084688
large	0.359308118	0.182518672	-0.174891539	0.215112063	-0.424946976	-0.336737381	-0.089723437
leader	-0.319749005	0.062605981	-0.004547051	0.718476594	-0.175792173	-0.268599112	-0.119500142
partnership	0.045633953	0.451717231	-0.240377174	-0.367050588	-0.124433579	0.394044958	-0.059154569
impact	0.563500659	0.189021114	-0.416837322	-0.314123461	-0.329138845	0.088556147	0.502470708
social	-0.602918271	-0.147531452	0.333586489	0.196378211	0.00028669	-0.056401109	0.148107401

	people transport Average 1	supplier source purchase Average 2	management shareholder employee Average 3	customer market Average 4	quality society investor Average 5	operation government stakeholder competition media Average 6	supply chain network Average 7	
product	1	0	0	0	0	0	0	1
company	0	0	0	0	0	1	0	1
business	0	0	0	1	0	0	0	1
program	0	0	1	0	0	0	0	1
water	1	0	0	0	0	0	0	1
global	0	0	0	1	0	0	0	1
health	0	0	1	0	0	0	0	1

system	0	0	0	0	1	0	0	1
energy	0	0	0	1	0	0	0	1
new	0	0	0	1	0	0	0	1
world	1	0	0	0	0	0	0	1
year	0	0	0	1	0	0	0	1
consumer	1	0	0	0	0	0	0	1
information	0	0	0	0	0	0	1	1
technology	0	0	0	1	0	0	0	1
material	1	0	0	0	0	0	0	1
development	0	0	0	0	0	1	0	1
sustainable	1	0	0	0	0	0	0	1
community	0	0	0	0	0	1	0	1
food	0	1	0	0	0	0	0	1
corporate	0	0	1	0	0	0	0	1
report	0	0	0	0	0	1	0	1
country	1	0	0	0	0	0	0	1
waste	1	0	0	0	0	0	0	1
performance	0	0	0	1	0	0	0	1
facility	0	1	0	0	0	0	0	1
service	0	0	0	1	0	0	0	1
safety	0	0	1	0	0	0	0	1
goal	1	0	0	0	0	0	0	1
data	0	0	0	0	0	0	1	1
activity	0	0	0	0	1	0	0	1
local	0	1	0	0	0	0	0	1
policy	0	0	1	0	0	0	0	1
group	0	0	0	0	1	0	0	1
area	0	0	0	0	0	0	1	1
emission	0	0	0	0	1	0	0	1

part	0	0	0	0	1	0	0	1
packaging	1	0	0	0	0	0	0	1
initiative	0	0	0	0	0	1	0	1
standard	0	0	1	0	0	0	0	1
organization	0	0	0	0	0	0	1	1
work	0	0	0	0	0	1	0	1
high	0	0	1	0	0	0	0	1
number	1	0	0	0	0	0	0	1
site	0	0	1	0	0	0	0	1
project	0	0	0	0	0	1	0	1
total	0	0	1	0	0	0	0	1
change	0	0	0	1	0	0	0	1
environment	0	0	0	0	1	0	0	1
industry	0	1	0	0	0	0	0	1
education	0	0	0	0	0	1	0	1
effort	0	0	0	0	1	0	0	1
approach	1	0	0	0	0	0	0	1
process	0	0	1	0	0	0	0	1
resource	0	0	0	0	0	1	0	1
large	1	0	0	0	0	0	0	1
leader	0	0	0	1	0	0	0	1
partnership	0	1	0	0	0	0	0	1
impact	1	0	0	0	0	0	0	1
social	0	0	1	0	0	0	0	1
	14	5	11	10	7	9	4	

Microsoft Excel 14.0 Sensitivity Report

Worksheet: [Keyword clusters vs most influential 04_11_2013.xlsx]7 clusters x 60

Report Created: 4/11/2013 1:46:04 PM

Engine: Gurobi Solver

Objective Cell (Max)

Cell	Name	Final Value
B1		31.86030495

Decision Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
B76	product Average 1	1	0	0.75968611	1E+100	0.549938208
C76	product Average 2	0	-0.549938208	0.209747901	0.549938208	1E+100
D76	product Average 3	0	-0.915576919	-0.15589081	0.915576919	1E+100
E76	product Average 4	0	-0.993099746	-0.233413637	0.993099746	1E+100
F76	product Average 5	0	-1.091027006	-0.331340897	1.091027006	1E+100
G76	product Average 6	0	-1.111871167	-0.352185057	1.111871167	1E+100
H76	product Average 7	0	-0.793668068	-0.033981958	0.793668068	1E+100
B77	company Average 1	0	-0.918432066	-0.453968656	0.918432066	1E+100
C77	company Average 2	0	-0.632218753	-0.167755342	0.632218753	1E+100

D77	company Average 3	0	-0.128607383	0.335856027	0.128607383	1E+100
E77	company Average 4	0	-0.401247678	0.063215733	0.401247678	1E+100
F77	company Average 5	0	-0.367474856	0.096988554	0.367474856	1E+100
G77	company Average 6	1	0	0.464463411	1E+100	0.128607383
H77	company Average 7	0	-0.824041729	-0.359578319	0.824041729	1E+100
B78	business Average 1	0	-1.001297062	-0.567773266	1.001297062	1E+100
C78	business Average 2	0	-0.43742939	-0.003905594	0.43742939	1E+100
D78	business Average 3	0	-0.267983135	0.165540661	0.267983135	1E+100
E78	business Average 4	1	0	0.433523797	1E+100	0.117707041
F78	business Average 5	0	-0.544201544	-0.110677747	0.544201544	1E+100
G78	business Average 6	0	-0.117707041	0.315816756	0.117707041	1E+100
H78	business Average 7	0	-0.6334893	-0.199965503	0.6334893	1E+100
B79	program Average 1	0	-0.89061517	-0.582723793	0.89061517	1E+100
C79	program Average 2	0	-0.220874873	0.087016505	0.220874873	1E+100
D79	program Average 3	1	0	0.307891378	1E+100	0.220874873
E79	program Average 4	0	-0.300040816	0.007850562	0.300040816	1E+100
F79	program Average 5	0	-0.339343778	-0.0314524	0.339343778	1E+100

G79	program Average 6	0	-0.31218415	-0.004292772	0.31218415	1E+100
H79	program Average 7	0	-0.343155345	-0.035263967	0.343155345	1E+100
B80	water Average 1	1	0	0.662041121	1E+100	0.42554147
C80	water Average 2	0	-0.520108113	0.141933008	0.520108113	1E+100
D80	water Average 3	0	-1.070078064	-0.408036943	1.070078064	1E+100
E80	water Average 4	0	-0.887208942	-0.225167821	0.887208942	1E+100
F80	water Average 5	0	-0.99911714	-0.337076019	0.99911714	1E+100
G80	water Average 6	0	-0.42554147	0.236499651	0.42554147	1E+100
H80	water Average 7	0	-0.514705182	0.147335939	0.514705182	1E+100
B81	global Average 1	0	-0.725600049	-0.377622521	0.725600049	1E+100
C81	global Average 2	0	-0.224402192	0.123575336	0.224402192	1E+100
D81	global Average 3	0	-0.152655273	0.195322255	0.152655273	1E+100
E81	global Average 4	1	0	0.347977528	1E+100	0.003193065
F81	global Average 5	0	-0.003193065	0.344784463	0.003193065	1E+100
G81	global Average 6	0	-0.172689914	0.175287614	0.172689914	1E+100
H81	global Average 7	0	-0.752094323	-0.404116795	0.752094323	1E+100
B82	health Average 1	0	-0.145582255	0.111988738	0.145582255	1E+100

C82	health Average 2	0	-0.142466431	0.115104562	0.142466431	1E+100
D82	health Average 3	1	0	0.257570993	1E+100	0.142466431
E82	health Average 4	0	-0.67380145	-0.416230458	0.67380145	1E+100
F82	health Average 5	0	-0.546395506	-0.288824514	0.546395506	1E+100
G82	health Average 6	0	-0.384658761	-0.127087769	0.384658761	1E+100
H82	health Average 7	0	-0.336291436	-0.078720443	0.336291436	1E+100
B83	system Average 1	0	-0.968578892	-0.359478265	0.968578892	1E+100
C83	system Average 2	0	-0.737457626	-0.128356999	0.737457626	1E+100
D83	system Average 3	0	-0.595346744	0.013753883	0.595346744	1E+100
E83	system Average 4	0	-0.115852087	0.49324854	0.115852087	1E+100
F83	system Average 5	1	0	0.609100627	1E+100	0.115852087
G83	system Average 6	0	-0.301589105	0.307511522	0.301589105	1E+100
H83	system Average 7	0	-0.74225655	-0.133155923	0.74225655	1E+100
B84	energy Average 1	0	-0.743059948	-0.142735412	0.743059948	1E+100
C84	energy Average 2	0	-0.211467132	0.388857403	0.211467132	1E+100
D84	energy Average 3	0	-0.818564628	-0.218240092	0.818564628	1E+100
E84	energy Average 4	1	0	0.600324536	1E+100	0.211467132

F84	energy Average 5	0	-0.891258699	-0.290934163	0.891258699	1E+100
G84	energy Average 6	0	-0.901788143	-0.301463607	0.901788143	1E+100
H84	energy Average 7	0	-0.417991247	0.182333289	0.417991247	1E+100
B85	new Average 1	0	-0.924795239	-0.294124923	0.924795239	1E+100
C85	new Average 2	0	-0.784780778	-0.154110462	0.784780778	1E+100
D85	new Average 3	0	-0.759709477	-0.129039161	0.759709477	1E+100
E85	new Average 4	1	0	0.630670316	1E+100	0.467015875
F85	new Average 5	0	-0.467015875	0.163654441	0.467015875	1E+100
G85	new Average 6	0	-0.540779625	0.089890691	0.540779625	1E+100
H85	new Average 7	0	-0.593022701	0.037647615	0.593022701	1E+100
B86	world Average 1	1	0	0.681884282	1E+100	0.397952356
C86	world Average 2	0	-0.397952356	0.283931925	0.397952356	1E+100
D86	world Average 3	0	-1.039368975	-0.357484694	1.039368975	1E+100
E86	world Average 4	0	-0.566913919	0.114970363	0.566913919	1E+100
F86	world Average 5	0	-0.98111071	-0.299226428	0.98111071	1E+100
G86	world Average 6	0	-0.69855233	-0.016668048	0.69855233	1E+100
H86	world Average 7	0	-	-0.0909718	0.772856082	1E+100

			0.772856082			
B87	year Average 1	0	-1.141702219	-0.41314973	1.141702219	1E+100
C87	year Average 2	0	-0.613496392	0.115056097	0.613496392	1E+100
D87	year Average 3	0	-0.746191356	-0.017638867	0.746191356	1E+100
E87	year Average 4	1	0	0.728552489	1E+100	0.613496392
F87	year Average 5	0	-0.836237789	-0.1076853	0.836237789	1E+100
G87	year Average 6	0	-0.838322376	-0.109769887	0.838322376	1E+100
H87	year Average 7	0	-0.891917044	-0.163364555	0.891917044	1E+100
B88	consumer Average 1	1	0	0.837552091	1E+100	0.427134737
C88	consumer Average 2	0	-0.427134737	0.410417354	0.427134737	1E+100
D88	consumer Average 3	0	-1.130893923	-0.293341832	1.130893923	1E+100
E88	consumer Average 4	0	-1.066551607	-0.228999516	1.066551607	1E+100
F88	consumer Average 5	0	-1.070379492	-0.232827401	1.070379492	1E+100
G88	consumer Average 6	0	-1.123990046	-0.286437955	1.123990046	1E+100
H88	consumer Average 7	0	-0.868539895	-0.030987804	0.868539895	1E+100
B89	information Average 1	0	-0.399935645	0.054373589	0.399935645	1E+100
C89	information Average 2	0	-0.683341184	-0.22903195	0.683341184	1E+100

D89	information Average 3	0	-0.494716927	-0.040407693	0.494716927	1E+100
E89	information Average 4	0	-0.37844959	0.075859644	0.37844959	1E+100
F89	information Average 5	0	-0.324184505	0.130124728	0.324184505	1E+100
G89	information Average 6	0	-0.462938502	-0.008629269	0.462938502	1E+100
H89	information Average 7	1	0	0.454309234	1E+100	0.324184505
B90	technology Average 1	0	-1.05038798	-0.409145684	1.05038798	1E+100
C90	technology Average 2	0	-0.527708493	0.113533803	0.527708493	1E+100
D90	technology Average 3	0	-0.703253717	-0.062011421	0.703253717	1E+100
E90	technology Average 4	1	0	0.641242296	1E+100	0.454672577
F90	technology Average 5	0	-0.556914153	0.084328143	0.556914153	1E+100
G90	technology Average 6	0	-0.707008982	-0.065766686	0.707008982	1E+100
H90	technology Average 7	0	-0.454672577	0.186569719	0.454672577	1E+100
B91	material Average 1	1	0	0.753725727	1E+100	0.615443044
C91	material Average 2	0	-0.827269841	-0.073544114	0.827269841	1E+100
D91	material Average 3	0	-0.790113333	-0.036387606	0.790113333	1E+100
E91	material Average 4	0	-1.046375821	-0.292650094	1.046375821	1E+100
F91	material Average 5	0	-0.8558732	-0.102147473	0.8558732	1E+100
G91	material Average 6	0	-	-	1.073528062	1E+100

			1.073528062	0.319802335		
H91	material Average 7	0	- 0.615443044	0.138282683	0.615443044	1E+100
B92	development Average 1	0	- 0.259555701	0.16983594	0.259555701	1E+100
C92	development Average 2	0	-0.76899962	-0.33960798	0.76899962	1E+100
D92	development Average 3	0	- 0.417670158	0.011721482	0.417670158	1E+100
E92	development Average 4	0	- 0.467166333	- 0.037774693	0.467166333	1E+100
F92	development Average 5	0	- 0.186767079	0.242624561	0.186767079	1E+100
G92	development Average 6	1	0	0.42939164	1E+100	0.186767079
H92	development Average 7	0	- 0.552277282	- 0.122885642	0.552277282	1E+100
B93	sustainable Average 1	1	0	0.925963766	1E+100	0.697069488
C93	sustainable Average 2	0	- 0.697069488	0.228894278	0.697069488	1E+100
D93	sustainable Average 3	0	-1.29753675	- 0.371572984	1.29753675	1E+100
E93	sustainable Average 4	0	- 0.999128756	-0.07316499	0.999128756	1E+100
F93	sustainable Average 5	0	-1.13506502	- 0.209101254	1.13506502	1E+100
G93	sustainable Average 6	0	- 1.192498166	-0.2665344	1.192498166	1E+100
H93	sustainable Average 7	0	- 0.896389639	0.029574127	0.896389639	1E+100
B94	community Average 1	0	- 0.541860186	- 0.236492189	0.541860186	1E+100
C94	community Average 2	0	-	0.218912653	0.086455344	1E+100

			0.086455344			
D94	community Average 3	0	-0.326818759	-0.021450761	0.326818759	1E+100
E94	community Average 4	0	-0.580897445	-0.275529448	0.580897445	1E+100
F94	community Average 5	0	-0.469979509	-0.164611511	0.469979509	1E+100
G94	community Average 6	1	0	0.305367997	1E+100	0.086455344
H94	community Average 7	0	-0.435781729	-0.130413731	0.435781729	1E+100
B95	food Average 1	0	-0.622363519	0.061833539	0.622363519	1E+100
C95	food Average 2	1	0	0.684197057	1E+100	0.622363519
D95	food Average 3	0	-0.70950164	-0.025304582	0.70950164	1E+100
E95	food Average 4	0	-0.987897475	-0.303700418	0.987897475	1E+100
F95	food Average 5	0	-0.664049863	0.020147194	0.664049863	1E+100
G95	food Average 6	0	-0.914667324	-0.230470266	0.914667324	1E+100
H95	food Average 7	0	-0.837184483	-0.152987426	0.837184483	1E+100
B96	corporate Average 1	0	-0.866047793	-0.509687427	0.866047793	1E+100
C96	corporate Average 2	0	-0.365292335	-0.008931969	0.365292335	1E+100
D96	corporate Average 3	1	0	0.356360366	1E+100	0.210831168
E96	corporate Average 4	0	-0.223300014	0.133060352	0.223300014	1E+100
F96	corporate Average 5	0	-	0.145529197	0.210831168	1E+100

			0.210831168			
G96	corporate Average 6	0	-0.34113899	0.015221375	0.34113899	1E+100
H96	corporate Average 7	0	-0.492561128	-0.136200762	0.492561128	1E+100
B97	report Average 1	0	-0.755381429	-0.324641603	0.755381429	1E+100
C97	report Average 2	0	-0.751680851	-0.320941024	0.751680851	1E+100
D97	report Average 3	0	-0.250839985	0.179899842	0.250839985	1E+100
E97	report Average 4	0	-0.622736723	-0.191996897	0.622736723	1E+100
F97	report Average 5	0	-0.414812308	0.015927518	0.414812308	1E+100
G97	report Average 6	1	0	0.430739826	1E+100	0.250839985
H97	report Average 7	0	-0.51083514	-0.080095313	0.51083514	1E+100
B98	country Average 1	1	0	0.786289481	1E+100	0.433228832
C98	country Average 2	0	-0.433228832	0.353060649	0.433228832	1E+100
D98	country Average 3	0	-1.349059673	-0.562770192	1.349059673	1E+100
E98	country Average 4	0	-1.048097315	-0.261807834	1.048097315	1E+100
F98	country Average 5	0	-1.062809248	-0.276519767	1.062809248	1E+100
G98	country Average 6	0	-0.815614444	-0.029324963	0.815614444	1E+100
H98	country Average 7	0	-0.669971221	0.11631826	0.669971221	1E+100
B99	waste Average 1	1	0	0.644445357	1E+100	0.126212865

C99	waste Average 2	0	-0.126212865	0.518232492	0.126212865	1E+100
D99	waste Average 3	0	-0.820357238	-0.175911881	0.820357238	1E+100
E99	waste Average 4	0	-0.972487198	-0.328041841	0.972487198	1E+100
F99	waste Average 5	0	-0.793440516	-0.148995159	0.793440516	1E+100
G99	waste Average 6	0	-1.115629518	-0.471184161	1.115629518	1E+100
H99	waste Average 7	0	-0.705733136	-0.061287779	0.705733136	1E+100
B100	performance Average 1	0	-1.085098286	-0.444367335	1.085098286	1E+100
C100	performance Average 2	0	-0.357892674	0.282838277	0.357892674	1E+100
D100	performance Average 3	0	-0.74659106	-0.105860109	0.74659106	1E+100
E100	performance Average 4	1	0	0.640730951	1E+100	0.357892674
F100	performance Average 5	0	-0.843826674	-0.203095723	0.843826674	1E+100
G100	performance Average 6	0	-0.757639285	-0.116908334	0.757639285	1E+100
H100	performance Average 7	0	-0.648574628	-0.007843677	0.648574628	1E+100
B101	facility Average 1	0	-0.590273802	0.035587722	0.590273802	1E+100
C101	facility Average 2	1	0	0.625861524	1E+100	0.501690117
D101	facility Average 3	0	-0.641482855	-0.015621331	0.641482855	1E+100
E101	facility Average 4	0	-	0.124171407	0.501690117	1E+100

			0.501690117			
F101	facility Average 5	0	-0.821978144	-0.19611662	0.821978144	1E+100
G101	facility Average 6	0	-0.937213664	-0.31135214	0.937213664	1E+100
H101	facility Average 7	0	-0.681545272	-0.055683748	0.681545272	1E+100
B102	service Average 1	0	-1.101144913	-0.475360057	1.101144913	1E+100
C102	service Average 2	0	-0.794998474	-0.169213618	0.794998474	1E+100
D102	service Average 3	0	-0.487283237	0.138501619	0.487283237	1E+100
E102	service Average 4	1	0	0.625784856	1E+100	0.487283237
F102	service Average 5	0	-0.524300518	0.101484338	0.524300518	1E+100
G102	service Average 6	0	-0.73469377	-0.108908914	0.73469377	1E+100
H102	service Average 7	0	-0.63078102	-0.004996164	0.63078102	1E+100
B103	safety Average 1	0	-0.702345776	-0.264763781	0.702345776	1E+100
C103	safety Average 2	0	-0.559278364	-0.121696369	0.559278364	1E+100
D103	safety Average 3	1	0	0.437581995	1E+100	0.181438284
E103	safety Average 4	0	-0.644778068	-0.207196073	0.644778068	1E+100
F103	safety Average 5	0	-0.181438284	0.256143711	0.181438284	1E+100
G103	safety Average 6	0	-0.618212501	-0.180630506	0.618212501	1E+100

H103	safety Average 7	0	-0.769850004	-0.332268009	0.769850004	1E+100
B104	goal Average 1	1	0	0.633133576	1E+100	0.485281857
C104	goal Average 2	0	-0.485281857	0.147851718	0.485281857	1E+100
D104	goal Average 3	0	-0.782955634	-0.149822058	0.782955634	1E+100
E104	goal Average 4	0	-0.937935902	-0.304802326	0.937935902	1E+100
F104	goal Average 5	0	-0.999953464	-0.366819889	0.999953464	1E+100
G104	goal Average 6	0	-0.581721188	0.051412387	0.581721188	1E+100
H104	goal Average 7	0	-0.511547374	0.121586201	0.511547374	1E+100
B105	data Average 1	0	-0.173635094	-0.173635094	0.173635094	1E+100
C105	data Average 2	0	-0.039597955	-0.039597955	0.039597955	1E+100
D105	data Average 3	0	-0.134406619	-0.134406619	0.134406619	1E+100
E105	data Average 4	0	-0.220783025	-0.220783025	0.220783025	1E+100
F105	data Average 5	0	-0.276019485	-0.276019485	0.276019485	1E+100
G105	data Average 6	0	-0.064214894	-0.064214894	0.064214894	1E+100
H105	data Average 7	1	0.577189302	0.577189302	1E+100	0.577189302
B106	activity Average 1	0	-0.963364793	-0.102854078	0.963364793	1E+100
C106	activity Average 2	0	-	-	1.278473081	1E+100

			1.278473081	0.417962367		
D106	activity Average 3	0	-0.54858325	0.311927464	0.54858325	1E+100
E106	activity Average 4	0	- 0.684454789	0.176055926	0.684454789	1E+100
F106	activity Average 5	1	0	0.860510715	1E+100	0.54858325
G106	activity Average 6	0	-0.83202141	0.028489305	0.83202141	1E+100
H106	activity Average 7	0	- 1.226551893	- 0.366041178	1.226551893	1E+100
B107	local Average 1	0	- 0.633936297	- 0.295419735	0.633936297	1E+100
C107	local Average 2	1	0	0.338516562	1E+100	0.075195444
D107	local Average 3	0	- 0.337221969	0.001294593	0.337221969	1E+100
E107	local Average 4	0	- 0.699659259	- 0.361142697	0.699659259	1E+100
F107	local Average 5	0	- 0.424214913	- 0.085698351	0.424214913	1E+100
G107	local Average 6	0	- 0.075195444	0.263321118	0.075195444	1E+100
H107	local Average 7	0	- 0.399505169	- 0.060988607	0.399505169	1E+100
B108	policy Average 1	0	- 0.833384343	- 0.454076905	0.833384343	1E+100
C108	policy Average 2	0	-0.32554852	0.053758918	0.32554852	1E+100
D108	policy Average 3	1	0	0.379307439	1E+100	0.219057863
E108	policy Average 4	0	- 0.842979153	- 0.463671715	0.842979153	1E+100
F108	policy Average 5	0	- 0.648343424	- 0.269035985	0.648343424	1E+100
G108	policy Average 6	0	-	0.160249576	0.219057863	1E+100

			0.219057863			
H108	policy Average 7	0	-0.220293461	0.159013977	0.220293461	1E+100
B109	group Average 1	0	-0.79954248	-0.302416347	0.79954248	1E+100
C109	group Average 2	0	-0.822796373	-0.32567024	0.822796373	1E+100
D109	group Average 3	0	-0.307388861	0.189737272	0.307388861	1E+100
E109	group Average 4	0	-0.419984091	0.077142042	0.419984091	1E+100
F109	group Average 5	1	0	0.497126133	1E+100	0.201326359
G109	group Average 6	0	-0.201326359	0.295799774	0.201326359	1E+100
H109	group Average 7	0	-0.463159701	0.033966432	0.463159701	1E+100
B110	area Average 1	0	-0.094629203	0.308341612	0.094629203	1E+100
C110	area Average 2	0	-0.378962481	0.024008334	0.378962481	1E+100
D110	area Average 3	0	-0.514971768	-0.112000953	0.514971768	1E+100
E110	area Average 4	0	-0.587831556	-0.184860741	0.587831556	1E+100
F110	area Average 5	0	-0.212809424	0.190161392	0.212809424	1E+100
G110	area Average 6	0	-0.124611722	0.278359094	0.124611722	1E+100
H110	area Average 7	1	0	0.402970815	1E+100	0.094629203
B111	emission Average 1	0	-0.377070394	-0.003988467	0.377070394	1E+100

C111	emission Average 2	0	-0.339671501	0.033410426	0.339671501	1E+100
D111	emission Average 3	0	-0.183385991	0.189695936	0.183385991	1E+100
E111	emission Average 4	0	-0.272802695	0.100279232	0.272802695	1E+100
F111	emission Average 5	1	0	0.373081927	1E+100	0.183385991
G111	emission Average 6	0	-0.601727067	-0.22864514	0.601727067	1E+100
H111	emission Average 7	0	-0.338301156	0.034780771	0.338301156	1E+100
B112	part Average 1	0	-0.552889602	0.234828471	0.552889602	1E+100
C112	part Average 2	0	-0.629114479	0.158603594	0.629114479	1E+100
D112	part Average 3	0	-0.824238364	-0.036520292	0.824238364	1E+100
E112	part Average 4	0	-0.680518134	0.107199939	0.680518134	1E+100
F112	part Average 5	1	0	0.787718073	1E+100	0.552889602
G112	part Average 6	0	-0.651830416	0.135887657	0.651830416	1E+100
H112	part Average 7	0	-1.007378755	-0.219660682	1.007378755	1E+100
B113	packaging Average 1	1	0	0.860234125	1E+100	0.489670871
C113	packaging Average 2	0	-0.489670871	0.370563254	0.489670871	1E+100
D113	packaging Average 3	0	-1.237189216	-0.376955091	1.237189216	1E+100
E113	packaging Average 4	0	-1.090478481	-0.230244356	1.090478481	1E+100

F113	packaging Average 5	0	-1.107255435	-0.24702131	1.107255435	1E+100
G113	packaging Average 6	0	-1.001495073	-0.141260948	1.001495073	1E+100
H113	packaging Average 7	0	-0.844295445	0.01593868	0.844295445	1E+100
B114	initiative Average 1	0	-0.788275035	-0.342521579	0.788275035	1E+100
C114	initiative Average 2	0	-0.523716417	-0.07796296	0.523716417	1E+100
D114	initiative Average 3	0	-0.470059958	-0.024306501	0.470059958	1E+100
E114	initiative Average 4	0	-0.696091526	-0.25033807	0.696091526	1E+100
F114	initiative Average 5	0	-0.646272223	-0.200518766	0.646272223	1E+100
G114	initiative Average 6	1	0	0.445753456	1E+100	0.291741457
H114	initiative Average 7	0	-0.291741457	0.154011999	0.291741457	1E+100
B115	standard Average 1	0	-0.822238566	-0.444748907	0.822238566	1E+100
C115	standard Average 2	0	-0.223770384	0.153719275	0.223770384	1E+100
D115	standard Average 3	1	0	0.377489659	1E+100	0.223770384
E115	standard Average 4	0	-0.865916674	-0.488427015	0.865916674	1E+100
F115	standard Average 5	0	-0.554429328	-0.176939669	0.554429328	1E+100
G115	standard Average 6	0	-0.457565267	-0.080075608	0.457565267	1E+100
H115	standard Average 7	0	-	0.002718624	0.374771035	1E+100

			0.374771035			
B116	organization Average 1	0	-0.791588835	-0.433838694	0.791588835	1E+100
C116	organization Average 2	0	-0.203795818	0.153954323	0.203795818	1E+100
D116	organization Average 3	0	-0.131742961	0.22600718	0.131742961	1E+100
E116	organization Average 4	0	-0.641856864	-0.284106723	0.641856864	1E+100
F116	organization Average 5	0	-0.314941661	0.04280848	0.314941661	1E+100
G116	organization Average 6	0	-0.4147971	-0.057046959	0.4147971	1E+100
H116	organization Average 7	1	0	0.357750141	1E+100	0.131742961
B117	work Average 1	0	-0.675547864	-0.264434269	0.675547864	1E+100
C117	work Average 2	0	-0.475303397	-0.064189802	0.475303397	1E+100
D117	work Average 3	0	-0.343662788	0.067450807	0.343662788	1E+100
E117	work Average 4	0	-0.77753758	-0.366423985	0.77753758	1E+100
F117	work Average 5	0	-0.527117989	-0.116004394	0.527117989	1E+100
G117	work Average 6	1	0	0.411113595	1E+100	0.343662788
H117	work Average 7	0	-0.507593838	-0.096480243	0.507593838	1E+100
B118	high Average 1	0	-0.526486189	-0.2677092	0.526486189	1E+100
C118	high Average 2	0	-0.482592123	-0.223815134	0.482592123	1E+100

D118	high Average 3	1	0	0.258776989	1E+100	0.073878606
E118	high Average 4	0	-0.073878606	0.184898384	0.073878606	1E+100
F118	high Average 5	0	-0.205452212	0.053324777	0.205452212	1E+100
G118	high Average 6	0	-0.524663518	-0.265886529	0.524663518	1E+100
H118	high Average 7	0	-0.419797598	-0.161020609	0.419797598	1E+100
B119	number Average 1	1	0	0.860275754	1E+100	0.667998604
C119	number Average 2	0	-0.703162702	0.157113052	0.703162702	1E+100
D119	number Average 3	0	-1.340682004	-0.48040625	1.340682004	1E+100
E119	number Average 4	0	-0.955093042	-0.094817288	0.955093042	1E+100
F119	number Average 5	0	-1.086622059	-0.226346306	1.086622059	1E+100
G119	number Average 6	0	-1.019094956	-0.158819203	1.019094956	1E+100
H119	number Average 7	0	-0.667998604	0.19227715	0.667998604	1E+100
B120	site Average 1	0	-0.448164492	-0.331986938	0.448164492	1E+100
C120	site Average 2	0	-0.414317516	-0.298139961	0.414317516	1E+100
D120	site Average 3	1	0	0.116177554	1E+100	0.007930629
E120	site Average 4	0	-0.247610275	-0.131432721	0.247610275	1E+100
F120	site Average 5	0	-0.247746649	-0.131569095	0.247746649	1E+100

G120	site Average 6	0	-0.222582997	-0.106405443	0.222582997	1E+100
H120	site Average 7	0	-0.007930629	0.108246926	0.007930629	1E+100
B121	project Average 1	0	-0.970148301	-0.563117141	0.970148301	1E+100
C121	project Average 2	0	-0.579861128	-0.172829968	0.579861128	1E+100
D121	project Average 3	0	-0.400734753	0.006296407	0.400734753	1E+100
E121	project Average 4	0	-0.342735867	0.064295294	0.342735867	1E+100
F121	project Average 5	0	-0.619931441	-0.21290028	0.619931441	1E+100
G121	project Average 6	1	0	0.40703116	1E+100	0.225937296
H121	project Average 7	0	-0.225937296	0.181093865	0.225937296	1E+100
B122	total Average 1	0	-0.42440105	-0.198039753	0.42440105	1E+100
C122	total Average 2	0	-0.546083036	-0.319721739	0.546083036	1E+100
D122	total Average 3	1	0	0.226361297	1E+100	0.071380779
E122	total Average 4	0	-0.512009722	-0.285648425	0.512009722	1E+100
F122	total Average 5	0	-0.386522742	-0.160161445	0.386522742	1E+100
G122	total Average 6	0	-0.071380779	0.154980517	0.071380779	1E+100
H122	total Average 7	0	-0.184586469	0.041774828	0.184586469	1E+100
B123	change Average 1	0	-	0.256714386	0.138339485	1E+100

			0.138339485			
C123	change Average 2	0	-0.39345447	0.0015994	0.39345447	1E+100
D123	change Average 3	0	-0.688711011	-0.29365714	0.688711011	1E+100
E123	change Average 4	1	0	0.395053871	1E+100	0.138339485
F123	change Average 5	0	-0.515070293	-0.120016422	0.515070293	1E+100
G123	change Average 6	0	-0.532622443	-0.137568572	0.532622443	1E+100
H123	change Average 7	0	-0.310587491	0.08446638	0.310587491	1E+100
B124	environment Average 1	0	-1.036252329	-0.314316408	1.036252329	1E+100
C124	environment Average 2	0	-1.132216086	-0.410280165	1.132216086	1E+100
D124	environment Average 3	0	-0.313104001	0.408831921	0.313104001	1E+100
E124	environment Average 4	0	-0.388710554	0.333225367	0.388710554	1E+100
F124	environment Average 5	1	0	0.721935921	1E+100	0.313104001
G124	environment Average 6	0	-0.783873434	-0.061937513	0.783873434	1E+100
H124	environment Average 7	0	-0.938243385	-0.216307463	0.938243385	1E+100
B125	industry Average 1	0	-0.982585966	-0.346690371	0.982585966	1E+100
C125	industry Average 2	1	0	0.635895596	1E+100	0.25134839
D125	industry Average 3	0	-0.89823086	-0.262335264	0.89823086	1E+100
E125	industry Average 4	0	-0.617662547	0.018233049	0.617662547	1E+100

F125	industry Average 5	0	-0.828706908	-0.192811313	0.828706908	1E+100
G125	industry Average 6	0	-0.573430919	0.062464676	0.573430919	1E+100
H125	industry Average 7	0	-0.25134839	0.384547206	0.25134839	1E+100
B126	education Average 1	0	-0.674035915	-0.448631427	0.674035915	1E+100
C126	education Average 2	0	-0.285189332	-0.059784844	0.285189332	1E+100
D126	education Average 3	0	-0.07507863	0.150325858	0.07507863	1E+100
E126	education Average 4	0	-0.379800201	-0.154395713	0.379800201	1E+100
F126	education Average 5	0	-0.274368944	-0.048964456	0.274368944	1E+100
G126	education Average 6	1	0	0.225404488	1E+100	0.025779152
H126	education Average 7	0	-0.025779152	0.199625336	0.025779152	1E+100
B127	effort Average 1	0	-0.751314147	-0.262025613	0.751314147	1E+100
C127	effort Average 2	0	-0.427368498	0.061920036	0.427368498	1E+100
D127	effort Average 3	0	-0.098756836	0.390531698	0.098756836	1E+100
E127	effort Average 4	0	-0.791317247	-0.302028713	0.791317247	1E+100
F127	effort Average 5	1	0	0.489288534	1E+100	0.098756836
G127	effort Average 6	0	-0.202348461	0.286940073	0.202348461	1E+100
H127	effort Average 7	0	-0.750037175	-0.260748641	0.750037175	1E+100
B128	approach Average 1	1	0	0.884385106	1E+100	0.769010279

C128	approach Average 2	0	-0.769010279	0.115374827	0.769010279	1E+100
D128	approach Average 3	0	-1.125539144	-0.241154039	1.125539144	1E+100
E128	approach Average 4	0	-1.143386922	-0.259001817	1.143386922	1E+100
F128	approach Average 5	0	-1.062564391	-0.178179286	1.062564391	1E+100
G128	approach Average 6	0	-1.225862687	-0.341477582	1.225862687	1E+100
H128	approach Average 7	0	-0.786670195	0.097714911	0.786670195	1E+100
B129	process Average 1	0	-0.795020498	-0.474196668	0.795020498	1E+100
C129	process Average 2	0	-0.714817846	-0.393994015	0.714817846	1E+100
D129	process Average 3	1	0	0.32082383	1E+100	0.11570389
E129	process Average 4	0	-0.643098136	-0.322274306	0.643098136	1E+100
F129	process Average 5	0	-0.317950077	0.002873753	0.317950077	1E+100
G129	process Average 6	0	-0.11570389	0.205119941	0.11570389	1E+100
H129	process Average 7	0	-0.214632872	0.106190959	0.214632872	1E+100
B130	resource Average 1	0	-0.842876391	-0.315696901	0.842876391	1E+100
C130	resource Average 2	0	-0.390133347	0.137046143	0.390133347	1E+100
D130	resource Average 3	0	-0.486427256	0.040752235	0.486427256	1E+100
E130	resource Average 4	0	-	-	0.676192122	1E+100

			0.676192122	0.149012632		
F130	resource Average 5	0	-0.078934534	0.448244957	0.078934534	1E+100
G130	resource Average 6	1	0	0.52717949	1E+100	0.078934534
H130	resource Average 7	0	-0.352094803	0.175084688	0.352094803	1E+100
B131	large Average 1	1	0	0.359308118	1E+100	0.144196055
C131	large Average 2	0	-0.176789445	0.182518672	0.176789445	1E+100
D131	large Average 3	0	-0.534199657	-0.174891539	0.534199657	1E+100
E131	large Average 4	0	-0.144196055	0.215112063	0.144196055	1E+100
F131	large Average 5	0	-0.784255094	-0.424946976	0.784255094	1E+100
G131	large Average 6	0	-0.696045499	-0.336737381	0.696045499	1E+100
H131	large Average 7	0	-0.449031554	-0.089723437	0.449031554	1E+100
B132	leader Average 1	0	-1.038225598	-0.319749005	1.038225598	1E+100
C132	leader Average 2	0	-0.655870613	0.062605981	0.655870613	1E+100
D132	leader Average 3	0	-0.723023645	-0.004547051	0.723023645	1E+100
E132	leader Average 4	1	0	0.718476594	1E+100	0.655870613
F132	leader Average 5	0	-0.894268767	-0.175792173	0.894268767	1E+100
G132	leader Average 6	0	-0.987075706	-0.268599112	0.987075706	1E+100
H132	leader Average 7	0	-	-	0.837976735	1E+100

			0.837976735	0.119500142		
B133	partnership Average 1	0	-0.406083278	0.045633953	0.406083278	1E+100
C133	partnership Average 2	1	0	0.451717231	1E+100	0.057672274
D133	partnership Average 3	0	-0.692094405	-0.240377174	0.692094405	1E+100
E133	partnership Average 4	0	-0.818767819	-0.367050588	0.818767819	1E+100
F133	partnership Average 5	0	-0.57615081	-0.124433579	0.57615081	1E+100
G133	partnership Average 6	0	-0.057672274	0.394044958	0.057672274	1E+100
H133	partnership Average 7	0	-0.5108718	-0.059154569	0.5108718	1E+100
B134	impact Average 1	1	0	0.563500659	1E+100	0.061029951
C134	impact Average 2	0	-0.374479545	0.189021114	0.374479545	1E+100
D134	impact Average 3	0	-0.980337981	-0.416837322	0.980337981	1E+100
E134	impact Average 4	0	-0.87762412	-0.314123461	0.87762412	1E+100
F134	impact Average 5	0	-0.892639504	-0.329138845	0.892639504	1E+100
G134	impact Average 6	0	-0.474944512	0.088556147	0.474944512	1E+100
H134	impact Average 7	0	-0.061029951	0.502470708	0.061029951	1E+100
B135	social Average 1	0	-0.93650476	-0.602918271	0.93650476	1E+100
C135	social Average 2	0	-0.481117942	-0.147531452	0.481117942	1E+100

D135	social Average 3	1	0	0.333586489	1E+100	0.137208278
E135	social Average 4	0	-0.137208278	0.196378211	0.137208278	1E+100
F135	social Average 5	0	-0.3332998	0.00028669	0.3332998	1E+100
G135	social Average 6	0	-0.389987599	-0.056401109	0.389987599	1E+100
H135	social Average 7	0	-0.185479088	0.148107401	0.185479088	1E+100

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
I76	product	1	0.75968611	1	0	1
I77	company	1	0.464463411	1	0	1
I78	business	1	0.433523797	1	0	1
I79	program	1	0.307891378	1	0	1
I80	water	1	0.662041121	1	0	1
I81	global	1	0.347977528	1	0	1
I82	health	1	0.257570993	1	0	1
I83	system	1	0.609100627	1	0	1
I84	energy	1	0.600324536	1	0	1
I85	new	1	0.630670316	1	0	1
I86	world	1	0.681884282	1	0	1
I87	year	1	0.728552489	1	0	1
I88	consumer	1	0.837552091	1	0	1
I89	information	1	0.454309234	1	0	1
I90	technology	1	0.641242296	1	0	1
I91	material	1	0.753725727	1	0	1

I92	development	1	0.42939164	1	0	1
I93	sustainable	1	0.925963766	1	0	1
I94	community	1	0.305367997	1	0	1
I95	food	1	0.684197057	1	0	1
I96	corporate	1	0.356360366	1	0	1
I97	report	1	0.430739826	1	0	1
I98	country	1	0.786289481	1	0	1
I99	waste	1	0.644445357	1	0	1
I100	performance	1	0.640730951	1	0	1
I101	facility	1	0.625861524	1	0	1
I102	service	1	0.625784856	1	0	1
I103	safety	1	0.437581995	1	0	1
I104	goal	1	0.633133576	1	0	1
I105	data	1	0	1	1E+100	0
I106	activity	1	0.860510715	1	0	1
I107	local	1	0.338516562	1	0	1
I108	policy	1	0.379307439	1	0	1
I109	group	1	0.497126133	1	0	1
I110	area	1	0.402970815	1	0	1
I111	emission	1	0.373081927	1	0	1
I112	part	1	0.787718073	1	0	1
I113	packaging	1	0.860234125	1	0	1
I114	initiative	1	0.445753456	1	0	1
I115	standard	1	0.377489659	1	0	1
I116	organization	1	0.357750141	1	0	1
I117	work	1	0.411113595	1	0	1
I118	high	1	0.258776989	1	0	1
I119	number	1	0.860275754	1	0	1

I120	site	1	0.116177554	1	0	1
I121	project	1	0.40703116	1	0	1
I122	total	1	0.226361297	1	0	1
I123	change	1	0.395053871	1	0	1
I124	environment	1	0.721935921	1	0	1
I125	industry	1	0.635895596	1	0	1
I126	education	1	0.225404488	1	0	1
I127	effort	1	0.489288534	1	0	1
I128	approach	1	0.884385106	1	0	1
I129	process	1	0.32082383	1	0	1
I130	resource	1	0.52717949	1	0	1
I131	large	1	0.359308118	1	0	1
I132	leader	1	0.718476594	1	0	1
I133	partnership	1	0.451717231	1	0	1
I134	impact	1	0.563500659	1	0	1
I135	social	1	0.333586489	1	0	1