



**THE DYNAMICS OF LEAN AND GREEN LOGISTICS
SYSTEMS WITHIN THE DURBAN ROAD FREIGHT
NETWORK**

by

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This work is dedicated to my parents Savy and Ronnie Pillay

To the two people who will always be in my corner, my parents. I love you both dearly. Thank you for always inspiring me and supporting me to reach for my dreams. Now the sky's the limit. I will forever be indebted to you both for all that you've done for me.

To my brothers, sisters, friends and family -Thank you for being in my life and providing a constant sense of motivation to make this study a reality.

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Lastly, thank you to the divine power in life that is greater than all material accomplishments. A spiritual realm that is all encompassing, a world of escapism when life becomes too heavy for the mind and soul to tolerate. The essence and major arcadia of our very existence.

ABSTRACT

Green supply chain management is a recent development that ensures sustainability within supply chain networks. Organisations are under pressure to adapt their business operations in line with the triple bottom line; this integrates environmental, societal and economic considerations. The logistics sector is not immune to these pressures. This industry has made an important contribution to economic growth and development and global institutions now emphasise the role that logistics and transportation activities play in the broader supply chain. However, eco-consciousness can erode profit margins due to the high cost of investment in green assets. Maximising value to customers and minimising cost and the impact on the environment requires a balanced strategic plan. Businesses have therefore renewed their efforts to implement lean practices that seek to minimise wastage, while retaining value added activities that contribute to a sustainable supply chain. This study examines the dynamics of lean and green logistics systems within the Durban road freight network. The aim of this study is to assist industry leaders, researchers and the broader society to understand the nature of lean and green logistics unique to logistics providers operating in Durban. This study has four objectives; firstly to understand the effects of lean logistics within the Durban road freight network, secondly to examine the dynamics of lean logistics in relation to costs; thirdly to identify the opportunities arising from the implementation of green logistics; and lastly to evaluate the relationship between lean practices and green diffusion in logistics systems. The researcher has chosen an exploratory research design to investigate the relationship between lean and green logistics. Various univariate, bivariate and multivariate statistical analysis techniques are employed to analyse the data collected from 210 respondents. This study reveals several elements that arise from the implementation of lean logistics in the Durban region. This includes lean warehousing and optimum warehousing functions that are seen as a driver of lean initiatives, where JIT strategies and lean profitability feature strongly amongst these findings. Company policy and technological advances are key factors for transport optimisation for lean and green implementation. Logistics businesses could grow from strength to strength by internalising their lean practices through externalising the application of green. Sustainability is internationally acknowledged as a prerequisite for business and South Africa needs to play catch up. The recommendations suggested by the researcher will provide insight and further understanding to the logistics sector, during the implementation of both lean and green in a logistics system vastly characterised by high cost constraints.

Key words: Green supply chain management, Green logistics, Green initiatives, Lean logistics, Lean initiatives, sustainable supply chain

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ABBREVIATIONS

TBL	Triple Bottom Line
ANOVA	Analysis of Variance
CIPS	Chartered Institute of Purchasing and Supply
CSCMP	Council of Supply Chain Management Professionals
CSIR	Council of Scientific and Industrial Research
CSR	Corporate Social Responsibility
EPA	Environmental Protection Agency
GHG	Green House Gases
IT	Information Technology
IT	Information Technology
JIT	Just in time
JIT-L	Just-in Time Logistics
KMO	Kaiser-Meyer-Olkin
LARG	Lean, Agile, Resilience and Green
LTMS	Logistics and Transport Management System
OR	Odds Ratio
R&D	Research and Development
RFID	Radio Frequency Identification Device
SA	South Africa
SPSS	Statistical Package for the Social Sciences
TCS	TATA Consultancy Services
TEU	Twenty-foot Equivalent Units
TPS	Toyota Production System
UK	United Kingdom
US	United States
USA	United States of America
VIF	Variance Inflation Factor

CHAPTER ONE

Introduction

1.1 Introduction

Throughout the years, supply chain management has gradually progressed into an integrated field of study which considers the internal business environment and external stakeholder involvement. The grouping of both upstream and downstream members involved in an integrated supply network has developed into a fundamental platform for business growth and sustainability. Even so, the increase in international trade has strengthened ties between communities, countries and economies, deepening the level of integration between global business partners. Countries are increasing dependency on their trading partners, giving rise to a comprehensive supply chain network.

In the new millennium, environmental consciousness has become the cornerstone of global operations, focusing on the impacts of climate change and the subsequent depletion of natural resources. The quest for a 'cleaner' planet has motivated the global community to seek a balance between business activities and the preservation of environmental resources. Boardroom agendas now prioritise environmental consciousness as a vital component of business sustainability; however global supply chains face an even broader challenge of efficacy – Green. The implementation of green supply chain management practices has altered the functionality of operations, calling on global business leaders to adopt innovative ways to adhere to the triple bottom line (TBL). The logistics industry in the Durban region is no exception to this trend. The Durban-Gauteng corridor accounts for the vast majority of freight movement in South Africa, and the 30-year freight growth forecast expects freight volumes to increase by 164% within the region (Transnet National Ports Authority, 2013). In 2012, volume of TEU's entering the Durban Port grew by 8% from 2009 (Transnet National Ports Authority, 2013). Indeed, this industry is a significant contributor to the emission of green-house gasses (GHG) and the continued growth of this sector calls for reevaluation of resource utilisation.

However, the attainment of a comprehensive green supply chain network requires significant investment in business operations evaluated against an exclusive framework based on business value- creation. The freight transport system in South Africa is characterised by high costs, thus business responsiveness to cost savings and resource optimisation have recognised the significance of eliminating non-value adding activities whilst retaining those elements that contribute towards long term business growth, profitability and sustainability (Allix, 2013). The continuous elimination of waste within functional divisions of an

organisation can collectively steer the business towards the attainment of optimal business performance (Miller, Pawloski and Stanridge, 2010:2-7).

1.2 Background

The Council of Supply Chain Management Professionals (CSCMP) defines Supply Chain Management as the inter- and intra-integration of supply and demand management across companies operating in a common network. It encompasses the planning and management of sourcing, procurement, conversion and logistics management activities (CSCMP, 2012). The Durban road freight network operates within a dynamic logistics structure, where collaboration and co-ordination with channel partners play a strategic role in developing an efficient logistics system (Department of Transport, 2008:15). A logistics system incorporates all the elements in a logistics network that are responsible for making products available to the market. Gonzalez-Feliu (2013:2-4) and Pienaar and Vogt (2009:324-330) identify these elements as; vehicle fleet which encompass the loading of cargo onto vehicles that transport the goods to points of usage; hierarchical network structures that are characterised as a single-stage, multi-stage or hybrid-stage system; and a transport system composed of physical components and stakeholders such as service providers, transport users and the authorities. The physical components include road freight as a mode of transport and various classes of nodes such as warehouse facilities and terminals (Pienaar and Vogt, 2009:329).

Lean logistics refers to the identification and removal of waste from logistics systems with the aim of improving speed and product flow whilst increasing efficiency (Baudin, 2004:28); and green logistics which takes environmental factors into consideration in logistics management, are two of the four paradigms of thriving supply chains. This study analyses the interaction between lean and green practices in the Durban region. It aims to examine the characteristics of lean and green logistics practices within the Durban logistics industry. Logistics companies operating in the Durban region were selected as the primary site of investigation as this is the busiest point of freight movement resulting from increased port activities at the Durban Harbour (Transnet National Ports Authority, 2013). The dynamics of lean and green logistics investigated in this study refers to the characteristics of these two concepts that exist primarily in the Durban road freight sector in terms of the transport system. According to Waite (2012:64), the term 'dynamics' is explained as "the forces or properties which stimulate growth, development, or change within a system or process." Hence, the use of 'dynamics' is fitting in the context of this study, as it seeks to understand the properties of lean and green logistics within the Durban road freight network whilst recognising the effect of change each concept has on transportation flows.

1.3 Problem Statement

Implementing green logistics provides significant benefits to an organisation; however, this practice also requires firms to invest in costly infrastructure, as well as high initial capital outlays. By adopting a corporate mind-set that reduces waste and non-value adding activities, companies can benefit from the synchronisation of both lean and green thinking in their logistics operations. This saves costs, increases product flows, customer service and ultimately improves logistics efficiency (Allix, 2013). The properties of these two concepts have yet not received sufficient research attention in the Durban logistics industry in order to ensure improved logistics efficiency and business optimisation.

1.4 Aim of the study

The aim of this study is to assist industry leaders, researchers and the broader society to understand the nature of lean and green logistics unique to logistics providers operating in Durban. Due to the challenges faced by implementing green initiatives, which include high costs, limited access to technology, lack of skills and knowledge; companies seek to employ alternative lean methods, as a cost effective strategy to optimise operations and resources (World Bank, 2014).

1.5 Need for the study

The study is needed to understand the complexity of the relationship between lean and green logistics. Understanding the nature of these two concepts is a primary objective of this study. This is achieved by exploring the dynamics of lean and green logistics within the Durban region. This research is therefore important to impart knowledge, required to help interested parties gain more insight to the problems logistics providers in the Durban region experience.

1.6 Hypotheses

H₀₁: The size of the company determines the implementation of green initiatives

H₀₂: The size of the company is relative to the understanding of green initiatives among employees

H₀₃: The adoption of lean initiatives is linked to the company's policy in green initiatives

H₀₄: Green logistics initiatives relate to lean warehousing

H₀₅: Lean logistics initiatives relate to JIT benefits realised by logistics firms

H₀₆: The adoption of green logistics initiatives is related to network efficiency in the transport system

H₀₇: Lean logistics initiatives relates to total cost optimisation in a logistics system

1.7 Objectives

The objectives of this study are as follows:

- I. To understand the effects of lean logistics within the Durban road freight network
- II. To examine the dynamics of lean logistics and optimised cost containment strategies
- III. To identify the opportunities arising from the implementation of green logistics within the Durban road freight region
- IV. To evaluate the relationship between lean practices and green diffusion in logistics systems

1.8 Research Questions

The critical research questions are:

- I. What are the effects of lean logistics within the Durban road freight industry?
- II. What are the dynamics of lean practices in terms of real business value-creation in Durban road freight operations?
- III. What is the relationship between lean and green logistics in the opportunities derived from implementing green logistics thinking within the Durban road freight network?
- IV. How can the application of lean and green logistics optimise road freight operations?

1.9 Research Methodology

The type of research design that will be used in this study is exploratory and Sekaran and Bougie (2010:103), describes exploratory research as a study undertaken when insufficient knowledge or research is available on problems or research issues that have been dealt with in the past. This research design has been chosen to explore and better understand the subject of lean and green logistics in the Durban road freight industry.

The nature of this study is quantitative. The quantitative aspect serves to answer questions about the relationships among the variables that are measured, deriving meaning from the data that is analysed through use of statistics, diagrams and tables (Sekaran and Bougie, 2010:144). Hence, the source of data in this study will come from questionnaires. The time horizon for this study is cross-sectional since data will be collected at one point in time from all respondents. The target population for this study are various logistics companies in the Durban area. Participants will comprise of bottom, middle and top level management, as well staff in non-managerial positions from the different departments of the company. Convenience and purposive sampling will be used as part of non-probability sampling (Black, 2010:224). The sample size for this study is 210. Univariate data analysis will be used by to find the measures of central tendency and measures of dispersion. This section of the analysis will answer objective one of the study. The second scientific component will be bivariate data analysis. Bivariate analysis constitutes Pearson Correlation which gives the

direction, strength and significance of the bivariate relationship among the variables in the study. The second tool is cross tabulation that establishes a relationship between two variables. Bivariate analysis will answer objective three. As part of multivariate data analysis, logistics regression will be used to predict the outcomes of the categorical data and help answer objective two. Multiple regression analysis is employed to test the regressed effect of each variable to answer the third and fourth objective. Reliability will be tested using Cronbach's Alpha which is used to test for consistency, dependability and trustworthiness of all data collected (Osbourne, 2008:39).

1.10 Limitations

The study reveals possible research and methodological limitations. This includes lack of participation by every company operating in the Durban region that determines the size of the sample. The magnitude of logistics companies operating in this region does not permit the researcher to capture the responses of all representative parties. Some companies did not wish to participate in the study due to time availability of personnel participation and fear of revealing company sensitive information. Methodological limitations include the use of convenience and purposive sampling that will not permit generalisation over the entire population, however, this fits in with the intension of the research design that seeks to explore and understand the nature of lean and green logistics.

1.11 Structure of the dissertation

Chapter one: Introduction

Chapter one presents an introduction to the study. It discusses the operational, conceptual and theoretical framework to the study by contextualising the topic in terms of the need for the study. This chapter further outlines the problem statement and limitations of the research and what the researcher seeks to achieve from the study.

Chapter two: Literature Review

Chapter two provides the theoretical framework for the study by examining the previous literature on lean and green logistics. It presents an analysis of arguments and viewpoints, arranged in a succinct manner that captures the concept of lean and green logistics and the associated dynamics.

Chapter three: Research Methodology

This chapter identifies and discusses the various research methods used in this study and the analysis tools utilised on the data collected. Chapter four discusses the sample size, the type of study, the sampling design and methods of data collection and the measuring instruments utilised.

Chapter four: Data Analysis

Chapter four presents the results of the study from the questionnaires using the software SPSS as a tool for statistical analysis. Statistics, tables, charts and diagrams are used to describe how the respondents perceive the dynamics associated with lean and green logistics.

Chapter five: Discussion on the Empirical Results

This chapter discusses the results presented in chapter four. These are analysed against the study's theoretical framework and the objectives of the study.

Chapter six: Conclusion and Recommendations

Chapter six concludes the study by determining whether or not the research questions have been answered and what future research needs to be conducted. The chapter also presents recommendations based on the findings of the study emerging from the analysis of data collected on the Durban road freight industry.

1.12 Conclusion

Chapter one provides the basic outline and structure of the dissertation in terms of the topic, the problem statement, research questions, objectives and hypotheses tested. The background into the topic has been highlighted and the research methodology of this study is mentioned. A concise introduction of each chapter is illustrated to conclude the content of this chapter.

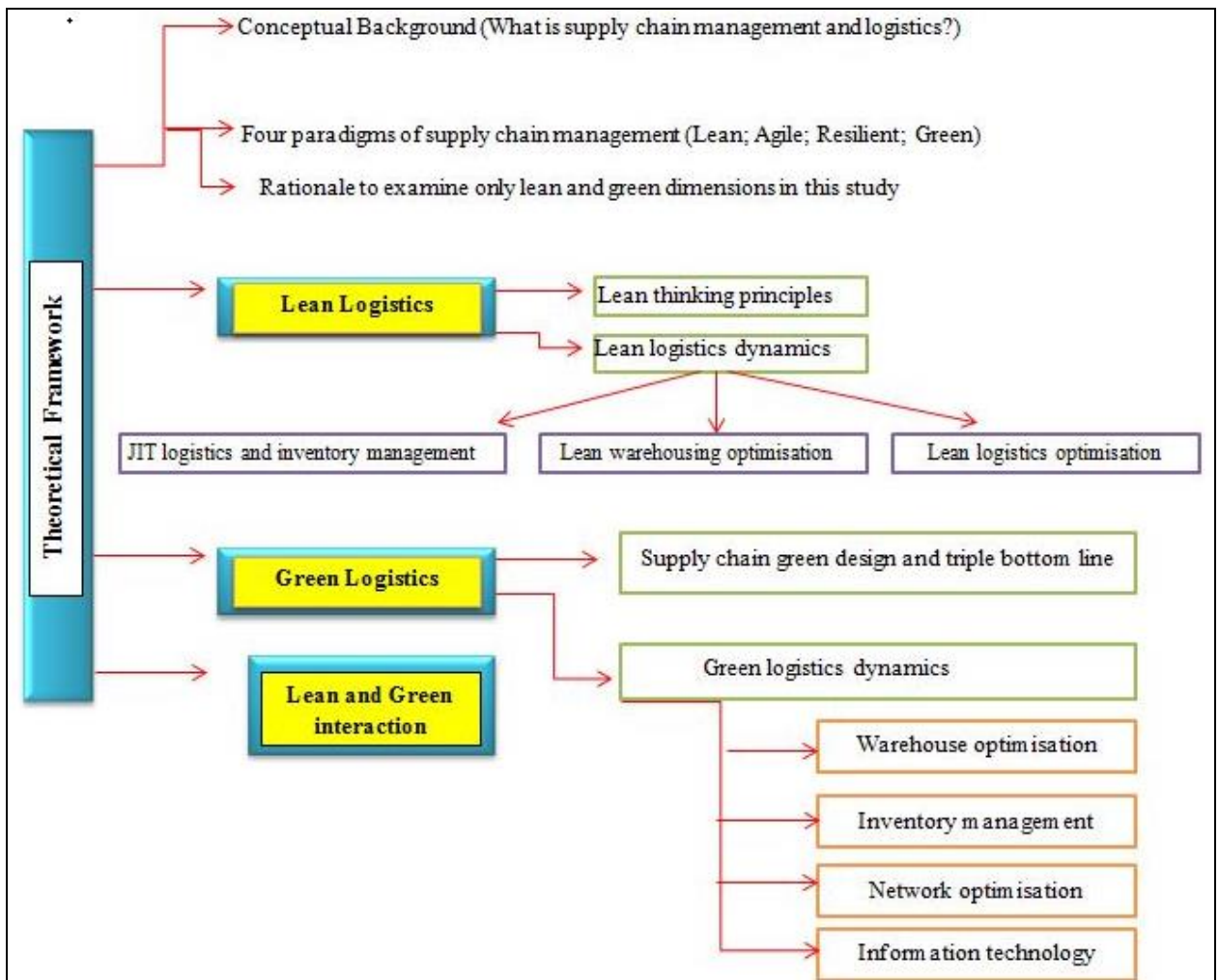
CHAPTER TWO

Literature Review

2.1 Introduction

The recent spotlight on supply chain management has tasked businesses around the world to re-examine the way in which they conduct their daily trading activities. Considerable media and academic attention to dynamic supply chains has driven companies to seek ways to enhance profitability and growth; an optimised supply chain has now taken the front seat in global firms. This chapter sets the theoretical foundation for this study by examining the major concepts and findings of previous literary works on the topic of lean and green logistics. A background of supply chain management is provided followed by a gradual progression towards the two concepts of lean and green. The four paradigms of supply chain are discussed and rationale is provided for choosing two out of the four dimensions. The four core principles of lean thinking is examined and discussions are set against the main themes of this research, namely the fundamentals of lean logistics in terms of just-in-time logistics and inventory management; warehouse optimisation and logistics optimisation. Thereafter, the nature of green logistics and previous literary works are highlighted. The discussion on green logistics is expressed in terms of warehouse layout optimisation; inventory management; network optimisation and information technology. The latter end of this chapter views the cost attributes of both lean and green as well as the complementary attributes. The interplay between lean and green is highlighted before concluding this chapter. Figure 2.1 highlights the main features of chapter two by illustrating the theoretical framework of this study. The illustration displays the major themes and sub-topic addressed. The theoretical framework provides the basis for this study and assists in maintaining focus within this research.

Figure 2.1 Theoretical Framework



Source: Designed by researcher

2.2 Conceptual Background

According to Christopher (1998:21), supply chain management is the management of upstream and downstream supplier-customer integration that aims to deliver superior customer value at the least cost to the value chain. However, as the concept has evolved over time so too has the classification of terms. The Chartered Institute of Purchasing and Supply (CIPS) (2012) describes supply chain management as the interrelated processes associated with the management of resources, information and the flow of goods between suppliers in a sector's supply chain. The dialogue between supply chain participants usually involves shared information and may result in less opportunism and improved relationships (CIPS, 2012). While a number of definitions have been proposed, these appear to be slight adaptations of one another and, in essence, they take on similar meaning. The concept

essentially considers all phases of a product's life cycle, from the extraction of raw materials up to and including the eventual product disposal (Wisner, Tan and Leong, 2012:1-3).

Hall (2003:2) considers transportation as the movement of people and goods from one location to another, whilst the European Logistics Association (2012) defines logistics as "the organisation, planning, control and execution of the goods flow from development and purchasing, through production and distribution, to the final customer in order to satisfy the requirements of the market at minimum costs and capital use." Pienaar and Vogt (2009:9) define logistics management as "a science concerned with the efficient flow of goods, in its various forms such as raw materials, work in progress or finished goods, from supplier to customer. In addition, it is concerned with the activities related to inventory management and control, warehousing, materials handling, order processing and related information activities responsible for the timeous flow of goods." Logistics and supply chain management are major concerns for today's companies and corporate policies and strategies have shifted their focus from the bottom line to business optimisation.

According to Frost and Sullivan (2013:12) the increased cost of doing business globally is a formidable challenge and a driving force of globalisation, particularly from a supply chain perspective. However, the study reveals that the companies that have best managed these cost constraints are those that have built a flexible, agile, and optimised supply chain. When modern industry leaders speak of efficiency, profitability and sustainability, the emphasis is on four vital characteristics that shape successful supply chains today, namely; lean, agile, resilience and green (LARG).

2.3 Mechanics of LARG in Supply Chain Management

Firstly, lean refers to streamlining processes and reducing wasteful activities within an operation. When lean is applied to a supply chain, every process is examined to identify areas that utilise unnecessary resources. The identification and elimination of non-value adding activities ultimately improves an organisation's competitiveness and overall profitability (Smith and Hawkins, 2004:155). Thus, the lean element ensures profit maximisation and cost reduction strategies embrace all transactional activities and processes throughout the product lifecycle, from the point of product design to customer order delivery (Govindan, Azavedo, Carvalho and Cruz-Machado, 2013:1-2).

Secondly, the agile paradigm is centred on flexibility and an efficient response to volatile and turbulent market demand in terms of both volume and variety. It aims to satisfy customer needs as and when required, which is the main objective of any thriving supply chain. Businesses that are agile have a powerful competitive weapon that differentiates a standard supply chain from a successful one (Bendul, 2012:114-115). Mangan, Lalwani and Butcher (2008:42) discuss agility in detail, identifying the characteristics of an agile supply chain and the variables that give rise to supply chain complexity. Their industry experience and knowledge provides sound insight that helps supply chain managers to plan strategically in order to improve supply chain agility. Thirdly, Blecker, Kerstin and Ringle (2012:149-152) describes resilience as the ability to withstand or recover quickly from difficult conditions. A resilient supply chain is able to respond appropriately to unforeseen circumstances that may threaten or undermine supply chain performance. Supply chain uncertainty can emanate from social and economic unrest, political catastrophes and even natural disasters. Managing risk improves a company's competitiveness (Sheffi, 2008:1-3).

Finally, the green dimension integrates environmental thinking into supply chain management, with the objective of reducing operational impact on the environment. The green philosophy runs through product design, material sourcing and selection, manufacturing processes, and delivery of the final product to consumers as well as end-of-life management of the product after its useful life (Srivastara, 2007:54). Zhu, Sarkis, Cordeiro and Lai (2008:577-581), and Chiou, Chan, Lettice and Chung (2011:822-826) define green supply chain management as the incorporation of environmental consciousness into day-to-day decision making at each stage of an organisation's materials management and logistics functions. Thus environmental sustainability and improved ecological efficiency have become pertinent for profitability enhancements.

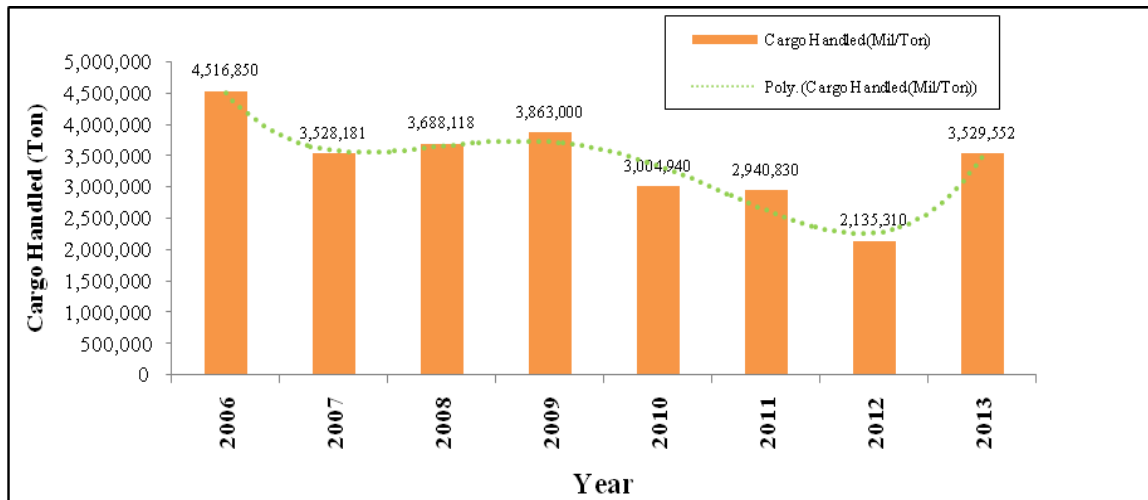
Logistics and supply chain management contribute significantly to an economy as markets continue to be driven by the forces of supply and demand. Tseng, Yue, and Taylor (2005:1657) affirm that rise of international trade has underlined the importance of logistics management. The growth of international trade requires sophisticated transportation and logistics networks that are part of a flexible supply chain; this has complex effects on internal processes and the physical environment (United States International Trade Commission, 2005:21-25). The transportation and logistics industry are significant contributors to the increase in GHG emissions, motivating collaborative initiatives by the private and public sectors to curb these negative effects.

While, as noted, there are four paradigms that describe an ideal supply chain, the researcher has chosen to discuss two – lean and green. This is based on the premise that lean relates to cost reduction and flexibility, with the focus on process improvements that seek to reduce or eliminate waste, thereby retaining value-added activities; whilst green promotes environmental consciousness in business activities. Understanding the mechanics within each dimension and ascertaining the existence of a relationship will greatly assist the South African logistics industry.

South Africa is categorised as an emerging economy whose trade points are developing at a rapid pace (Ernst and Young, 2013:4). Exploring innovative ways to maximise resource utilisation is perhaps the least costly method to curb expenses and improve profit margins. Hence, the choice to include lean in this study is driven by the researcher's interest in identifying ways in which the road freight industry can tackle the dynamics associated with the implementation of green diffusion strategies, but at the same time do more with less. Green diffusion strategies are green initiatives absorbed by companies that implement green strategies to harmonise their business activities with the environment. These strategies permeate at every level of the company to attain the corporate green goal (EPA, 213:1). Appreciating the dimension of green logistics and the subsequent incorporation of lean logistics will contribute significantly to understanding of the dynamics of lean and green logistics in the Durban road freight network.

The road freight industry has been selected as a point of reference for this study due to the lack of studies conducted in this sector, despite the fact that the Durban region has witnessed an increase in road freight activities. The Port of Durban capacitates 60% of South Africa's international trade activities (imports and exports) and is thus considered a focal point in the transportation and logistics chain (Transnet National Ports Authority, 2013). Statistics released by Transnet National Ports Authority (2013) show a dramatic increase in the total cargo handled from January 2006 to January 2013. Figure 2.2 below illustrates the increase in cargo entering the Durban Port.

Figure 2.2 Cargo Volumes entering the Port of Durban



Source: Designed by researcher (Figures adapted from Transnet National Port Authority, 2013).

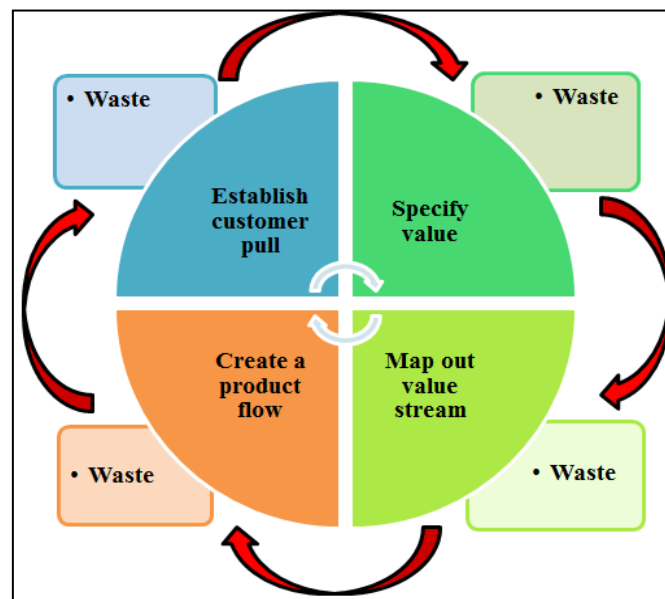
According to Steyn (2013:1), the increased demand for container handling and storage was placing the Durban Port under immense pressure. The volume of containers is forecast to grow from 2.69 million (TEUs) to between 9 and 12 million (TEUs) over the next 30 years (Booyens, 2013). This will increase traffic congestion, the number of vehicles on the roads, pollution, and the array of factors that result from an upsurge in shipment activities. Hence, there is a need for a well-integrated transportation and logistics network that promotes efficiency, cost saving and optimal service levels.

2.4 Lean Logistics

Lean methods have their roots entrenched in the year 1913 when Henry Ford integrated the production process in his motor manufacturing plant. He created a production flow by marrying interchangeable parts with standard work processes moving on a conveyor belt to establish what is now known as a work flow (Lean Enterprise Institute, 2009). The aim was to design processes and sequences to speed up the assembling process, delivering vehicles timeously and accurately. While this increased inventory turnover, the flaw in the system was its inability to provide variety to meet the different tastes and preferences of customers. In the 1930s Taiichi Ohno and his team at Toyota applied this concept to their production process and devised what is now known as the Toyota Production System (TPS). This realigned the focus of manufacturing by shifting the emphasis from production flow to the entire production process, resulting in reduced costs and improved quality, variety and throughput times, which ultimately increased customer satisfaction and value (Lean Enterprise Institute, 2009).

In more recent times, lean production has been adopted by many industries other than automobiles, extending beyond manufacturing (Lean Enterprise Institute, 2009). Lean tools are now evolving as a universal method in the services, retail, healthcare, logistics and distribution sectors. Womack and Jones (2005:12-17) and Harrison and Hoek (2011:25) identify four core principles of lean thinking depicted in figure 2.3. The implementation of these principles will promote an overall organisational strategy that constantly reviews processes and systems in order to deliver value to the customer. This results in high levels of service whilst promoting sustainable growth and flexibility in a changing environment. The following four principles are discussed.

Figure 2.3 Four core principles of lean thinking



Source: Designed by researcher (Adapted from Harrison, A. and Hoek, R. (2011) *Logistics Management and Strategy*. 4th Edition. London: Prentice Hall)

- a) Specify value: The identification of customer value is added along the supply chain network.
- b) Map out value stream: Identifying the value stream for each product and eliminating wasteful procedures. This helps to create value from the customer's perspective.
- c) Create a product flow: By identifying customer value and applying value stream mapping techniques, processes become more streamlined, smoothing out kinks in the system and minimising interruptions, inventories and downtime.
- d) Establish customer pull: Responding to customers' needs promotes a continuous flow and ensures that the information on demand is communicated throughout the chain.

Womack and Jones (2005:12-17) extend these ideas to entire supply chains. Venkat and Wakeland (2006:1-6) express similar views describing the value of “pull” from customer demand as the propagation of correct information upstream and the responsiveness with the right product moving downstream at an efficient pace with minimal waste along the supply chain. Lean logistics is characterised by frequent replenishment volumes in less than full (LTF) container quantities at the various points along the provision stream (Venkat and Wakeland, 2006:3). Organisations that adopt lean logistics thinking in their supply chain stand to gain improved customer service levels, waste reduction, cost savings and reduced environmental impact (Haasis, Kreowski and Sholz-Reiter, 2007:45-46) An environmentally conscious organisation also benefits from the perceived eco-conscious image in the eye and minds of customers and suppliers (Rao, 2008:40).

2.4.1 Lean Logistics Dynamics

2.4.1.1 Just in time – Logistics and Inventory Management

Just-in-time (JIT) can be defined as an integrated set of activities designed to achieve high-volume production using minimal inventories and the elimination of waste (Chase, Jacobs and Aquilano, 2004:38-45; Chary, Herroelen and Lambrecht, 1991:370). JIT management was first applied by the Toyota Corporation; it involves the delivery of the necessary goods to the production line just in time, without storage of raw materials. JIT uses minimal resources and responds promptly to fulfil customers’ needs with minimal waste, using all the factors of production (Lai and Cheng, 2012:35-36). The effectiveness of JIT has impacted the manufacturing sector by improving efficiency and quality, increasing productivity levels, reducing costs, minimising waste and subsequent improvements in communication have been realised (Lai and Cheng 2012:1). The prevalence of JIT in the service sector was witnessed in the mid-1990s (Yasin, Small and Wafa, 2003:213-226).

Pressures from internal and external supply chain partners now require management to implement innovative managerial tools and philosophies. Leaders now recognise the progression of JIT into the 21st century as one of the most popular business revitalisation tools across industries (Thieruaf, 2001:163-164). JIT can be applied to the logistics field by introducing JIT logistics. Ozalp, Suvaci and Tonus (2010:1-7) found that the elimination of waste and improved service quality objectives of JIT fit well with business logistics. The study further showed the application of the JIT philosophy to the logistics sector can result in the determination of the sources of waste, faster delivery to customers, improved processes by means of organising business requirements and manpower plans for logistics, and increasing harmony among suppliers and customers. JIT Logistics (JIT-L) can be defined as the application of the JIT management philosophy to the four main components of the

logistics system, namely customer services; order processing; inventory management and transportation management (Ozalp, Suvaci, and Tonus, 2010:6).

This study investigates two of the four mentioned components (inventory management and transportation management) of the logistics system. Firstly, inventory management involves appropriate inventory levels which are necessary to respond effectively to demand in a supply chain (Lai and Cheng 2009:4). While stock levels are kept as low as possible, the correct level of stock must be available to satisfy customer demand. This will significantly reduce logistics costs by ensuring the right quantities are available in the right place at the right time. Unnecessary inventory movement along the supply chain can be avoided through effective inventory management.

Secondly transportation transfers materials, components and finished products between raw materials suppliers, distributors, retailers and end customers in a supply chain (Lai and Cheng 2012:4). Improved transportation management may result in increased sales, market share, profit and growth. By appropriately leveraging transportation capacities and resources, organisations can ensure the rapid market responsiveness to unpredictable demand and market preferences. The ability for firms to respond in an efficient manner to the market needs will ultimately determine the profitability and growth as a direct result of increased sales and, market share (Lai and Cheng 2012:39). In business logistics, waste can be defined as anything other than the minimum amount of equipment, space and workers' time required to produce a product or service. These elements all add value to the product or service (Lai and Cheng 2012:5). Firms can use the JIT philosophy to identify the sources of waste. Moreover, JIT can improve services by planning the man-power and facilities required to satisfy distribution needs, reduce product introduction time by ensuring responsive delivery, and improving the quality of logistics services by forging partnerships between suppliers and customers.

2.4.1.2 Lean Warehousing Optimisation

The two main objectives of a warehouse are to make a profit and provide a service to customers (Totstar and Karlsson, 2008:14). Several activities ensure that these objectives are achieved. Mazini (2012:2) affirms that warehouses are becoming a strategic tool for competitive advantage. Warehouses today are distribution centres that support a JIT supply chain that is low cost, flexible, and efficient, especially in the rapidly growing world of e-commerce Mazini (2012:3-4). E-commerce affects both the warehouse and the inbound and outbound logistics that support the facility. However, seven forms of waste can present themselves in a warehouse operation.

Firstly, transport refers to the movement of products or employees; the customer does not pay for this process and it does not add any value to the product. While this waste can never be fully eliminated, it should be continually reduced. High levels of transport will increase the risk of damage and deterioration (Carierra, 2005:53). Secondly, inventory is another waste that cannot fully be eliminated. Increased inventory levels tend to increase lead time, as it is harder to find the products while picking them; it also increases the distance as more space is needed to keep them in the warehouse. This will result in higher rentals for unnecessary large facilities (Carierra, 2005:54).

Furthermore, the more products the company purchases the more capital investment is required. This will make it harder for the company to invest in new products, development or other areas of the business. There is also the risk of the products not being sold and having to be replaced by newer products (Sproull, 2009:74). Lean aspires towards JIT in order that the items are available at the time when they are required. Thirdly, motion refers to movement by a human or a machine (Sproull, 2009:75). This could occur when an employee is reaching for different articles on an assembly line or when picking. A functional and ergonomic workplace is important. Products that are stored in a warehouse or before a manufacturing process starts do not generate any value for the company or the customer. This is referred to as waiting (Carierra, 2005:56).

Waiting is the fourth most important waste, as it constrains flow. When products stack up and are waiting to be processed, the lead time is extended. This will impact the flexibility to change products and to ensure a quick response (Sproull, 2009:78). Fifthly, overproduction is often referred to the most serious waste and is the root of many problems. When a company produces more than is needed just to be safe, it will generate more movement than necessary (Rampersad and Homs, 2007:176). The inventory will increase and flexibility will suffer. Pull is an effective way to prevent overproduction; the batches will be smaller and unnecessary products will not be processed. The sixth form of waste is over-processing which refers to the use of large machines or equipment (Rampersad and Homs, 2007:177). Many companies buy expensive machines that are able to produce large volumes of products when they don't need them. It is better to invest in smaller, more flexible, less expensive machines (Rampersad and Homs, 2007:177). Investing in a large machine will result in "pressure to run the machine as often as possible rather than only when needed." Finally, it is very important to locate defects as soon as possible; when defects are notice earlier in the process costs are characterised in small proportions, but if it is not detected until the final product reaches the customer, the value of the goods is reduced and the costs could escalate

dramatically. Thus defects must be regarded as a challenge and an opportunity to improve (Carierra, 2007:58).

2.4.1.3 Lean Logistics Optimisation

Yalaoui, Chehade, Yalaoui, and Amodéo (2012:43) describe logistics optimisation as means of increasing total supply chain efficiency by maximising resource utilisation within the logistics system. Principally, the goal of optimisation is to maximise profits and minimise costs bound by budget, capacity and resource constraints (Kerstin, 2008:219). However, every business that desires to reach their ranks of competitive advantage, cost and leadership levels face the trade-off associated with conflicting goals. Nevertheless, Salema, Povoá, and Novais (2007:1065) further state that companies adopting a systems optimisation approach to business will consider all desired objectives and related cost and constraints, in order to achieve the most efficient and effective logistics decision and design.

According to Burrows (2013:127), the substantial increase in market demand for product variety has created further demand for systems that can effectively respond to changing market needs. However, the rate at which trade is rising will supersede any form of current process and infrastructural developments, hence efficient logistics models are essential. This calls for flexible solutions that mobilise companies to manoeuvre their assets toward flow based logistics. Although waste is likely to present itself in such a system, the introduction and application of lean principles in logistics is catalytic in a logistics system that seeks to retain value adding business activities (Burrows, 2013:218).

Gibson, Hanna, Defee, Chen and CSCMP (2013:93-96) further iterates that lean logistics creates the potential to optimise supply chain performance by increasing transparency and process visibility. Their discussion highlights that an inefficient supply chain incurs high inflexible supply chain costs and limited flexibility to market responsiveness. The synchronised action of all functional areas across the supply chain means optimised interfaces of logistics processes, streamlined and standardised processes of lean logistics structures and integrated elements across the supply chain system (Gibson *et al.*, 2013:95). Similarly, the European Conference Ministers of Transport (2011:53-57) discusses the advantages of lean logistics and the application of tactical planning; asserting the application of lean initiatives to logistics operations is a rudimentary tool to reduce costs. However the combination of lean and tactical logistics planning strategies unlocks further opportunities for waste elimination and an optimised logistics system. The road freight industry is growing at substantial rates and it is only the co-ordination and planning of optimised logistics system

that will enable the industry to minimise their carbon footprint whilst still remaining profitable (European Conference Ministers of Transport, 2011:55). Thus green logistics also requires executive focus.

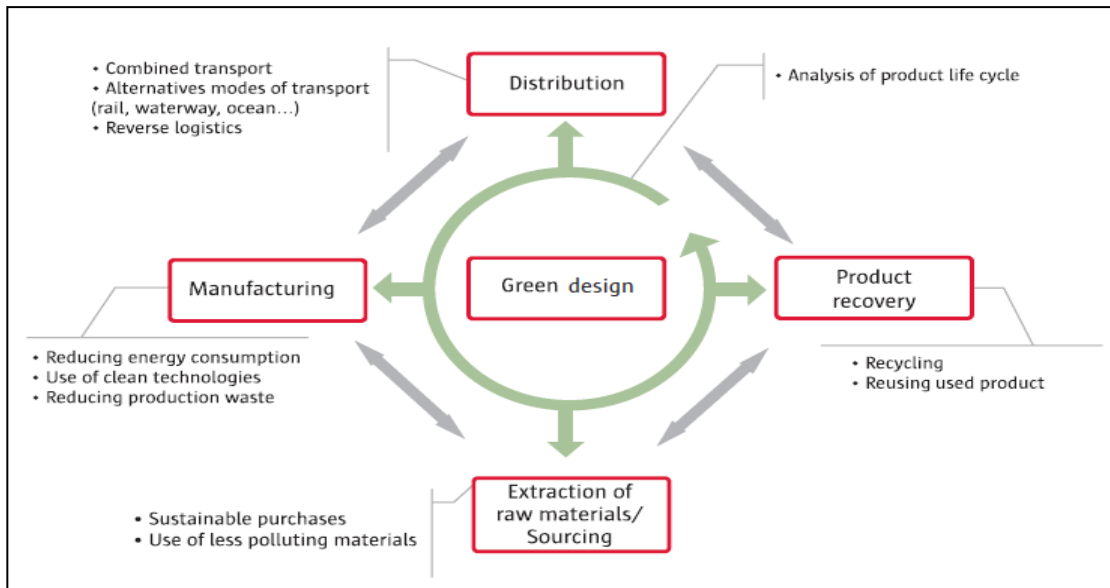
2.5 Green Logistics

2.5.1 Green Supply Chain Management and Logistics

The commercial arena considers greening as the way organisations interact with the environment in which business is conducted (Estes, 2009:2). Methods that utilise resources efficiently and effectively are sought after whilst reducing any harmful effects to the natural surroundings. Businesses worldwide are on a journey to explore ways to harmonise commercial operations with the environment, promoting a progressive transition to a green Earth where the economy, society and environment function in synchronicity with one another (Zokaei, Lovins, Wood and Hines, 2013:3-6). Green logistics is recognised as the aim of achieving carbon reduction targets from the logistics function in the supply chain whilst maintaining cost and service level performance targets. In this instance, the logistics function in the supply chain comprises of transport, warehousing, inventory management and distribution activities (McKinnon, Browne and Whiteing, 2012:5-11). Similarly, (Chittyal, Dargopatil and Bhogade, 2013:81) define green logistics as a set of activities that ensure the eco-efficient management of the flow of goods and information from point of origin to point of consumption with the aim of satisfying customer requirements.

As businesses boom, supply chains become one of the biggest contributors to the carbon footprint of most goods (Ryan, 2010). Eyefortransport (2008) notes that 75% of a company's carbon footprint is generated through supply chain related activities. Figure 2.4 illustrates the supply chain green design of a product's lifecycle from the extraction of raw materials through to the production, distribution and product recovery stage. Each activity within each stage of the process focuses on specific areas that aim to mitigate detrimental effects on the environment. The 'Insight Survey Report' by BearingPoint (2008:18-20) uncovers the extent to which the green design impacts on all players within the supply chain, thereby compelling businesses to act in a responsible manner towards the environment throughout the full life cycle of the product. Chase and Jacobs (2011:59) add that cradle-to-grave assessment of products considers the true environmental costs by accounting for eco-effects from raw materials processing, to manufacture, to distribution and eventual disposal of the product by the consumer – all of which are included in green supply chain management.

Figure 2.4: Supply Chain Green Design

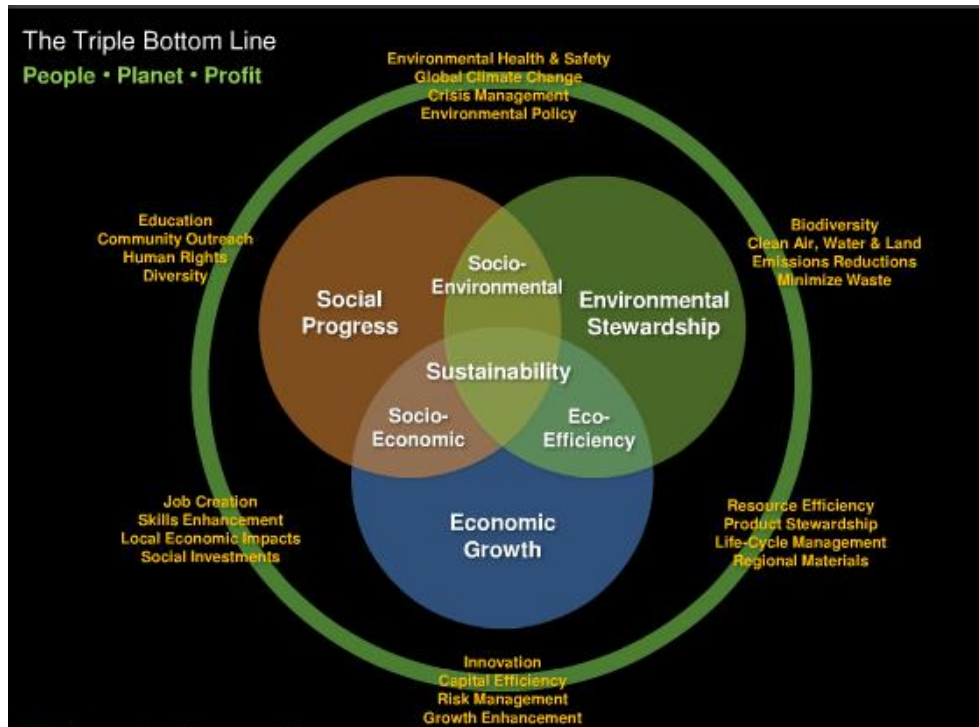


Source: BearingPoint. (2008) *Insight Survey Report: 2008 Supply Chain Monitor - How mature is the Green Supply Chain?* [online], available: http://www.escp-eap.eu/uploads/media/Supply_Chain_Observatory_2008.pdf. Accessed: [15 June 2012].

Logistics operations are a major contributor to GHG emissions and also contribute to air pollution, noise pollution, and accidents (Chittyal, Dargopatil and Bhogade, 2013:83). It has been reported that transportation activities contribute 8% of Carbon Dioxide emissions worldwide and that warehousing and freight movement add another 3% to this figure (TCS, 2010:4). Therefore, making logistics sustainable in the future suggests that innovative means need to be found to move beyond the mere reduction of carbon emissions. Sustainability from a business perspective denotes the management of the triple bottom line constituting the three pillars of social, financial and environmental elements (Winter and Knemeyer, 2013:19).

Therefore green logistics, which is concerned with the reduction of environmental and other negative impacts linked with the movement of supplies and resources between locations, can be viewed as an opportunity towards the attainment of sustainability within the logistics system, through the harmonisation of activities and achievement of optimal operations (Chittyal, Dargopatil and Bhogade, 2013:81-83). Figure 2.5 illustrates the impact of green logistics on the environment, society and the economy. These constitute what is commonly termed the 'triple bottom line' and evaluate the organisation in terms of social, economic and environmental criteria (Chase and Jacobs, 201:55).

Figure 2.5: Impact of Green Logistics on Society, Economy and the Environment



Source: GCBL.org. (2012) *The Triple Bottom Line* [online], available: <http://www.gcbl.org/transform/sustainability-agenda>. Accessed: [23 October 2013].

‘Social’ pertains to fair business practices, including the issues of labour, community, and the region in which the firm operates (Chase and Jacobs, 2011:56). ‘Economic’ concerns the business’s obligation to compensate shareholders who provide capital and financial resources through investment. In terms of sustainability, the economic component is concerned with long term economic benefit (Chase and Jacobs, 2011:56). Finally, the ‘Environmental’ dimension refers to the organisation’s impact on the environment. A company should protect the environment by reducing its ecological footprint. This is achieved by managing its consumption of natural resources and the implementation of waste reduction methods (Chase and Jacobs, 2011:56).

2.5.2 Green Logistics Dynamics

Greening the supply chain is an ever growing concern for many business enterprises and a challenge for logistics management in the 21st century. With rising costs of fuel and the relative cost of input resources used in infrastructure and buildings, companies have been forced to explore green alternatives that have led to significantly lower prices and large cost savings (Frost and Sullivan, 2011:). Hence, energy efficient technologies and recycling initiatives help improve the bottom line (profitability) of the business thereby increasing business performance and cost savings. The literature discusses the various green initiatives

and practices in the logistics industry (Evangelista, Hüge-Brodin, Isaksson and Sweeney, 2011; Geroliminis and Daganzo, 2010; and Evangelista, Sweeney, Ferruzzi and Carrasco, 2010). The following elements of green constitute the underlying themes in this study.

2.5.2.1 Warehouse Layout Optimisation

Warehousing plays an integral role in the transportation industry as it provides space for goods storage and in-transit consignments. Efficient warehouse layout can increase productivity, control inventory issues and improve accuracy in shipping. When a warehouse is designed, the most important factor to consider is the appropriate use of space; if properly planned, this can minimise overhead costs and increase productivity (Baker and Canessa, 2009:428). Zheng and Zang (2010:115) propose that proper warehouse layout can reduce transportation mileage while saving on costs. These authors argue that if the layout of the warehouse is too dense, the number of transporters is increased; leading to increased energy consumption and carbon emissions (Zheng and Zang, 2010:117).

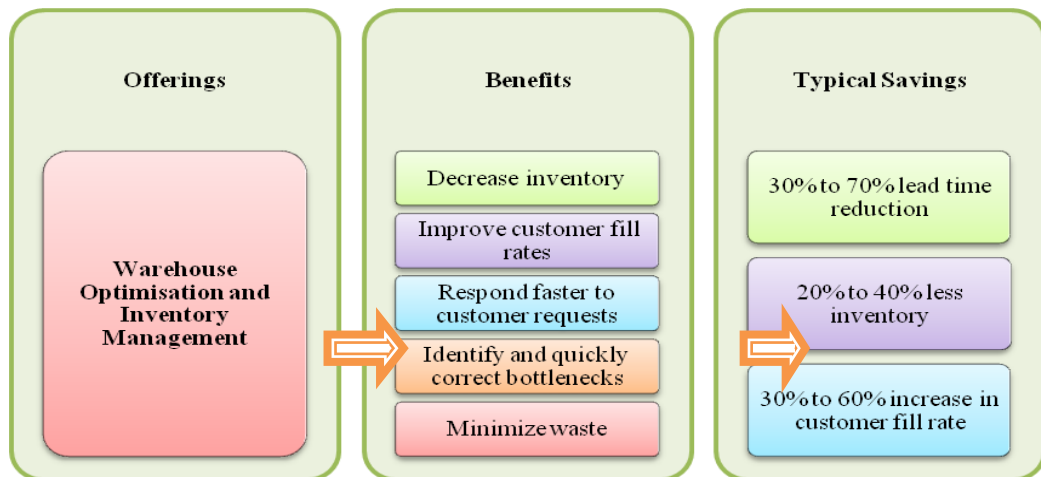
2.5.2.2 Inventory Management

Inventory management refers to the resources that are stored for usage at a later stage either through transformation from a raw to a finished state, or through use in the current state. Inventory is found in three forms: raw materials, work in progress or finished goods (Pienaar and Vogt, 2009:213). Inventory plays an important role in the planning and control of operations facilities and, hence, the overall goal of greening operations. Through appropriate JIT systems and logistics requirements planning, companies can ensure that the right goods are available at the right place, at the right time and in the right quantities (Wassonhove, 2006:478).

The logistical integration of distribution requirements and materials requirements results in reduced total inventory, thereby reducing total carrying costs along the supply chain. Whilst Michalski (2013:187-192) argues that inventory management alters the value of the firm by finding a balance between carrying too little and too much inventory, whilst Bonney (1994:109) states that it alters the internal flexibility of the company by allowing production levels to change, which impacts delivery to customers.

Thus the integration of the components of the logistics network is required to gain synergies that create and drive business value by means of optimal inventory management. This will reduce transportation, allow for more efficient delivery due to accurate demand forecasts and ultimately, reduce GHG gas emissions. Figure 2.6 indicates the cost savings that arise from optimal warehouse and inventory management (Hamilton, 2006:2).

Figure 2.6: Cost savings from optimal warehouse and inventory management



Source: Designed by researcher (From Hamilton, B. (2006) *Supply Chain Strategy within Advanced Analytics*. [online], available: <http://www.boosallen.com/media/file/Inventory-Optimisation-Fact-Sheet.pdf>. Accessed: [17 April 2013].

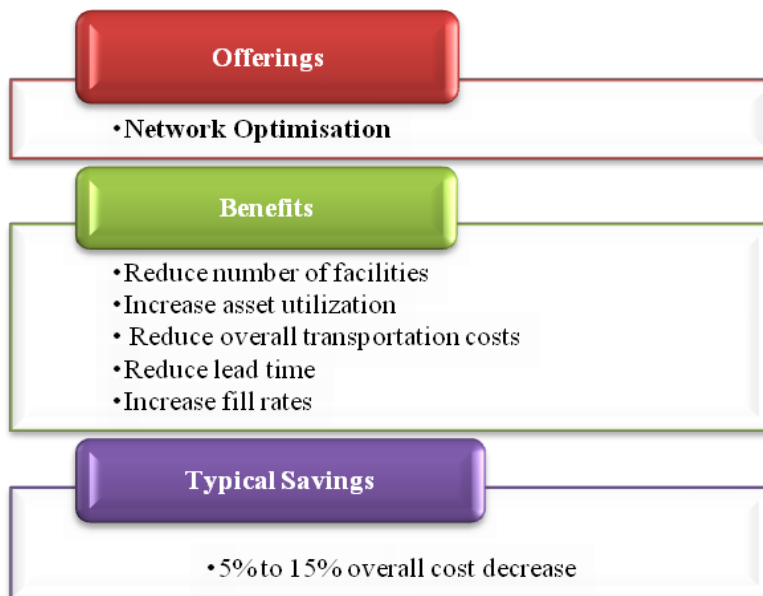
2.5.2.3 Network Optimisation

Network optimisation is a process that describes peak network efficiency. It is typically defined into three segments: sourcing, manufacturing and distribution optimisation. Firstly, sourcing optimisation helps evaluate procurement inputs and finds the best solution relative to the procurement function. It assesses the global market, supplier conditions and supply chain conditions and identifies the best possible alternatives for strategic sourcing goals (Mason, Lalwani and Boughton, 2007:190). Secondly, manufacturing optimisation is the efficient use of resources during production and a reduced production cycle time. When implemented correctly, an optimum manufacturing plant can achieve increased sales from shorter order-to-delivery times, thereby increasing average turnover (Svensson, 2010). Thirdly, distribution optimisation constitutes route planning and optimisation and load optimisation. Route planning and optimisation aims to improve delivery times whilst simultaneously reducing the cost of delivery.

Optimisation techniques which are now available in simulation models provide options for distribution rounds, multi-modal routes, pick up deliveries and optimal routing schedules (Mason *et al.*, 2007:190). Similarly, load optimisation enables the adjustment to a system's load, thereby ensuring that it meets the desired optimal activity levels. Optimal network models are able to answer questions related to a company's carbon footprint and supply chain designs that cause carbon emissions. Such models are a powerful tool to measure GHG gas emissions and analyse the carbon footprint (Zhang, Liu, Li and Yu, 2013:330). Hamilton

(2006:2) illustrates the benefits and cost savings (table 2.1) that companies could realise from an optimal network.

Table 2.1: Benefits and savings from an optimal network



Source: Hamilton, B. (2006) *Supply Chain Strategy within Advanced Analytics*. [online], available: <http://www.boosallen.com/media/file/Inventory-Optimisation-Fact-Sheet.pdf>. Accessed: [17 April 2013].

Network optimisation is the most fundamental type of modelling to optimise interrelated transportation flows that can bring substantial cost savings and carbon reduction. According to TATA Consultancy Services (TCS) (2010:8), congestion can exacerbate carbon emissions directly and indirectly. Direct increase of carbon emissions can be caused when vehicles that move at unproductive speeds increase their carbon emissions per kilometre travelled. Indirect carbon emissions are increased during periods of congestion when vehicles are re-routed.

By restructuring the network, companies are likely to realise an 11% reduction in cost and carbon emissions (TCS, 2010:8). Methods to optimise the logistics route through greening include but are not limited to; reducing the distance travelled by a product in the supply chain; using superior vehicle technology and design to increase fuel efficiency and reduce total costs and developing a strategy that considers ecological factors apart from the costs of using carbon constraint-based solutions (TCS, 2010:8).

Geroliminis and Daganzo (2010:4) observe that there are inconsistencies between logistics and greening. Cost-saving strategies implemented by logistical parties are usually at odds with the environment since the environmental costs are usually externalised. These researchers explain that “logistical activities do not pay the full costs of using the logistical infrastructure; thus, operators choose the most polluting, least energy efficient and most infrastructure-intensive transportation to increase the speed of distribution” (Geroliminis and Daganzo, 2010:4). However, Zuo and Li (2010:16) suggest three ways to increase fill rates whilst simultaneously lowering the environmental impact associated with logistics activities.

Firstly, standardisation in the transportation system can be conducted across two levels. The first is between transportation vehicles and the second is load carriers. Load carriers have to fit the vehicles; standardisation provides an opportunity to increase fill rates which reduces the environmental impact. Secondly, advances in information system support make it possible for warehouses to fulfil several functions (Zuo and Li, 2010:16). It is possible to change the management of a product over time as well as its movement between locations. Hence the use of advanced information technology systems results in increased fill rates. Thirdly, Zuo and Li (2010:16) believe that virtual warehousing promotes a comprehensive understanding of warehousing and transportation coupled with mechanisms that can lower costs and increase service delivery through improved decision making processes, thereby reducing the environmental impact.

2.6 Information Technology

Information technology (IT) plays an important role in the adoption and implementation of lean and green practices. It enables a company to achieve its goals. Using IT to optimise transportation routes ensures that goods are delivered in an energy efficient and cost effective manner. The automation of transportation planning processes allows transporters to mitigate the risks associated with unexpected events. Automation provides an optimal plan; it enables the organisation to identify waste processes through the implementation of dashboards and metrics, whilst simultaneously identifying complexity within the supply chain (Eckerson, 2010:122) Hence, through logistics and supply chain optimisation, organisations will be better positioned to reduce their carbon footprint, minimise wastage and ensure optimal resource utilisation, thereby achieving organisational goals.

The implementation of appropriate IT systems promotes efficiency by reducing the use of resources and streamlining business processes (Gibson *et al.*, 2013:101). TATA Consultancy Services (2010:13) asserts that visibility solutions can assist logistics players to track assets. This reduces the consumption of resources while achieving higher service levels. Through

asset tracking, companies gain greater control over their resources and assets. RFID (Radio Frequency Identification Device) technology is an example of an asset tracking unit that can promote the successful implementation of lean and green supply chain management strategies. In the context of logistics, the use of RFID can give a company greater control over the number of products returned, and facilitate process efficiency for reverse logistics (Tajima, 2007:264-265).

RFID technology is an enabler of significant reductions in logistics-related costs by eliminating unnecessary transportation. It identifies the optimal mode of transportation for the movement of goods; this can have a significant carbon benefit (Tajima, 2007:264-265). IT solutions integrate an organisation with its supply chain partners. Hence, companies can achieve improved utilisation of logistics assets. Improved transport utilisation can reduce overall energy requirements. Therefore, collaboration in logistics helps organisations achieve supply chain sustainability and cost efficiency, whilst ensuring that the requirements of supply chain network modelling, customer satisfaction, and optimisation are fulfilled (Wu, Yenyurt, Kim, and Cavusgil, 2006:495).

Some of the research papers analysed focus on factors influencing green initiatives. In relation to drivers, the works of Lin and Ho (2008:169) analyses organisational determinants influencing the implementation of green innovations in the logistics industry. The authors studied the influence of technological, organisational and environmental drivers on the logistics firms' willingness to implement green innovations. The results indicate that support for innovation of top management, quality of human capital, organisational knowledge accumulation have positive influence on the adoption of green innovative initiatives.

Through the analysis of literature on environmental works of companies', the research paper of Evangelista, Hüge-Brodin, Isaksson, and Sweeney (2011:17) reveal a broader perspective in analysing drivers affecting the pricing of green initiatives. The authors identify the internal driving forces. Internal driving forces includes not only organisational issues but also factors related to cost efficiency, employees interest, company's strategy and revenue and cash flow. The results indicate that higher revenues as result of better environmental performance, innovation opportunity and top management involvement are the most influential internal driving forces for green logistics adoption. A similar approach has been used by Evangelista *et al.*, (2010:9) whose study investigates the impact of internal factors affecting large and small companies. In their research, the influence of top management is perceived as the most influential internal factor among large organisations as well as entrepreneur for small companies.

The influence of firm characteristics on the adoption of green initiatives undertaken by organisations has been studied in recent literature. In general, size (in terms of both employees and turnover) is one of the most important firm characteristics expected to influence the adoption of green initiatives. Lin and Ho (2008:164-168) have shown that number of employee, company history, and company size influence initiatives taken by companies. In addition, differences between small and large logistics companies have been found by Evangelista *et al.*, (2011:15). For example, large companies show a higher level of awareness of environmental sustainability in comparison with smaller ones.

2.7 Interplay between Lean and Green

The U.S. Environmental Protection Agency (EPA, 2013:1) found that lean produces an operational and cultural environment that is highly conducive to waste minimisation and pollution prevention, and that it provides an excellent platform for environmental management tools such as life-cycle assessment and design for environment. Value stream mapping, a standard tool in lean, examines the time it takes to produce a product and the proportion of that time that is value-added; this provides the basis for optimising performance over the single dimension of time. However, it does not explicitly consider the resources consumed and the waste generated in manufacturing a product (EPA, 2013:1). To address this question, Simons and Mason (2003:84) developed 'sustainable value stream mapping' by adding a sustainability metric (supply chain carbon dioxide divided by market weight of product) to the conventional value stream mapping process. Similarly, Karp (2005:37) advocates adding environmental aspects to value stream maps.

The issue of environmental performance becomes even more complicated when entire supply chains are considered. With the rapid increase in long-distance trade, supply chains that cover longer distances, consume significantly more fossil-fuel energy for transportation and emit much more carbon dioxide than in the past (Venkat and Wakeland, 2006:4). Karp (2005:38) reports, "as large manufacturers rely on lengthy supply chains the environmental impact of suppliers continue to grow."

The transportation sector already produces a quarter of all energy-related carbon dioxide emissions and these are growing fast at a rate of approximately 2.5% per year (Venkat and Wakeland, 2006:4). This has important implications for lean supply chains. Lean principles call for distances on a supply chain to be as short as possible. However, in the age of global trade, very few supply chains can consist entirely of short transportation links. Currently, a typical supply chain is likely to have at least a few moderately long transportation links, making energy use and carbon dioxide emissions due to transportation significant

contributors to negative environmental performance. Since its primary focus is waste minimisation, it could be argued that lean manufacturing has a positive impact on the environment.

However, certain constraints need to be taken into account to determine whether or not lean thinking has a positive impact on the overall green supply chain performance. In order to mitigate the negative impact of transport on the environment, the integration of forward and reverse flows in the lean supply chain should be considered in order to determine how supply chain companies and transport providers can holistically optimise transport movements (Mason *et al.*, 2007:192).

2.8 Green and Lean Logistics in South Africa

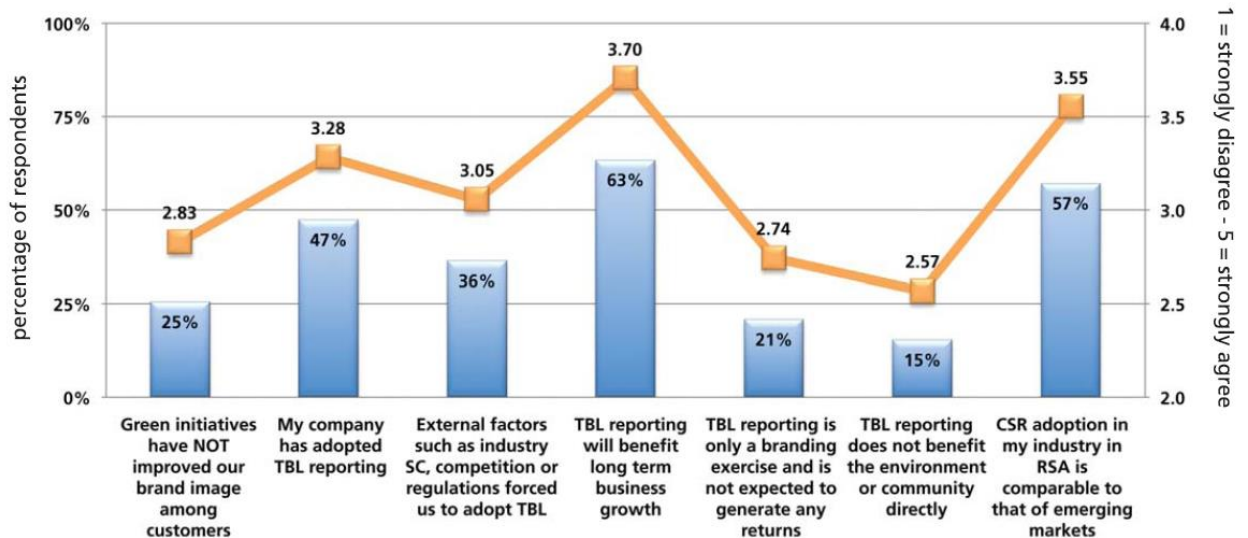
Road transporters aim to provide superior service levels at reduced costs. However, the economic and environmental viability of supply chain operations are negatively affected by the rise in road freight distribution volumes. The Council for Scientific and Industrial Research (2012:11) revealed in their research that South Africa contributes 1% to the global annual carbon dioxide emissions (CSIR, 2012:11). This figure is nearly doubled that of the world average (CSIR, 2012:11).

The report highlights that for the South African economy to reduce its green- house gas emissions, three areas with a coherent vision need to be implemented, namely; policy, investment and technology (SA Government Information, 2008). Firstly, policy frameworks need to provide guidance to the country and send appropriate messages to markets. Secondly, investment in low investment tools and mechanisms in a low-carbon society must be uncovered and pursued. Lastly, there is a need for greater deployment of existing eco-friendly technologies, together with investing in large scale research and development of new technologies.

In South Africa, approximately 75% of industrial carbon footprints come from transportation and logistics (Schoeman and Sanchez, 2009). This figure burdens supply chains to accept responsibility, invest and take the required measures towards a green supply chain. Transport accounts for 13% of GHG emissions while the industry contributes 19% to GHG emissions (CSIR, 2011:15). For South Africa to meet the “required by science” targets – that is, reducing annual emissions by 1300 Metric Ton (Mt) carbon dioxide (CO₂) equivalents (e) per year by 2050 – its transport sector will have to transform audaciously. The South African government has set energy reduction targets for the transportation sector and requires transport operators to reduce their energy consumption by 9% by 2015 (SA Government Information, 2008:12).

Further studies reveal that sustainability and governance are compatible components that successfully initiate green change. However, the findings by Frost and Sullivan (2011:9-11) show ‘emphasis not only on sustainability and governance but also carbon emission reduction and environmental awareness. A sustainable business translates to risk monitoring and mitigation to ensure the continuity of the business, by keeping the best interests of internal and external stakeholder involvement in mind.’ Hence, the study reports on Triple Bottom Line (TBL) intended to gauge this commitment to sustainability. Sustainability is reported in terms of TBL, reduction targets, green supply chain and industry alignment. The following figures show the findings by Frost and Sullivan (2011:13-18) on supply chain and sustainability.

Figure 2.7: Triple Bottom Line

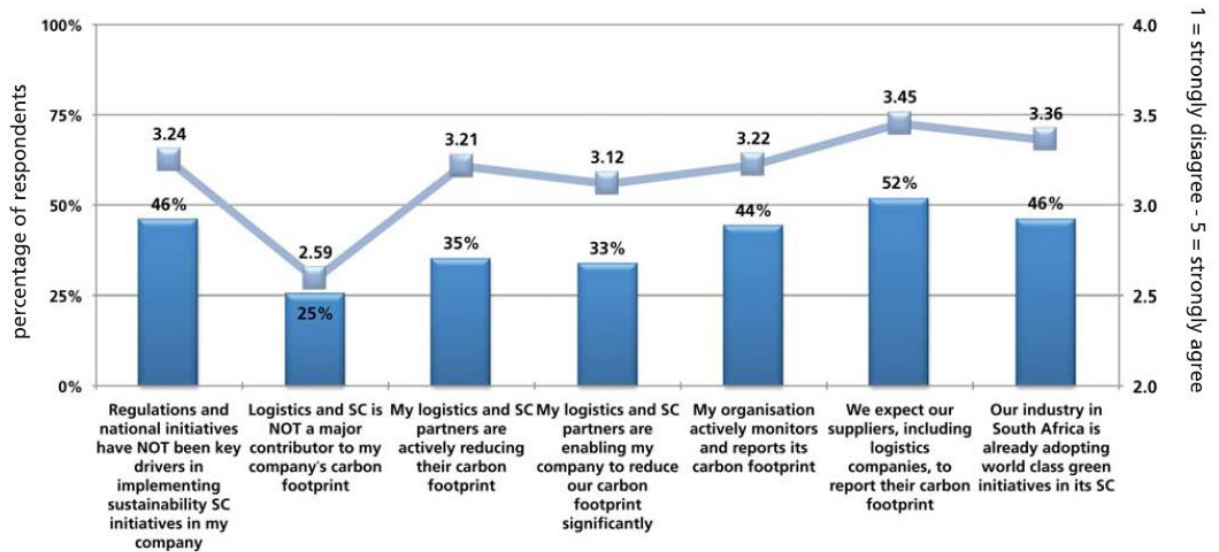


Source: Frost and Sullivan. (2011) *Evolving Supply Chains-Competitive Supply Chains and Emerging Economies*. [online], available: <http://www.barloworld-logistics.com/industry-insight/>. Accessed: [23 March 2013].

The graph shows that, while many companies have been forced by external factors to adopt TBL reporting (35%), a strong majority feel that it will benefit their business in the long term. The major sustainability initiatives that have been implemented or are planned are depicted in the diagram. The figure imparts knowledge on vital information that form part of the researcher’s objectives and sheds light on the barriers and drivers that influence the adoption green initiatives. Such results are recorded in the aforementioned study.

Taking a view on what South African supply chains are doing, is just as important as analysing an organisations contributions to TBL. Hence, the theme of the ‘Supply Chain Foresight’ survey centres closely upon evolving strategies and supply chain competitiveness in emerging economies. By shifting the focus onto supply chain strategies, green supply chains become the order of the day, tasking organisations to deal directly with issues centred on corporate social responsibility (CSR) and sustainability. Research conducted on green supply chains in South Africa reveals the following:

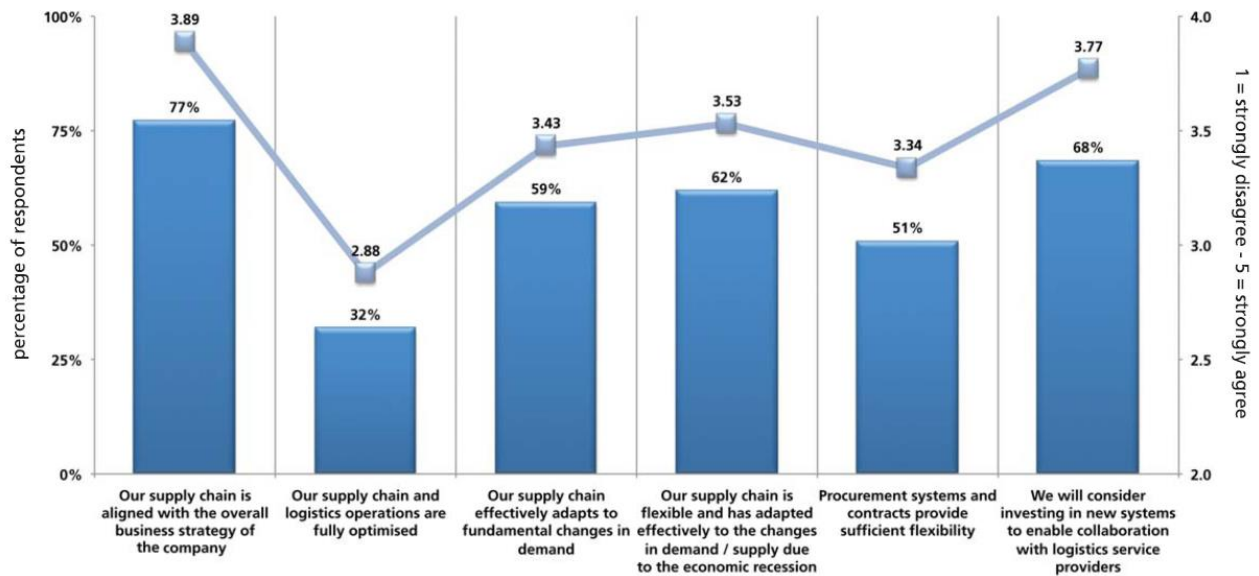
Figure 2.8: The Green Supply Chain



Source: Frost and Sullivan. (2011) *Evolving Supply Chains-Competitive Supply Chains and Emerging Economies*. [online], available: <http://www.barloworld-logistics.com/industry-insight/>. Accessed: [23 March 2013].

A large proportion of companies expect suppliers and logistics providers to report their carbon footprint (52%) and the results are evident that South Africa is adopting world class green initiatives in industrial supply chains. However, in light of a steady progression that has been evident in developing markets over the last few years, green supply chain has become an important item on the boardroom planning agenda – a main concern lay in industry alignment.

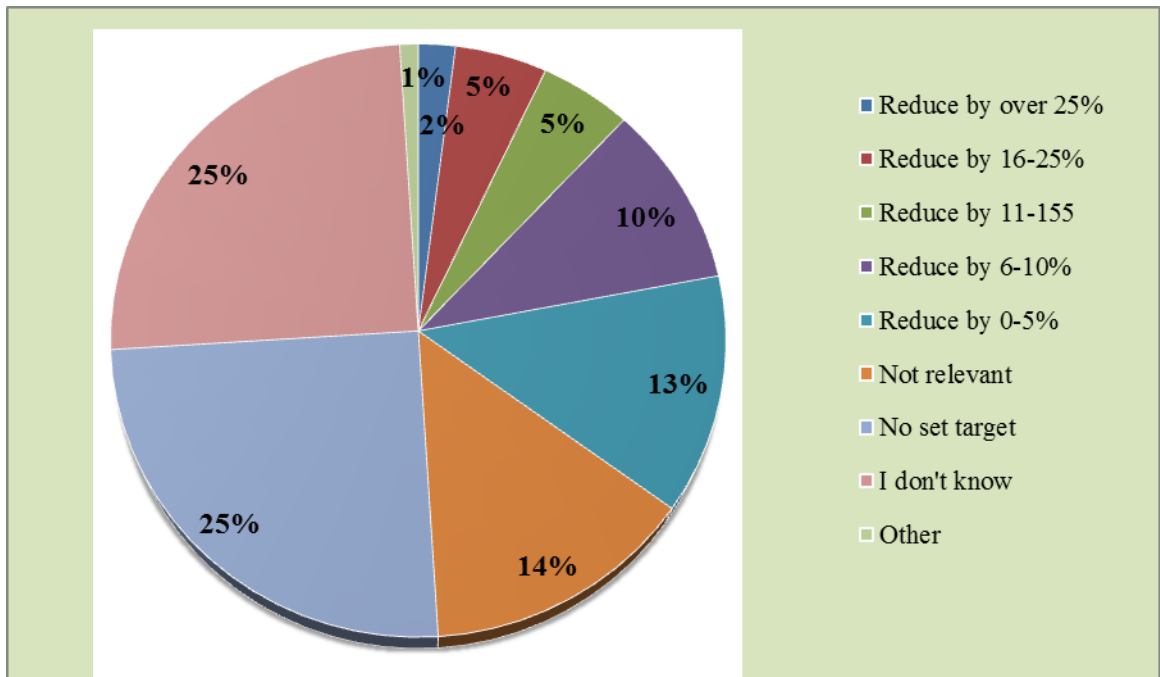
Figure 2.9: Industry Alignment



Source: Frost and Sullivan. (2011) *Evolving Supply Chains-Competitive Supply Chains and Emerging Economies*. [online], available: <http://www.barloworld-logistics.com/industry-insight/>. Accessed: [23 March 2013].

The study reveals over three quarters of the respondents believe that supply chain and business strategies of their companies are aligned. Despite this encouraging note, less than a third of respondents feel that supply chain and logistics operations are fully optimised, which may explain why over two thirds of respondents are considering investment in technology to enable collaboration chain with service providers. The apparent lack of confidence in the optimal use of supply chain and logistics may also reflect the top five challenges of eliminating waste and inefficiency in the chain. It may also reflect an ingrained desire to constantly improve. However, improvement comes with information sharing and collaboration between supply chain trading partners, hence lack of such will ultimately constrain supply chains from improving. With respect to greening, companies ought to share their green targets with key contributors in the supply chain. When the study assessed the level of knowledge regarding reduction targets, the results were less than favourable.

Figure 2.10: Knowledge on Carbon Emissions Reduction Targets



Source: Frost and Sullivan. (2011) *Evolving Supply Chains-Competitive Supply Chains and Emerging Economies*. [online], available: <http://www.barloworld-logistics.com/industry-insight/>. Accessed: [23 March 2013].

The figure illustrates that despite the strong focus on TBL and sustainability reporting, even given that it's driven by legislation, there is still little awareness and commitment to the environmental pillar of the triple bottom line. A quarter of respondents (25%) are unaware of their company's reduction targets, and another 25% say their company has no set target. Such statistics make the state of green transportation in South Africa questionable.

2.9 Conclusion

Based on literature, it is imperative that organisations and industry leaders recognise the need to change their actions that cause detrimental effects to the environment. Although green can become a costly effort for companies, there are several lean methodologies discussed in this literary framework that can assist companies in operating under lean platforms that serve both the bottom line and the environment.

CHAPTER THREE

Research Methodology

3.1 Introduction

According to the South African government's National Climate Change Response (2011:12), the transport sector contributes 13% to fuel combustion and 8% to South Africa's total emissions. Thus, transport and logistics companies are under pressure to go green. However, this industry is plagued by high costs and the inefficient utilisation of resources (Allix, 2013). The element of lean is introduced in this study to demonstrate the overlapping characteristics of both concepts lean and green (Ittmann and King, 2010:1). This chapter outlines the manner in which the research for this study is conducted. It details the nature of the study, the type of research design, and the methodology employed for analysing the data.

3.2 Type of design

A research design exploratory in nature has been adopted for this research. Cooper and Schindler (2008:143) describe exploratory studies as "loose structures with the objective of discovering future research tasks." The immediate purpose of exploration is usually to develop hypotheses or questions for further research. Given the lack of theory and empirical studies in this field, the exploratory design is an appropriate research method. This study is divided into two parts; the first phase provides an extensive literature review which is instrumental in designing the data collection guide. The second phase involves data collection that constitutes the participation of a sample of logistics service providers within the Durban region. The empirical analysis explores a number of key issues relating to 3PLs' supply chain green offerings and lean practices.

3.3 Nature of the study

The study is quantitative in nature. The quantitative aspect serves to answer questions about the relationships among the variables studied and derives meaning from the data analysed through the use of statistics, diagrams and tables (Cooper and Schindler, 2008:146). The nature of this study is also discussed in relation to the time horizon as either being longitudinal or cross-sectional. This study is cross-sectional in nature as data is gathered from various logistics companies in the Durban region at a single point in time (Cooper and Schindler, 2008:144).

3.4 Sampling design

Sampling design is defined as the process of selecting the number of units for a study in a way that represents the larger population from which they are selected (Sekaran and Bougie, 2010:266). There are two main kinds of sampling design: probability and non-probability sampling. A non-probability sampling design has been used in this research. This method of sampling does not confidently enable generalisation across the population, however, since the nature of this study is exploratory; non-probability sampling is a preferred method to provide insight on the subject of lean and green logistics in the Durban region.

3.5 Target Population

Neelankavil (2007:234) defines the target population as total elements in the target group or population that is relevant to the research study. The target population for this study is various logistics companies in the Durban region. According to the Online Business List (2014), there are approximately 221 logistics companies operating in the Durban region. This study aims to get at least six participants in proportion to the required categories from judgemental sampling within each company. The logistics companies (targeted population) will be multiplied by six to reflect the estimated population size (221 companies multiplied by six individual participants equals 1326 population size). According to Sekaran (2003:294) sample table, this figure (1326) is equivalent to the sample size of approximately 300. The six participants describe the mixture of lower (1 participant), middle (2 or 3 participants), top (2 or 3 participants) level management and supervisors (1 participant) in this study. Since it is not possible to reach all the members of the target population, the population most accessible operate in the Durban South basin. The sample consists of three major players and decision makers in the road freight industry, as well as medium to small size companies.

3.6 Type of sample and sample size

According to Sekaran and Bougie (2010:276) the non-probability sampling design attaches no probability to the elements being chosen in the population. There are two categories of non-probability sampling, namely convenience sampling and purposive sampling, more specifically, judgement sampling. Judgement sampling involves the choice of subjects who are most advantageously placed or in the best position to provide the information required (Cooper and Schindler, 2008:397). In the organisational setting, opinion leaders who are very knowledgeable are included in the sample (these are respondents that are placed in middle and top level managerial positions). These participants are in the best position to enlighten the researcher with their views, opinions and knowledge on the topic of lean and green logistics, and therefore constitute a rich data source. This study has employed both methods of sampling to gather information from logistics companies in the Durban region. These sampling methods have been chosen to obtain as much information possible from

logistics companies and their views on lean and green logistics. The respondents represent a mixture of lower, middle and top level management as well as non-managerial personnel such as supervisors that are strongly absorbed by management structures. From an initial distribution of 300 questionnaires, the researcher received 210 – this falls in line with the sample size guidance using Sekaran's table (Sekaran, 2003:294). Hence the sample size of this study is 210, representing a sample return rate of 70%.

3.7 Data Collection and measurement instruments

3.7.1 Questionnaire

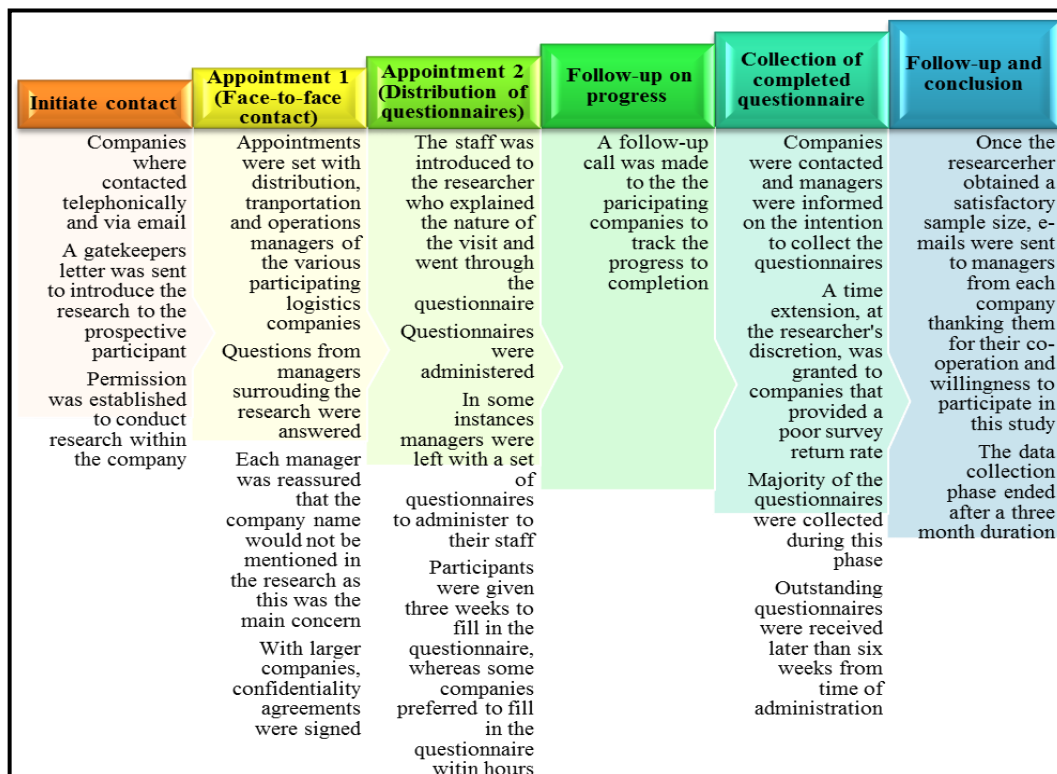
Data was collected by administering questionnaires to employees, in the various positions held, from various logistics companies in the Durban region. The questionnaire comprised four sections. Section A focused on biographical information on the respondent and the company. Section B of the questionnaire sought brief and concise information on the subject under investigation. These questions solicited 'yes' or 'no' answers and were designed around green initiatives, information awareness, technology and corporate policies.

The third section (section C) involved a more interactive approach. This method of questioning required the respondents to rank given statements according to their perceptions and experiences. This section views the factors that drive companies to adopt lean logistics. Respondents were required to choose three statements from the four provided and rank each statement in order of importance from 1-3; 1 indicating 'least important' and 3 indicating 'most important.' These statements are grouped under the four categories of lean logistics, namely; warehouse layout optimisation, inventory management, network optimisation and logistics optimisation. The fourth segment (section D) was based on the 1-5 point Likert scale, where respondents were asked to rate the statements in accordance to what they perceived to be true. Respondents could agree, disagree, or choose to be neutral when rating each statement. This section provides information on important data that will be used in conjunction with the other three sections in the analysis of the results.

Diagram 3.1 depicts the various steps involved in the administration of questionnaires. This process has six phases beginning from contact initiation through to conclusion. In phase one, the researcher initiates contact with the various logistics companies both telephonically and via e-mail. A verbal synopsis is provided to managers about the nature of the research and gatekeepers letters are sent to the contact person for review. This phase introduces the study to the potential participating organisation, and interested parties provide permission to conduct research within their organisation. The second phase is the face-to-face contact with the companies. Managers that had questions and concerns expressed their views at the first meeting. In the instances of large companies, confidentiality agreements were signed. During

this phase, the researcher assures management that all information is kept confidential and anonymous for the duration of this research study. Phase three comprised of the distribution of questionnaires. The research intent was explained to participants, as well as each section of the questionnaire. The researcher was available for questions from participants, who filled out each questionnaire at the time of issue. Questionnaires were issued to managerial and non-managerial personnel. In cases where staff could not avail themselves, questionnaires were left behind for completion. Phase four is described as a follow-up process where participants were contacted to track the progress of completed surveys. The collection of completed questionnaires occurred in phase five. Majority of the questionnaires were collected in this phase. The last phase, phase six, is described as the follow-up and conclusion. Managers were contacted from each company to thank them for their co-operation and willingness to participate in this research study. The data collection phase concluded thereafter.

Figure 3.1. Data collection process



Source: Designed by researcher as the process and administration for data collection

3.8 Data analysis

Data analysis is the most crucial aspect of a research study. Once the researcher had gathered the necessary information from the sample, statistical analysis was conducted to confirm the objectives set out in the theoretical framework. Statistical analysis was performed using two types of software, SPSS and Excel. Three techniques are used to analyse the data: univariate, bivariate and multivariate data analysis.

3.9 Research Method

3.9.1 Univariate Data Analysis

Univariate analysis involves the examination across observations of one variable at a time (Bryman and Bell, 2007:357). In this study, univariate data analysis will be composed of:

- a) Frequency tables: These display the number of people and the percentage belonging to each category for the variable in question
- b) Diagrams such as bar charts, pie charts and histograms are some of the methods employed to display quantitative data. The advantage of using diagrams is the ease with which one is able to interpret and understand the collated information. Diagrams are the easiest method to use when working with nominal or ordinal variables. The nature of the variable is summarised *via* its distribution, central tendency and dispersion (Cooper and Schindler, 2008:446).

3.9.1.1 Descriptive Statistics

Descriptive statistics quantifies the attributes of the data in terms of its distribution, central tendency and dispersion (Bryman and Bell, 2007:259). Firstly, distribution is a description of how frequently the individual values occur. It is a very useful way of summarising cross-sectional data which can be represented using a frequency histogram. The distribution of a variable is also described in terms of its relative symmetry and skewness (Cooper and Schindler, 2008:457).

Secondly, central tendency of a distribution is the estimate of the “centre” of a distribution of values. It gives an indication of a typical value in a sample. Measures of central tendency are discussed in terms of mean, median and mode (Cooper and Schindler, 2008:448) Central tendency is described by the mean which measures the average value in the sample; the median which is the value found in the middle of the sample when all sample values are arranged in ascending or descending order; and lastly the mode which refers to the most common value in the sample. All three measures can be compared in order to provide an indication of the skewness of the distribution.

The following conditions hold true regarding the mean, median and mode (Sekaran and Bougie, 2009:316). If:

- a) Mean > Median > Mode = Distribution skewed to the right
- b) Mean < Median < Mode = Distribution skewed to the left
- c) Mean = Median = Mode = Distribution is symmetric

Thirdly, measures of dispersion seek to quantify how dispersed the values tend to be in the distribution. According to Cooper and Schindler (2008:448) the common measures of dispersion include:

- a) Variance that measures the dispersion about the mean
- b) Standard deviation that summarises how far from the mean the values tend to lie
- c) Range that is the difference between the largest and smallest score in the distribution

Frequency distributions are used to represent the data collected from Section A, B and C. The frequency distribution provides a better indication on the more popular responses in the sample. Descriptive statistics is used to evaluate the variables in section D which examine both lean and green logistics. The results from descriptive statics will be further evaluated against the bivariate and multivariate data analysis techniques and also confirm results using different forms of analysis.

3.9.2 Bivariate data analysis

Bivariate data analysis seeks to identify the association between two variables (Bryman and Bell, 2007:360). The purpose of using bivariate analysis is to look at the association between the selected variables under study. This technique can be performed on qualitative and quantitative data and can be represented in the form of graphs or statistics. The following research tools are used to identify the association, difference, relationships and correlation between two variables.

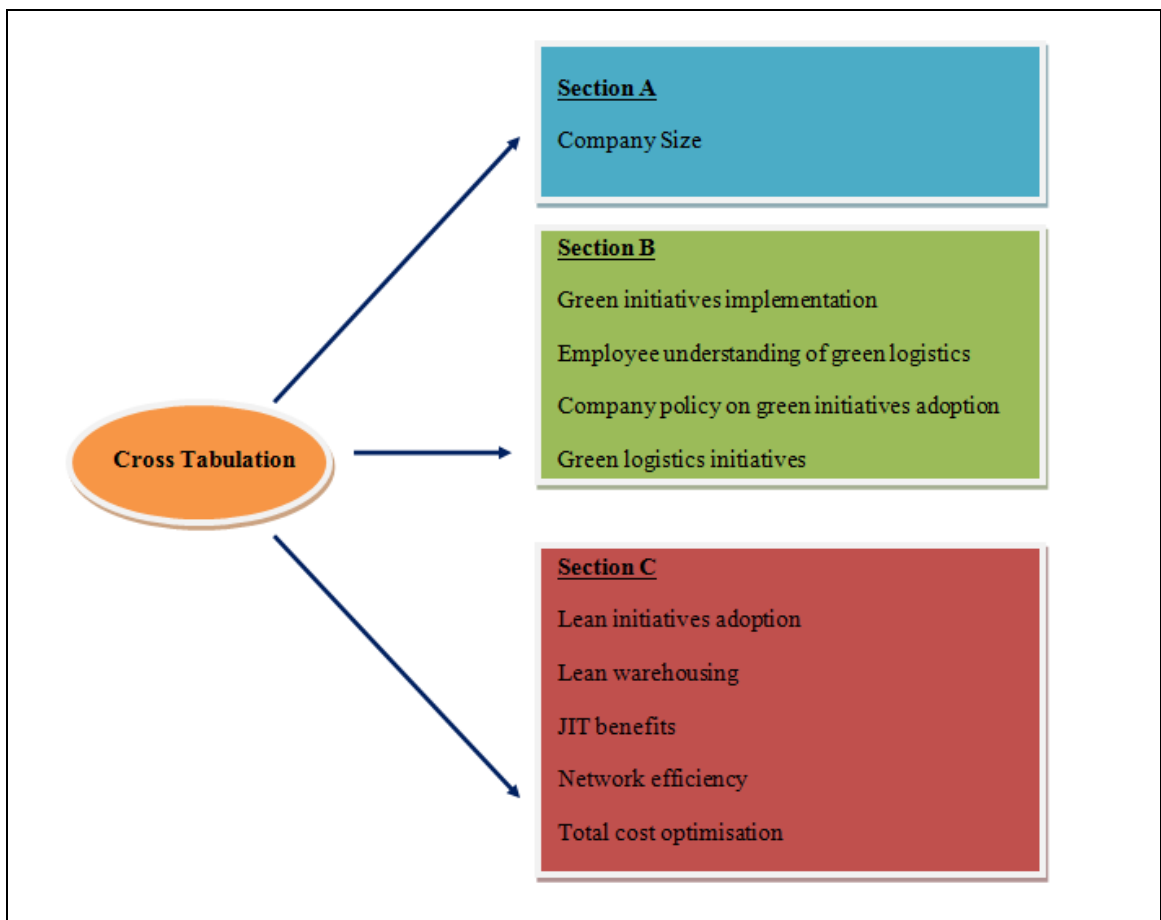
3.9.2.1 Cross-Tabulation

Cross tabulation is “a technique of comparing categorical data from demographic variables and the study’s target variables. It uses tables consisting of rows and columns that correspond to the coded values of each variable’s category” (Cooper and Schindler, 2008:459). When tables are constructed for statistical testing, they are referred to as contingency tables. The purpose of cross-tabulation is to establish a relationship between two variables; if so, the information can be represented in a two-dimensional frequency

distribution by cross-tabulating the variables. When variables take on different values and cannot be meaningfully cross-tabulated, graphic displays and summary statistics help describe the extent of the association between the variables.

To assess the existence of relationship between green logistics and lean logistics, cross tabulation is applied to variables in section A, B and section C. These variables are illustrated in figure 3.2:

Figure 3.2 Variables for cross-tabulation



Source: Designed by researcher

When the variables in figure 3.2 are cross-tabulated, they provide relative answers to the following statements:

- The size of the company determines the implementation of green initiatives
- The size of the company is relative to the understanding of green initiatives among employees
- The adoption of lean initiatives is linked to the company's policy in green initiatives
- Green logistics initiatives relate to lean warehousing

- e) Lean logistics initiatives relate to JIT benefits realised by logistics firms
- f) The adoption of green logistics initiatives is related to network efficiency in the transport system
- g) Lean logistics initiatives relates to total cost optimisation in a logistics system

The cross-tabulated results are then evaluated against the Chi-Square tests and hypotheses being investigated.

3.9.2.2 Pearson Product-Moment Correlation Coefficient

Karl Pearson was an influential figure in the world of mathematics and statistics. In 1911, he opened the world's first statistics department at University College London. His work embraced the development of mathematical statistics models and spread into various non-mathematical fields such as biology and social history (Department of Statistical Science, 2012). Pearson's thinking is the foundation for many mathematical and statistical methods commonly employed in quantitative fields; one such example is the Pearson Product-Moment Correlation Coefficient and its relationship with linear regression.

Pearson Product-Moment Correlation coefficient measures the magnitude and direction of linear associations. The measure is represented by symbol r which can take on a range of values falling between +1 through to -1 (Cooper and Schindler, 2008:510). The magnitude indicates the degree of the relationship to which variables move in unison or opposition. Thus, the size of the correlation of +0.4 is the same as that of -0.4 (Cooper and Schindler, 2008:510). The sign says nothing about the size, but is only indicative of the direction of the relationship. The direction indicates if large/small variables on one variable are associated with large/small variables on another. Thus, it is said when two variables interact in this way, they have a positive relationship; indicating that an increase in one variable leads to an increase in another and *vice versa*. Hence, when using Pearson r the cause and effect relationship cannot be determined, but one can deduce that the two variables are associated with each other. Thus, Pearson r gives both the strength and the direction of the relationship (Cooper and Schindler, 2008:510).

Table 3.1 below summaries the range of values and the interpretation of the strength and the direction of Pearson r values.

Table 3.1: Pearson Product-Moment Correlation

<i>Pearson r</i>	<i>Strength and Direction</i>
+1	Perfect positive
+0.7	Strong positive
+0.4	Moderate positive
0.0	No relationship
-0.4	Moderate negative
-0.7	Strong negative
-1	Perfect negative

Source: Cooper and Schindler. (2008) *Business Research Methods*.10th Edition. New York: McGraw Hill.

Pearson’s correlation co-efficient is applied to variables in section D which evaluates the dynamics of lean and green logistics. Although this instrument does not indicate the predictive power of each variable over the other, the strength and direction of the relationship is utilised in conjunction with the multiple regression model that illustrates model predictors. In this instance, Pearson r can provide greater insight on the strength and direction of the predictor variable that influences the overall regression model.

3.9.2.3 Inferential Statistics

Inference refers to drawing conclusions and testing hypotheses about a population based on the evidence collected in a sample (Walliman, 2009:257). It is important to ascertain if the variable in the sample deviates somewhat from the population; if it does, one needs to determine if the difference is statistically significant or insignificant. Cooper and Schindler (2008:468) state that, “a difference is statistically significant if there is a good reason to believe that the difference does not represent random sampling fluctuations.” One method of testing for statistical significance is the development of hypotheses.

Hypothesis testing: When testing for significance, two types of hypotheses are used. The null hypothesis (H_0) is a statement that no difference exists between the two variables under study or that there is no significant difference between the two groups. The alternate hypothesis (H_1) is the exact opposite of the null hypothesis, stating that there is a relationship between two variables or significant differences between two groups (Cooper and Schindler,

2008:458). For this study, the confidence level used will be 95% corresponding to a significance level of $p = 0.05$. If p is less than 0.05, the decision is to reject the null hypothesis and accept the alternate hypothesis, concluding that there is a significant difference or relationship between the variables. Hence, the variables reach statistical significance.

Chi-Square: The Chi-square test is a non-parametric test of significance that is used to perform hypothesis tests about the variance (Wegner, 2006:248). For the Chi-square test, the decision rule is to retain the null hypothesis and reject the alternate hypothesis if $p > 0.05$, and accept the alternate hypothesis and reject the null hypothesis if $p < 0.05$. Chi-square answers the question of whether there is a relationship between two nominal variables or whether they are independent of each other. The degree of freedom is a value related to the number of categories (k) or outcomes of the frequency distribution and estimated parameters (m) (Wegner, 2006). In this study, Pearson Chi-Square is the determinant test on the existence of the relationship between the two variables.

The following hypotheses are tested, and Pearson Chi-Square value is evaluated against the p -value threshold to ascertain the decision to reject or accept the null hypothesis:

H₀₁: The size of the company determines the implementation of green initiatives

H₀₂: The size of the company is relative to the understanding of green initiatives among employees

H₀₃: The adoption of lean initiatives is linked to the company's policy in green initiatives

H₀₄: Green logistics initiatives relate to lean warehousing

H₀₅: Lean logistics initiatives relate to JIT benefits realised by logistics firms

H₀₆: The adoption of green logistics initiatives is related to network efficiency in the transport system

H₀₇: Lean logistics initiatives relates to total cost optimisation in a logistics system

3.9.3. Multivariate Data Analysis

Multivariate data analysis is a statistical technique used to analyse data that arise from more than one variable. Multivariate analysis is described from two perspectives for this study, namely factor analysis and multiple regression. Factor analysis makes use of tables to obtain summary statistics on variables whilst identifying patterns and trends in the data. These are displayed in graphical plots (Pallant, 2009). Multivariate analysis also seeks to identify relationships between a set of variables, where the purpose is to predict which variable has a contingency effect on another. The corresponding analysis is called multiple regression analysis. Variables are classified as either dependant or independent. A dependant variable is

what is being measured in the study and what is affected during the research. It is influenced by the independent variable. An independent variable cannot be manipulated or controlled (Bryman and Bell, 2007). In this study, multiple regression and factor analysis is used to analyse the data. The two methods are discussed in more detail below.

3.9.3.1 Multiple-Regression

Multiple regression is used as a dependency tool to illustrate the effect the independent variable has on the dependant variable. It is an extension of the bivariate linear regression model, with the only difference being that, in multiple regression three or more variables are used. Multiple regression is used in three types of situations (Cooper and Schindler, 2008:456).

Firstly, it is used to develop a self-weighting estimating equation to predict the values of the dependent variable by using the values of the independent variable. Secondly, it is used to control compounding variables to provide better analysis of the contribution made by other variables in the study. Finally, multiple regression is used to test and explain causal theories.

According to Cooper and Schindler (2008:549) “collinearity exists when two independent variables are highly correlated” and these variables have damaging effects on the model. Multi-collinearity, on the other hand refers to the correlation of three or more independent variables and its damaging effects on the model. When multi-collinearity exists in the model, the value for the estimated regression co-efficient can fluctuate drastically, making it difficult to interpret the coefficients as an indicator of importance of predictor variables (Cooper and Schindler, 2008:549). The researcher can identify if multicollinearity exists in the model by looking at the tolerance and VIF values.

Tolerance is an indicator of how much of the variability of the independent variable is not explained by the other independent variables in the model. If tolerance is less than 0.10, it indicates that multiple correlation with other variables is high, suggesting the possibility of multicollinearity. If the variance inflation factor (VIF), which is the inverse of the tolerance value, is greater than 10, this also is an indicator of multicollinearity (Pallant, 2008:158). Normality exists when the ordinary least squares assumptions have not been violated. These assumptions state that, firstly, the regression model is linear in the parameters and is correctly specified; secondly, that the two independent variables are uncorrelated with the error term; thirdly, that the constant is homoscedastic; and finally, that there is no autocorrelation. Homoscedasticity is achieved when all random variables have homogeneity between them, meaning there is a constant variance (Garson, 2012:39). In conjunction with multiple regression tests, factor analysis is a commonly used method of data analysis.

3.9.3.2 Factor Analysis

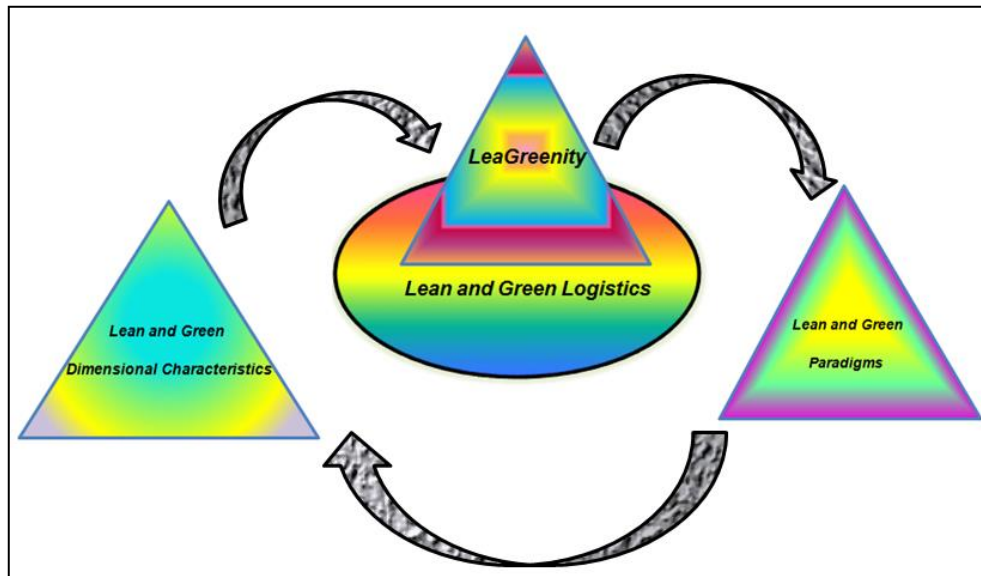
Factor analysis aims to reduce all variables to a manageable number of variables that belong together and have overlapping measurement characteristics (Cooper and Schindler, 2008:562). Two techniques can be used for factor analysis, namely, principal component analysis and factor analysis. These are similar and produce a small number of linear combinations that capture most of the variability in terms of correlation patterns. The linear combinations of variables are called factors, which account for the variance in data as a whole (Pallant, 2008:181).

Communalities refer to the estimate of the variance in each variable that is explained by the two factors (Cooper and Schindler, 2008:564). It indicates the overall fit among the rest of the variables. Factor extraction methods involve determining the number of factors that best represent the interrelationships among the set of variables. The most commonly used method for factor extraction is component extraction. This method of factor extraction that has been applied in the research helps determine which factors describe the underlying relationship among variables.

Factor analysis is applied to the thirteen variables on the 1-5 point Likert scale. The total of thirteen variables are reduced to manageable factors, which are then measured in terms of sampling adequacy using the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity is applied to confirm that some level of correlation does exist among the variables. The table of communalities show that all the items fit relatively well with each other, this is determined by the extraction value obtained using the statistical software package SPSS.

Another method for which factor extraction has been performed in this study is by using Kaiser's criterion and Cattell's scree test. These methods of factor extraction reduce the data to minimal influential variables. Kaiser's criterion, also known as the eigenvalue rule, enables a researcher to determine the amount of total variance that is explained by the factor (Pallant, 2008:181). Only eigenvalues greater than 1.0 are retained. The correlation coefficient are called loadings, whereas eigenvalues are the sum of the variances of the factor values. In this study, three factor loadings are generated by factor analysis, namely; LeaGreenity; Lean and green dimensional characteristics and; Lean and green paradigms – forming the GLean circular model. These loadings from factor extraction are labelled accordingly to represent the interrelationships among the set of variables.

Figure 3.3 The GLean circular model: Factors influencing lean and green logistics



Source: Designed by researcher

Catell's scree test involves plotting each of the eigen values to establish the factors that contribute the most in explaining the variance in the data set. The point at which the shape changes direction indicates a lower degree of explanation of variance by the factors (Pallant, 2008:184). The second form of regression analysis employed to determine the probability of an event occurring is, logistics regression.

3.9.3.3 Logistics Regression

The primary difference between the use of multiple regressions analysis and logistics regression analysis is the nature of the dependant variable. Where the dependant variable is continuous in multiple regressions, in logistics regression, the dependant variable is categorical. In such instances, logistics regression allows the researcher to predict the outcomes of two or more categories, for example, pass/fail, yes/no, win/lose (Pallant, 2011:168).

This study makes use of binary logistics regression to predict the likelihood of the event/person belonging to one group rather than another. Logistics regression is applied to the dichotomous questions of the survey using the force entry method. This analysis technique helps answer objective three of the study that strives to identify the opportunities arising from the drivers, barriers and challenges of green logistics. Thus in doing so, logistics regression provides the probability of the respondent answering yes or no to the statements listed. Each participant's responses are re-coded in SPSS to reflect the probabilities of either 0 = No or 1= Yes. Hence, in this study logistics regression applied to dichotomous questions

will enable the researcher to assess the predictive power of the dependant variable whilst controlling the effects of other model predictors.

The output generated in this regression analysis yields the Omnibus Test of Model Coefficients which indicates how well the model performs overall. This is more reliable than the original model that contains only the dependant categorical variable and is also validated by the Hosmer and Lemeshow Test which is deemed the most reliable test of model fit. The Cox and Snell R Square and the Nagelkerke R Square values are an indication of the level of variation in the dependant variable explained by the model. These values provide a range for which variability exists (Peng and So, 2002).

The sensitivity of the model is described as true positives and the specificity of the model as true negatives. This merely describes the percentage of the group possessing and not possessing the characteristic being tested. These values are calculated mathematically from the output generated by SPSS (Pallant, 2011:177). The predictor variables that make a significant contribution to the model are identified using the Wald Test whose values have corresponding statistically significant results at the 95% level of confidence. These variables have predictive power in the model and control the outcome of the dependant variable.

The B values are used in the probability equation to calculate the likelihood of a case falling into a certain category. Positive and negative B values indicate the direction of the relationship in terms of which factors increase the likelihood of obtaining a yes and which decrease it. The odds ratio is also an important value in logistics regression. From the SPSS output, the Exp(B) value predicts the odds of an outcome being in one of the categories of yes or no for each variable when the predictor value increases by one unit. However an important consideration in any form of data analysis is the reliability and validity of data.

3.10 Reliability

Reliability is measure of goodness. In qualitative data, there are two methods of reliability. Firstly, category reliability refers to the extent to which researchers can use category definitions to classify their conclusions/data. It is defined as a 'dependence' on the researcher's ability to formulate categories and present them to competent judges' definition of categories so that they can agree on which items of certain populations belong to a category and which do not (Cooper and Schindler, 2008).

Secondly, inter-judge reliability refers to the consistency between two coders that are coding the same data. Consistency will be used as a method of reliability for this study (Cooper and Schindler, 2008). Reliability will be tested using Cronbach's Alpha which is a test for internal consistency. This statistic provides an indication of the average correlation among

all the items. Values range from 0-1, with higher values indicating higher reliability (Bryman and Bell, 2007:164). Generally, reliability is achieved when Cronbach's Alpha value is greater than 0.6. The closer the value is to 1, the more reliable the data. Using SPSS, the value of Cronbach's Alpha for this study is 0.76, this indicates the data in this study is reliable.

3.11 Validity

Validity refers to a set of questions with the hope of tapping the concept. Validity can be determined by applying certain validity tests in order to measure the right concept (Bryman and Bell, 2007:165). The main type of validity relevant to this research study is construct validity. Construct validity involves measuring the degree to which the scale measures the underlying concept it claims to measure (Beins and McCarthy, 2012:68). Validity is ascertained by testing the pattern of correlation of a measure with other measures and arguing from the patterns of correlation that the measure is associated with variables in a theoretically predictable way. Each measure in this study is tested more than once using the various data analysis techniques, patterns of correlation in the results are then observed to support the findings, these patterns are then evaluated against the theoretical framework to ascertain the validity of the result and provide an extension to theory based on previous research findings. Validity must be secured first, because the researcher needs to ensure the measurement of the right concept and thereafter measure the stability and consistency of the concept which is determined by reliability.

3.12 Conclusion

This chapter has set the scope for the methods to be applied to gather the data for this study. It also discusses the data analysis technique that will be employed in the next chapter. Research methodology is a crucial aspect in a research study as it ensures the data collected and results gained are valid and accurate for further use and understanding on the topic being investigated. For this exploratory research, the use of convenience and judgement sampling will provide more information on the subject of lean and green logistics systems in the Durban road freight network. The results interpreted from the various data analysis techniques will help provide greater insight into lean and green logistics, whilst also enabling the identification of future research on this topic.

CHAPTER FOUR

Data Analysis

4.1. Introduction

Chapter four presents an analysis of the data collected. Three methods of data analysis are employed, namely, univariate, bivariate and multivariate data analysis. This chapter critically analyses all the variables in this study in order to gain insight into lean and green logistics systems. This chapter lays the foundation for chapter five which discusses the results in relation to the theoretical framework and objectives of the study. The Market Intelligence Group (2013) discusses the importance of data analysis by describing this activity as a means of providing support to the decision making process for business management teams. Data analysis offers several benefits to companies by providing meaningful insight from a dataset, coagulating a macroscopic industry issue to micro-manageable sub-parts, but most importantly data analysis facilitates critical decision making from research findings that eliminate human bias through appropriate statistical concepts and applications. The sequence of data analysis in this chapter will follow the patterned application of univariate, bivariate and multivariate techniques to the variables being examined.

4.2. Descriptive statistics

4.2.1 Frequency Distribution

Frequency distribution and descriptive statistics will be utilised as measuring instruments to analyse across observations one variable at a time. The following frequency distributions provide graphical summaries of the biographical data and company profiles obtained in section A of the questionnaire from 210 respondents. Frequency distribution graphs are presented on managerial position, gender, work experience, department, company size, lean initiatives adoption and meaning of GSCM. A consolidated frequency distribution also illustrates the responses on the variables tested in the section of dichotomy.

Figure 4.1: Managerial Position

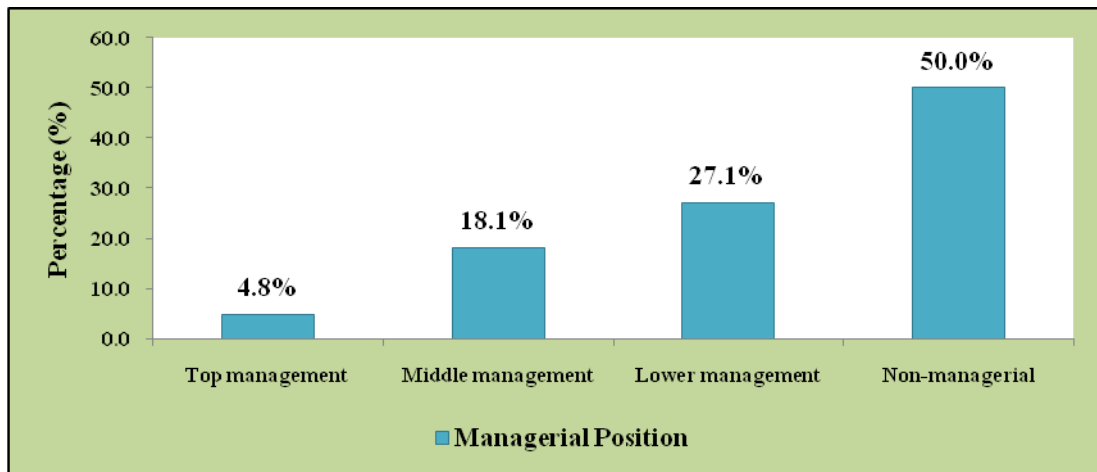


Figure 4.1 illustrates that a significant proportion of the sample (50%) consists of individuals in non-managerial positions, whilst the second highest category of participants (21.1%) are in lower management positions. Middle management represented 18.1% of the sample, followed by top management which comprising 10 respondents (4.8%). The poor representation of top management is largely due to the period in which the field work was conducted. The second half of the year is the peak season in the logistics industry; high ranking individuals are unavailable at this time due to operational commitments and high performance targets.

Figure 4.2 Gender

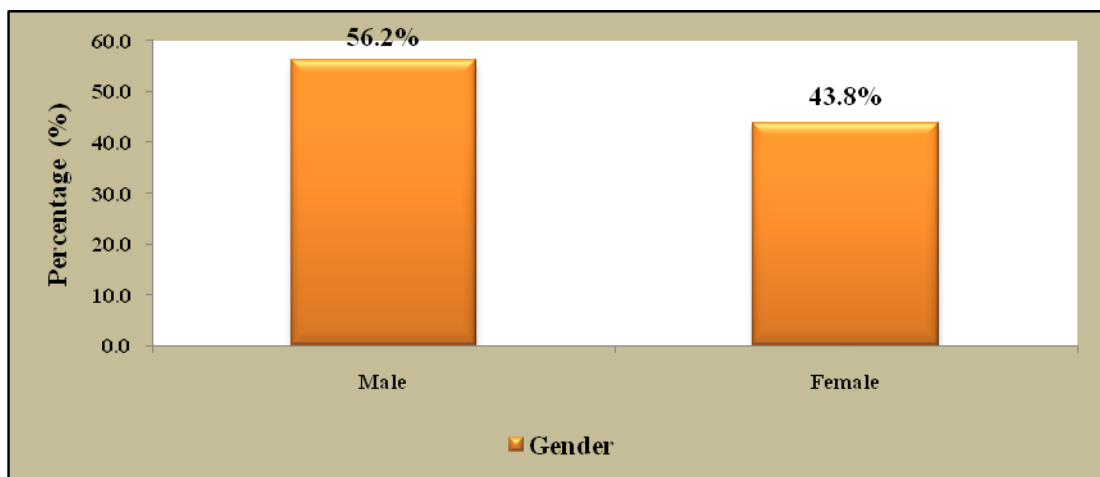


Figure 4.2 shows the male population is highly represented in the logistics industry (56.2%) than females (43.8%).

Figure 4.3 Work Experience

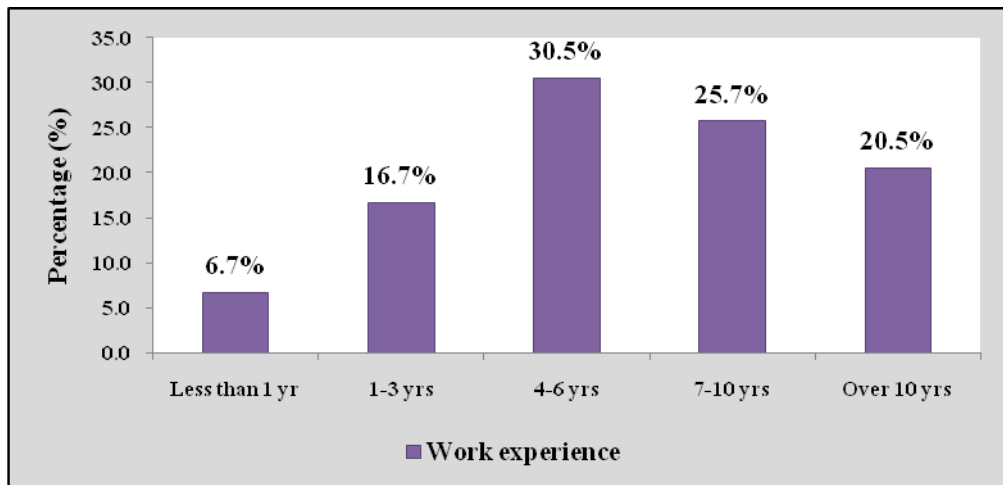


Figure 4.3 illustrates that only 6.7% of the sample have less than one year experience, while 35 respondents (16.7%) had one to three years' experience. Respondents with four to six years' experience make up the largest proportion of the sample (30.5%), followed by 54 respondents (25.7%) with seven to ten years; experience. The third largest proportion of the sample (20.5%) is composed of respondents with more than 10 years' work experience.

Figure 4.4 Department

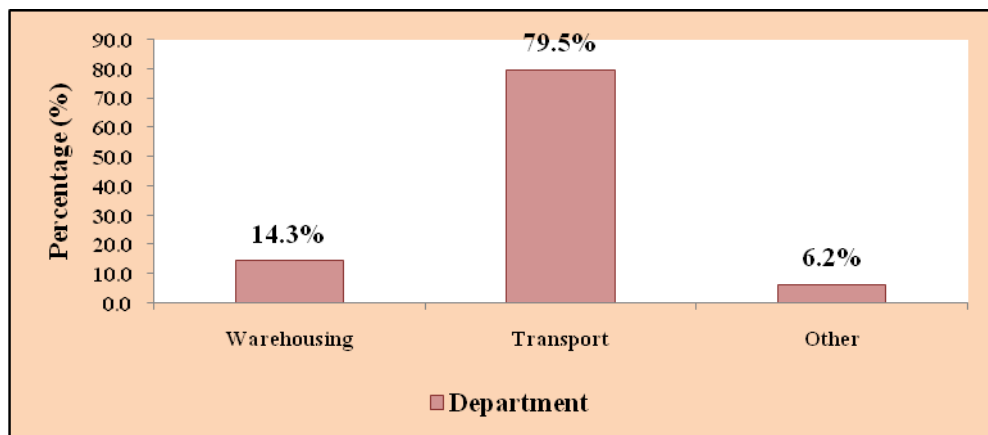
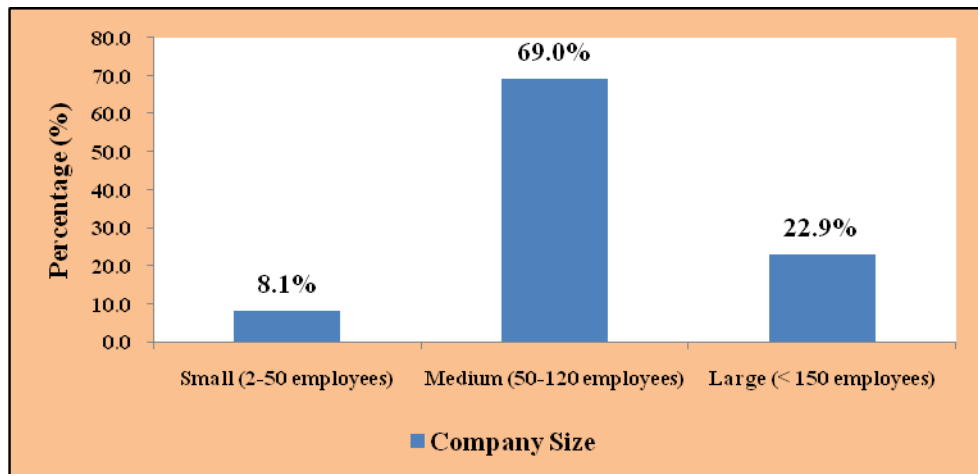


Figure 4.4 shows, that, the largest proportion of respondents (79.5%) works in the transport division while 14.3% are in warehousing. Only 13 respondents (6.2%) work in other divisions such as customer service, finance and human resources. Thus, the results generated by this study are mainly applicable to the transport sector.

Figure 4.5 Company Size



From figure 4.5, it is evident that 69% of respondents come from medium-size companies. This is characterised as an entity that employs between 50 and 120 individuals. 22.9% of the respondents represent large companies and 8.1% of the sample is comprised of respondents from small companies with a workforce of between two and 50 employees.

Figure 4.6 Lean Initiatives Adoption

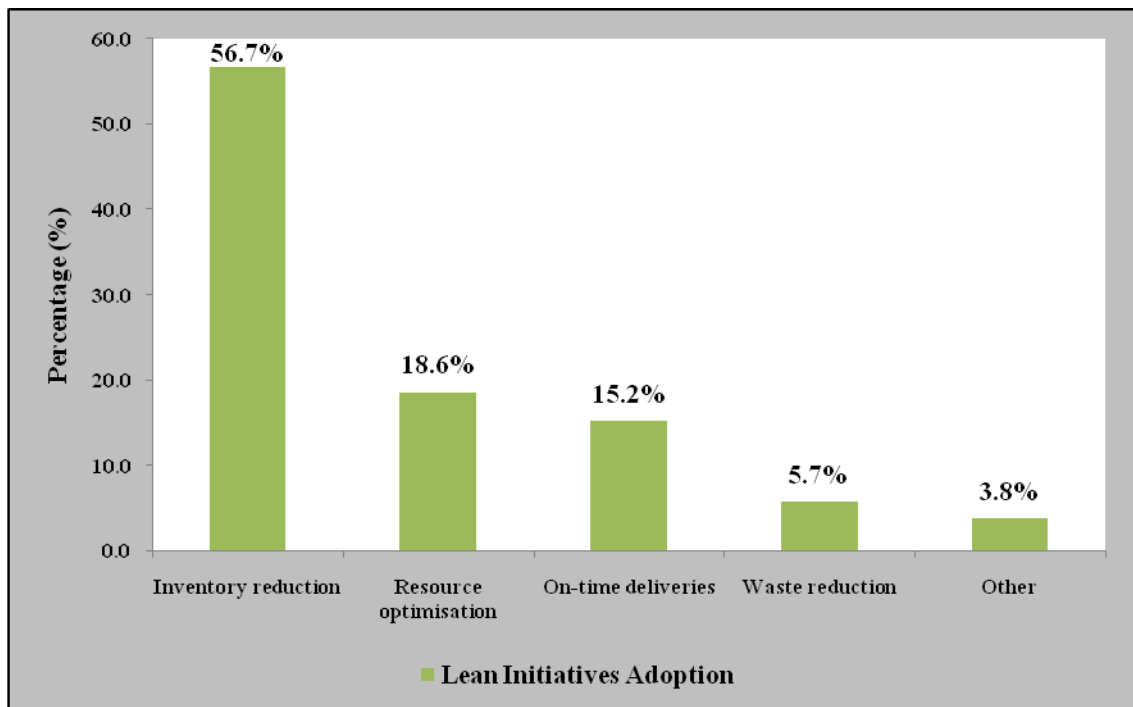


Figure 4.6 illustrates, that a large percentage of respondents' (56.7%) companies have chosen inventory reduction as a primary lean initiative. Resource optimisation (18.6%) and on-time deliveries (15.2%) are the second and third most common lean methods employed. Surprisingly, waste reduction falls at the lower end of the scale (5.7%), followed by other lean initiatives (3.8%).

Figure 4.7 Meaning of Green Supply Chain Management

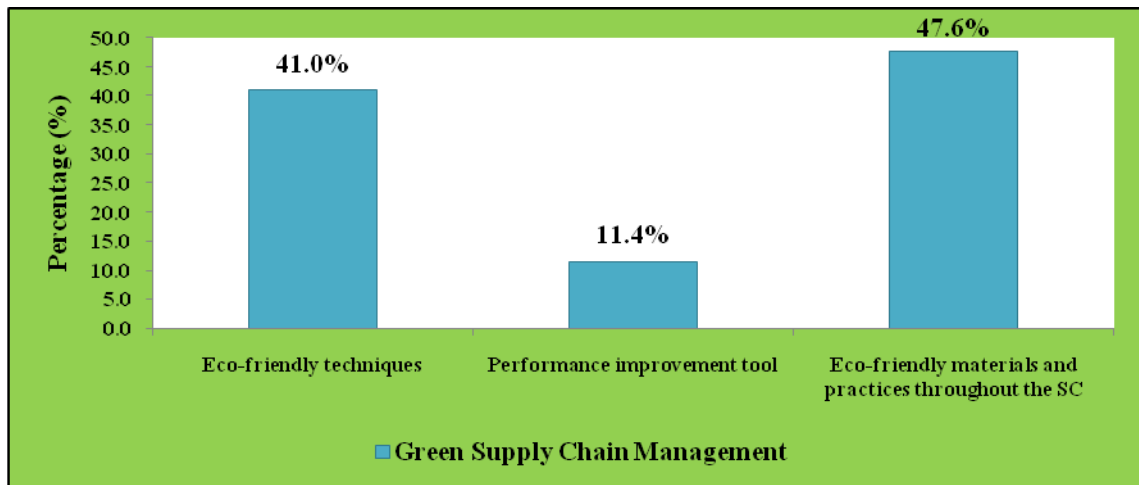


Figure 4.7 reveals that 41% of the respondents interpret green supply chain management to mean the application of eco-friendly techniques at specific stages in the supply chain; however, this concept is rather vague and lacks depth. In contrast 24 respondents (11.4%) regard green supply chain management as a performance improvement tool and 47.6% of respondents are correct in their interpretation that green supply chain management is the application of eco-friendly materials and practices at all levels of the supply chain.

Figure 4.8 Dichotomous Questions

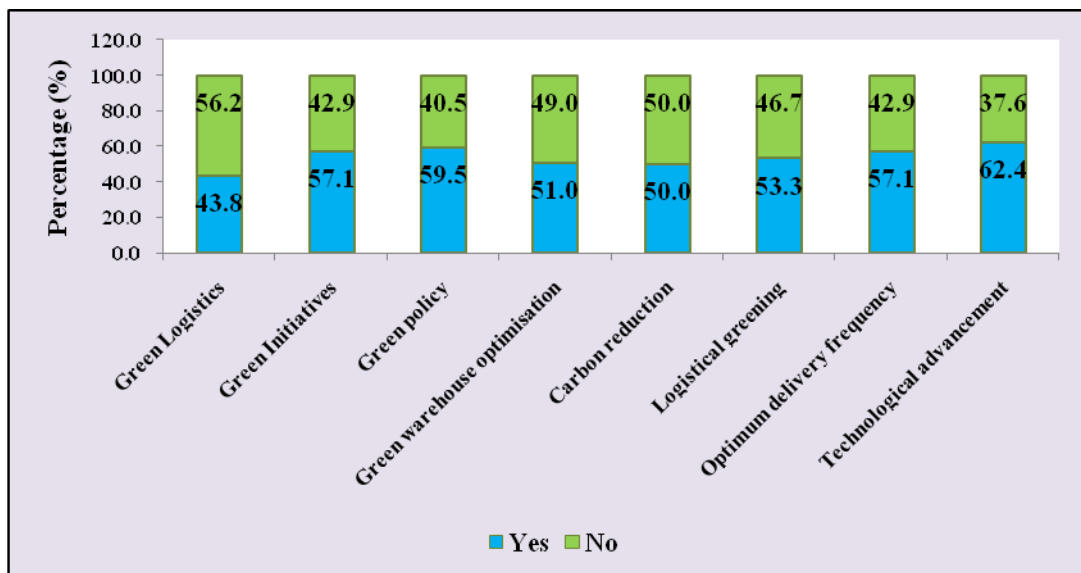
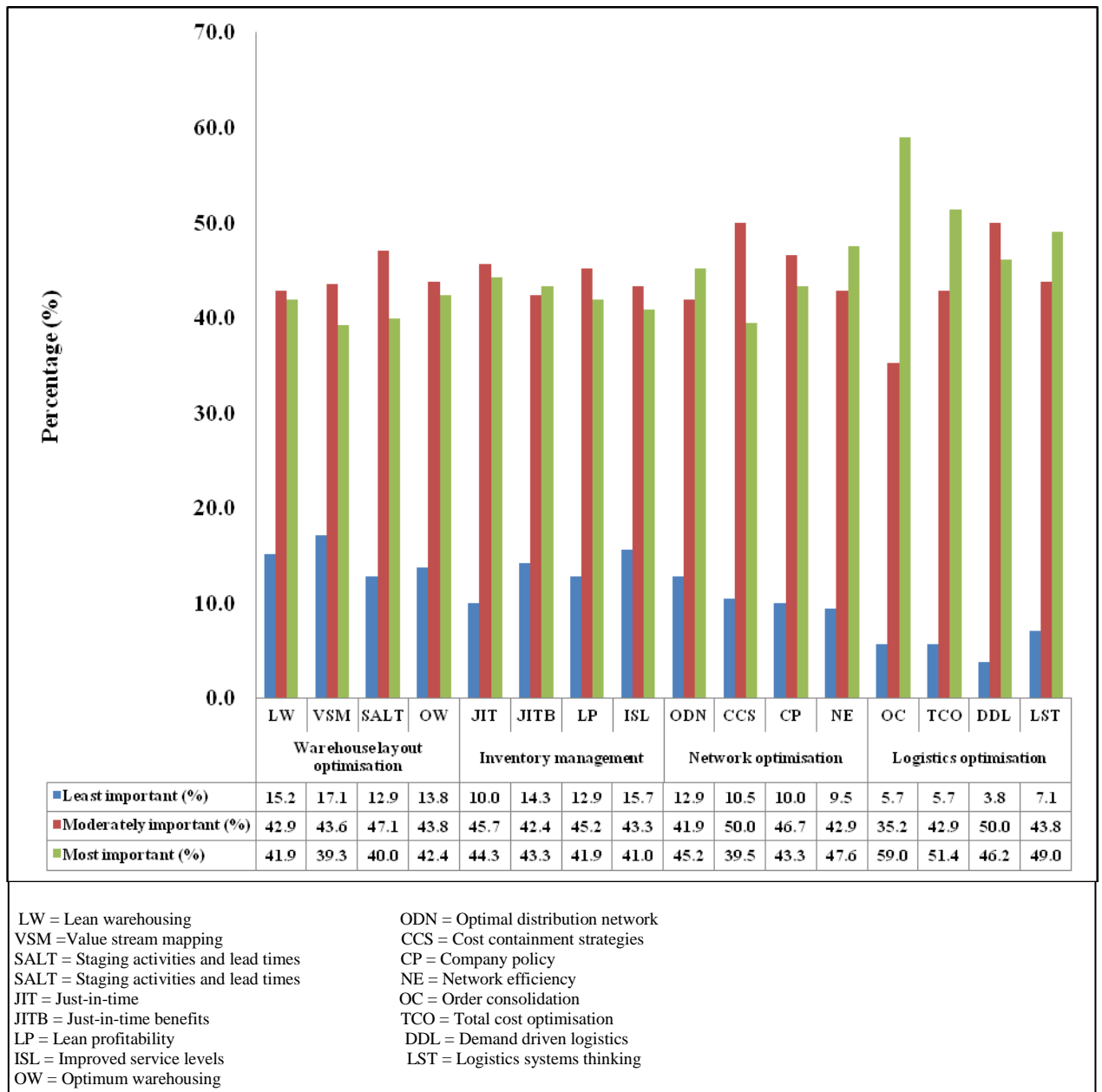


Figure 4.8 presents the results of data on dichotomous questions from section B of the questionnaire. These questions are focussed on the green dimension. The figure reveals that 56.2% of respondents did not believe that there was comprehensive understanding of green logistics amongst employees in their organisation, whilst 43.8% stated the opposite.

When asked if their company strives to implement green initiatives, 57.1% of the respondents answered in the affirmative, while 40.5% reported that encouraging green practices is not company policy.

While warehousing activities and infrastructure contribute significantly to an organisation's carbon footprint, this study reveals that 49% of the respondents believe that their company has not adopted green methods to optimise their warehousing activities. Similarly, only 50% of the respondents believe that their company actively engages in reducing the carbon footprint of its operations. The data reveal that 53.3% of respondents consider green logistics initiatives a means of enhancing bottom line performance targets, whilst 57.1% agreed that optimal delivery frequency is linked to environmentally-friendly activities. However, a significant proportion of the sample (62.4%) confirmed that technological innovation plays a vital role in the adoption of green logistics initiatives. Figure 4.9 reveals the dynamics of lean logistics that encompass internal and external lean methods.

Figure 4.9 Lean Logistics Dynamics



Section C of the questionnaire examined the dynamics of lean by soliciting information about methods the researcher identified that contribute to the optimisation of resources within a logistics system. These dynamics are warehouse layout optimisation, inventory management, network optimisation and logistics optimisation. Warehouse layout optimisation and inventory management are internal to the organisation, whereas network optimisation and logistics optimisation are external to the organisation but holistically drive the adoption of lean logistics practices. Each dynamic is influenced by four contributing

factors identified by the researcher that collectively impact the dynamics of lean logistics and the adoption of lean logistics.

Firstly, warehouse layout optimisation was identified as the first dynamic that encourages the adoption of lean logistics and results in lean methods being applied to warehousing activities. The four benefits of lean warehousing are discussed in accordance with how the respondents' rate these factors in relation to the adoption of lean logistics

Figure 4.9 shows that value stream mapping which enhances material, information and demand flows in a warehouse is the least important contributing factor for warehouse optimisation, scoring the highest out of the four factors (17.1%). In contrast, lean warehousing activities that increase staging activities and positively impact shipping lead times received the highest score (47.1%), as a moderately important factor encouraging the optimisation of warehousing activities within a logistics system.

Similarly, the benefits of lean that realise optimum warehousing functions through the achievement of maximum efficiency and space utilisation were identified as the most important factor (42.4%). This is closely followed by the benefits lean offers in terms of reducing wastage and improving time utilisation (41.9%).

Secondly, the findings presented in figure 4.9 illustrate that JIT inventory management that results in improved customer service levels and quality, inventory cost savings and optimised inventory, is the least important factor (15.7%), encouraging lean warehousing. However, JIT strategies that minimise inventories were rated the highest moderately important factor (45.7%) followed very closely by lean profitability which translates into significant bottom line improvements as a result of the application of lean inventory management techniques (45.2%). Nevertheless, 44.3% of the respondents ranked JIT strategies that minimise inventories, as the most important factor that drives companies to adopt lean inventory management.

Thirdly, an optimally designed distribution network has the potential to significantly reduce carbon emissions, impacting structural facilities, asset utilisation, lead time and fill rates. Figure 4.9 illustrates that 12.9% of the respondents ranked the value added benefits derived from an optimal distribution network the least important factor pertaining to the transition towards an optimal network. Cost containment strategies implemented by companies scored the highest (50%); respondents believe that it is a moderately important factor that constrains companies from achieving an optimal network. However, 47.6% of the respondents agree

that technological advances that have a direct impact on route planning and load optimisation heighten ripple effects in attaining an efficient network.

Lastly, logistics optimisation models can bring significant cost saving benefits to an organisation. The increased efficiency achieved by an optimised logistics network is recognised as a further enabler to improve profit margins and return on investments. The data reveals 7.1% of the sample cited the adoption of a logistics system thinking approach as the least important factor in logistics optimisation. However, the demand-driven logistics associated with the benefits of increased orders and shipment fulfilment, reduced inventory obsolescence and customer returns were recognised as a moderately important factor by 50% of the respondents. Order consolidation that increases capacity utilisation and reduces shipment frequency, was cited as the most important factor by 124 respondents (59%).

4.2.2 Descriptive Statistics

Descriptive statistics are used to illustrate the essential features of the data in the study. The descriptive statistics table reveals a range of 4. The minimum value is 1 and the maximum value is 5 from the sample of 210. The table provides further information on the mean, standard deviation, skewness and kurtosis figures that describe the nature of the variables under investigation. The values listed in table 4.1 are discussed in terms of the 13 variables measured on the 1-5 point Likert scale.

Table 4.1 Descriptive Statistics

	ODTF	TIS	JDSW	LL	GLL	LGD	VSM	GD	GLI	LLP	GL	SCL	GLE
N	210	210	210	210	210	210	210	210	210	210	210	210	210
Mean	3.88	3.87	3.85	3.83	3.76	3.73	3.70	3.68	3.55	3.21	3.20	3.17	3.06
Std. Dev	.842	.881	.816	.828	.764	.737	.863	.705	.847	.962	.927	1.044	1.040
Median	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	3.00	3.00	3.00
Mode	4	4	4	4	4	4	3	4	4	3	3	3	3
Skewness	-.209	-.287	-.139	-.447	-.605	-.318	-.020	-.191	-.413	-.409	-.336	-.349	-.562
Kurtosis	-.746	-.732	-.699	.294	.975	.379	-.561	-.093	.645	.189	.297	-.317	-.310
Minimum	2	2	2	1	1	1	1	2	1	1	1	1	1
Maximum	5	5	5	5	5	5	5	5	5	5	5	5	5
Range	3	3	3	4	4	4	4	3	4	4	4	4	4
Sum	815	812	808	805	790	783	778	772	745	675	672	666	643

ODTF = Optimal delivery time and flexibility
TIS = Technology, Investment, Skills
JDSW = JIT deliveries and strategic warehousing
LL= Lean Logistics
GLL = Green and Lean Logistics
LGD = Lean Green dimension
VSM = Value stream mapping
GD = Green diffusion
GLI = Green logistics initiatives
LLP = Lean logistics practices
GL = Green and Lean
GLE = Green logistics expenditure

The basis of all statistical analysis in this study presumes a 95% confidence interval. In this instance, the sampling distribution of the mean is normally shaped and is a reflection of the population mean. Data within a normal distribution possess values that lie within 1.96 standard deviations of the mean. Consequently, the sample mean has a 95% chance of being within 1.96 standard deviation errors from the true population mean.

Table 4.1 illustrates optimal delivery time flexibility; technology, investment, skills, JIT deliveries and strategic warehousing and lean logistics as the four highest ranking means within its scale. This indicates that these variables are the most important in lean and green logistics. They are interrelated as they possess both characteristics of lean and green that contributes to the organisational dynamics of both concepts. These identified variables possess values that lie within 1.96 standard deviations of the mean. Hence the sample mean is a reflection of the true population mean. The median and mode figure further confirms the central point in the sample, indicating “agree” as the most frequently occurring value between these four variables.

Green and lean logistics, lean green dimensions, value stream mapping, green diffusion and green logistics initiatives possess a mean that lies between 3.55 and 3.76. In all incidences the standard deviation is less than the mean, indicating little variation in data. Similarly, there is a common central value of 4 (median) which is also the most frequently occurring value in this sample.

Thus far, the statistics generated on each variable are expected and in line with the researcher’s conceptual framework; however, further statistical analysis that cross examines the statistics is performed to confirm the researcher’s findings.

The mean values for lean logistics practices, green logistics, supply chain logistics and green logistics expenditure lie between 3.06 and 3.21. These four variables have rather high standard deviations in relation to the rest of the variables measured. However, the variation in data still lies within 1.96 standard deviations from the mean, whilst the median and mode confirm the central value (3) in this normal distribution. The above statistics show that 70% of the respondents in this sample confirm the value added benefits of implementing green and lean logistics initiatives, whilst the remaining 30% are indifferent.

The distribution is a description of how frequently the individual values occur. It is a very useful way to summarise cross-sectional data which can be represented using a frequency histogram. The distribution of a variable is also described in terms of its relative symmetry and skewness (Cooper and Schindler, 2008:457). In all 13 cases, the skewness is a negative value ranging between -0.56 and -0.02, indicating a negatively skewed distribution with

scores clustering to the right toward the upper end of the scale. Values in this range are considered as being moderately skewed.

4.3 Inferential statistics

4.3.1 Cross-Tabulation

When tables are constructed for statistical testing, they are referred to as contingency tables. The purpose of cross-tabulation is to establish a relationship between two variables, and if so, the information can be represented in a two-dimensional frequency distribution by cross-tabulating the variables. Hence, cross tabulation is used to test the association between the selected variables. Tables 4.2 to 4.8 cross tabulate variables to establish if an association exists between the two variables. Table 4.2 examines whether or not an association exists between green initiatives and company size.

Table 4.2: Green initiatives and company size

Does company size relate to green initiatives implementation?			Company size			Total
			Small (2-50 emp)	Medium (50-120 emp)	Large (<150 emp)	
Green initiatives	Yes	Count	7	83	30	120
		Expected Count	9.7	82.9	27.4	120.0
		% of Total	3.3%	39.5%	14.3%	57.1%
	No	Count	10	62	18	90
		Expected Count	7.3	62.1	20.6	90.0
		% of Total	4.8%	29.5%	8.6%	42.9%
Total	Count	17	145	48	210	
	Expected Count	17.0	145.0	48.0	210.0	
	% of Total	8.1%	69.0%	22.9%	100.0%	

Table 4.2 illustrates that 57.1% of the respondents agreed that company size relates to and influences the implementation of green initiatives, although medium-sized businesses (39.5%) are considered to make stronger contributions among other categories. An important point to consider from these results is that there were more than three times the number of respondents from medium-sized companies in this study than large companies and eight times more than small companies. There is a 31.2% probability that green logistics implementation is influenced by the size of the company, just by chance. Thus, there is no association between company size and green logistics implementation. The Chi-square test for independence has generated statistically insignificant results at the $p=0.05$ level. Hence, the researcher infers that the size of a company does not play an influential role in the adoption of green logistics initiatives.

As noted, most of the companies represented in the sample are medium-sized businesses. Therefore future research on this topic should adopt a stratified research system to identify the size of the organisation *versus* the propensity to implement green initiatives. Table 4.3 seeks to verify the association between green logistics and company size. The aim is to identify if company size plays an influential role in the understanding of green logistics among it's employees.

Table 4.3: Green logistics and company size

Does company size relate to the understanding of green logistics among employees?			Company size			Total
			Small (2-50 emp)	Medium (50-120 emp)	Large (< 150 emp)	
Green logistics	Yes	Count	7	71	14	92
		Expected Count	7.4	63.5	21.0	92.0
		% of Total	3.3%	33.8%	6.7%	43.8%
	No	Count	10	74	34	118
		Expected Count	9.6	81.5	27.0	118.0
		% of Total	4.8%	35.2%	16.2%	56.2%
Total		Count	17	145	48	210
		Expected Count	17.0	145.0	48.0	210.0
		% of Total	8.1%	69.0%	22.9%	100.0%
Chi-Square Tests						
	Value	df	Asymp. Sig. (2-sided)			
Pearson Chi-Square	5.795 ^a	2	.055			
Likelihood Ratio	5.960	2	.051			
Linear-by-Linear Association	2.898	1	.089			
N of Valid Cases	210					
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.45.						

A large proportion of the sample (43.8%) believed that the understanding of green logistics is related to the size of the company. While medium-sized firms contribute significantly to this statistic (33.8%), the majority of the sample (56.2%) disagreed with this point of view. Participants representing small companies (3.3%) indicated that company size does influence employees' understanding of green logistics; however the majority of those in this category (4.8%) believed this to be untrue. Similarly, 6.7% of the respondents from large companies argued that employees' understanding of green logistics is impacted by the size of the firm; with 16.2% disagreeing. There is a 5% probability that employees' understanding of green logistics is influenced by the size of the organisation. The researcher infers that there is a relationship or association between company size and employees' understanding of green logistics. The Chi-square test for independence reaches statistical significance at $p = 0.05$. Hence the researcher infers that the size of a company plays an influential role in employees' understanding of green logistics.

Table 4.4 determines the potential association between green policies and lean initiatives adoption. It is important to understand if companies adopt lean initiatives as an auxiliary outcome from the adoption of green initiatives.

Table 4.4: Green policy and lean initiatives

Does lean initiatives adoption relate to company policy on green initiatives adoption?			Lean Initiatives					Total	
			Inventory reduction	Resource optimisation	On-time deliveries	Waste reduction	Other		
Green policy	Yes	Count	58	30	20	10	7	125	
		Expected Count	70.8	23.2	19.0	7.1	4.8	125.0	
		% of Total	27.6%	14.3%	9.5%	4.8%	3.3%	59.5%	
	No	Count	61	9	12	2	1	85	
		Expected Count	48.2	15.8	13.0	4.9	3.2	85.0	
		% of Total	29.0%	4.3%	5.7%	1.0%	.5%	40.5%	
Total		Count	119	39	32	12	8	210	
		Expected Count	119.0	39.0	32.0	12.0	8.0	210.0	
		% of Total	56.7%	18.6%	15.2%	5.7%	3.8%	100.0%	
Chi-Square Tests									
		Value	df	Asymp. Sig. (2-sided)					
		Pearson Chi-Square	16.185 ^a	4	.003				
		Likelihood Ratio	17.245	4	.002				
		Linear-by-Linear Association	10.762	1	.001				
		N of Valid Cases	210						
a. 3 cells (30.0%) have expected count less than 5. The minimum expected count is 3.24.									

Table 4.4 reveals that, 59.5% of the sample believes that the adoption of lean initiatives relates to the company's policy on green initiatives adoption, whilst 40.5% disagreed. Further analysis of the statistics reveals the following: Whilst 27.6% of the respondents feel that green policy influences the implementation of inventory reduction methods, 14.3% view resource optimisation in a similar light. Only 4.8% of the respondents indicated that waste reduction was impacted by green policy in contrast with 1% who disagreed. Nevertheless, 3.3% of the respondents stated that the implementation of other lean initiatives is impacted by company policy on green initiatives. There is a 3% probability that the adoption of lean initiatives is influenced by the company's policy on green initiatives, just by chance. However, a noteworthy 29% of the respondents do not view inventory reduction as a dependant variable impacted by green policy. An insignificant proportion of the sample felt that the adoption of lean initiatives is not influenced by company policy on green initiatives.

The corresponding inference is that there is a relationship or association between a company's policy on green initiatives adoption and the adoption of lean initiatives. The Chi-square test for independence generated statistically significant results at $p = 0.05$. Hence, the researcher infers that company policy on the adoption of green initiatives does play an influential role in the adoption of lean initiatives.

Table 4.5: Green initiatives and staging activities and lead times

Do green logistics initiatives relate lean warehousing that impact staging activities and lead times?			Staging activities and lead times			Total
			Least important	Moderately important	Most important	
Green initiatives	Yes	Count	16	47	57	120
		Expected Count	15.4	56.6	48.0	120.0
		% of Total	7.6%	22.4%	27.1%	57.1%
	No	Count	11	52	27	90
		Expected Count	11.6	42.4	36.0	90.0
		% of Total	5.2%	24.8%	12.9%	42.9%
Total	Count	27	99	84	210	
	Expected Count	27.0	99.0	84.0	210.0	
	% of Total	12.9%	47.1%	40.0%	100.0%	
Chi-Square Tests						
	Value	Df	Asymp. Sig. (2-sided)			
Pearson Chi-Square	7.766 ^a	2	.021			
Likelihood Ratio	7.838	2	.020			
Linear-by-Linear Association	3.022	1	.082			
N of Valid Cases	210					
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.57.						

Table 4.5 reveals that 57.1% of the respondents agree that green logistics initiatives relate to staging activities and lead times, whilst 42.9% disagreed. Further analysis of the statistics reveals the following; A significant proportion of the respondents (49.5%) view lean warehousing as an important factor impacting inventory management, whilst only 24.8% disagree. There is a 2.1% probability that green logistics initiatives relating to lean warehousing that impact staging activities and shipping lead times, occur just by chance. Thus, there is a relationship or association between green logistics initiatives and lean warehousing that impact staging activities and lead times. The Chi-square test for independence has generated a statistically significant result, $p = 0.02$. Hence the researcher concludes that green logistics initiatives do play an influential role in lean warehousing that impact staging activities and lead times.

Table 4.6: Green initiatives and JIT benefits

Does green logistics initiatives relate to Just-in-time benefits?			JIT benefits			Total
			Least important	Moderately important	Most important	
Green initiatives	Yes	Count	11	55	54	120
		Expected Count	17.1	50.9	52.0	120.0
		% of Total	5.2%	26.2%	25.7%	57.1%
	No	Count	19	34	37	90
		Expected Count	12.9	38.1	39.0	90.0
		% of Total	9.0%	16.2%	17.6%	42.9%
Total		Count	30	89	91	210
		Expected Count	30.0	89.0	91.0	210.0
		% of Total	14.3%	42.4%	43.3%	100.0%
Chi-Square Tests						
		Value	df	Asymp. Sig. (2-sided)		
	Pearson Chi-Square	6.103 ^a	2	.047		
	Likelihood Ratio	6.056	2	.048		
	Linear-by-Linear Association	2.609	1	.106		
	N of Valid Cases	210				
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.86.						

The above statistical tabulation examines the association or lack thereof between green logistics initiatives and JIT benefits. Table 4.6 reveals that 57.1% of the respondents consider JIT benefits a dependant factor in green initiatives, whilst 42.9% disagree. Nevertheless, the combination of the results from ‘moderately important’ and ‘most important’ reveal that 52% of respondents believe that JIT benefits are influenced by green initiatives. There is a 4.7% probability that the occurrence of JIT benefits is influenced by the implementation of green logistics initiatives, just by chance. The researcher infers that there is a relationship or association between green logistics initiatives and JIT benefits. The Chi-square test for independence has generated a statistically insignificant result, $p = 0.47$. Hence the researcher infers that green logistics initiatives do play an influential role in JIT benefits.

Table 4.7: Green initiatives and network efficiency

Does green logistics initiatives relate to network efficiency?			Network efficiency			Total
			Least important	Moderately important	Most important	
Green initiatives	Yes	Count	10	50	60	120
		Expected Count	11.4	51.4	57.1	120.0
		% of Total	4.8%	23.8%	28.6%	57.1%
	No	Count	10	40	40	90
		Expected Count	8.6	38.6	42.9	90.0
		% of Total	4.8%	19.0%	19.0%	42.9%
Total		Count	20	90	100	210
		Expected Count	20.0	90.0	100.0	210.0
		% of Total	9.5%	42.9%	47.6%	100.0%
Chi-Square Tests						
		Value	Df	Asymp. Sig. (2-sided)		
	Pearson Chi-Square	.843 ^a	2	.656		
	Likelihood Ratio	.840	2	.657		
	Linear-by-Linear Association	.834	1	.361		
	N of Valid Cases	210				
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.57.						

Table 4.7 shows that 52.4% of the respondents believe that green logistics initiatives are an important factor impacting network efficiency, whilst 19% disagree. 57.1% consider the possibility of a relationship between green logistics initiatives and network efficiency, while 42.9% argue against this possibility. There is a 65.6% probability that the occurrence of network efficiency is related to the implementation of green logistics initiatives, just by chance. The researcher infers that there is no relationship or association between green logistics initiatives and network efficiency. The Chi-square test for independence has generated a statistically insignificant result, $p = 0.65$. Hence the researcher infers that green logistics initiatives do not play an influential role in network efficiency.

Table 4.8: Green logistics and total cost optimisation

Do green logistics initiatives relate to total cost optimisation?			Total cost optimisation			Total
			Least important	Moderately important	Most important	
Green initiatives	Yes	Count	7	51	62	120
		Expected Count	6.9	51.4	61.7	120.0
		% of Total	3.3%	24.3%	29.5%	57.1%
	No	Count	5	39	46	90
		Expected Count	5.1	38.6	46.3	90.0
		% of Total	2.4%	18.6%	21.9%	42.9%
Total		Count	12	90	108	210
		Expected Count	12.0	90.0	108.0	210.0
		% of Total	5.7%	42.9%	51.4%	100.0%
Chi-Square Tests						
		Value	Df	Asymp. Sig. (2-sided)		
	Pearson Chi-Square	.018 ^a	2	.991		
	Likelihood Ratio	.018	2	.991		
	Linear-by-Linear Association	.001	1	.974		
	N of Valid Cases	210				
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.14.						

Table 4.8 illustrates that 57.1% of respondents answered this question in the affirmative, while 29.5% indicated that total cost optimisation is the most important factor, and 24.3% cited this as a moderately important factor. However, 42.9% of the respondents disagreed, believing that green logistics initiatives do not relate to total cost optimisation. There is a 99.1% probability that the occurrence of green initiatives is influenced by total cost optimisation, just by chance. Thus from the above results, the researcher infers that there is no relationship or association between green logistics initiatives and total cost optimisation in a centralised logistic system. The Chi-square test for independence has generated a statistically insignificant result, $p = 0.99$. Hence the researcher concludes that green logistics initiatives do not play an influential role in total cost optimisation in a centralised logistic system.

Table 4.9 summarises the corresponding Pearson Chi-Square values pertaining to the hypotheses under investigation. When testing for significance, two types of hypotheses are used. The null hypothesis (H_0) is a statement that no difference exists between the two variables under study. The alternate hypothesis (H_1) is the exact opposite of the null hypothesis, stating that there is a relationship between two variables or significant differences between two groups (Cooper and Schindler, 2008). The Chi-square test is a non-parametric test of significance that is useful when testing nominal data. It is used to perform hypothesis tests about the variance. It can be used for single or grouped categories to test for significant differences between the observed distribution and expected distribution based on the null hypothesis (Wegner, 2006:248). For the Chi-square test, the decision rule is to retain the null hypothesis and reject the alternate hypothesis if $p > 0.05$, and accept the alternate hypothesis and reject the null hypothesis if $p < 0.05$. Chi-square answers the question of

whether there is a relationship between two nominal variables or whether they are independent of each other.

Table 4.9: Pearson Chi Square values – Hypothesis results

<i>Hypothesis</i>	<i>Pearson Chi-Square Value</i>	<i>Decision</i>
H₀₁ : There is no relationship between company size and implementation of green logistics initiatives	$p = 0.31 > 0.05$	Accept
H_{A1} : There is a relationship between company size and implementation of green logistics initiatives		Reject
H₀₂ : There is no relationship between company size and employee understanding of green logistics	$p = 0.05 = 0.05$	Reject
H_{A2} : There is a relationship between company size and employee understanding of green logistics		Accept
H₀₃ : There is no relationship between lean initiatives adoption and company policy on green initiative adoption	$p = 0.03 < 0.05$	Reject
H_{A3} : There is a relationship between lean initiatives adoption and company policy on green initiatives adoption		Accept
H₀₄ : There is no relationship between green logistics initiatives and staging activities and lead times	$p = 0.02 < 0.05$	Reject
H_{A4} : There is a relationship between green logistics initiatives and staging activities and lead times		Accept
H₀₅ : There is no relationship between green logistics initiatives and JIT benefits	$p = 0.047 < 0.05$	Reject
H_{A5} : There is a relationship between green logistics initiatives and JIT benefits		Accept
H₀₆ : There is no relationship between green logistics initiatives and network efficiency	$p = 0.65 > 0.05$	Accept
H_{A6} : There is a relationship between green logistics initiatives and network efficiency		Reject
H₀₇ : There is no relationship between green logistics initiatives and total cost optimisation in a centralised logistics system	$p = 0.99 > 0.05$	Accept
H_{A7} : There is a relationship between green logistics initiatives and total cost optimisation in a centralised logistics system		Reject

Person Chi Square values support the results obtained from the variables cross tabulated and affirm the decision to accept or reject the null hypothesis which postulates an association among the two variables under investigation. However further analysis must be conducted to determine the existence of multivariate relations by utilising multivariate analysis techniques.

4.3.2 Factor Analysis

The reliability of the instrument is determined by utilising the method of internal consistency. Cronbach's Alpha value indicates the level of internal consistency by showing construct validity where the constructs are measured with sufficient reliability. Assessing the 13 variables on the five point Likert scale, Cronbach's Alpha of the instrument is 0.74. Acceptable alpha values range from 0.7 to 0.95 (Tavakol and Dennick, 2011:54). Thus the researcher infers that the instrument is reliable. Factor analysis is used to reduce the total number of items to manageable factors. The statistical measures assisted in assessing the factorability of the data is Bartlett's test of Sphericity and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy.

Table 4.10: KMO and Bartlett's Test, Communalities, Total Variance Explained, Rotated Component Matrix

KMO and Bartlett's Test						
Kaiser-Meyer-Olkin Measure of Sampling Adequacy					0.752	
Bartlett's Test of Sphericity					787.918	
Approx. Chi-Square					78	
Df					0.000	
Sig.						
Rotated Component Matrix						
	Factor Loading	Eigenvalue	% of Variance	Cumulative %	Communalities Extraction	Alpha
Factor 1: LeaGreenity						
JIT Deliveries and strategic warehousing	0.602	3.888	29.910	29.910	0.607	.831
Green logistics initiatives	0.509				0.431	.832
Green diffusion	0.731				0.571	.833
Lean green dimensions	0.770				0.600	.655
Green and lean logistics	0.651				0.453	.741
Factor 2: Lean and Green Dimensional Characteristics						
Lean logistics	0.804	1.970	15.154	45.065	0.667	.834
Value stream mapping	0.725				0.586	.832
Optimal delivery time and flexibility	0.625				0.666	.832
Technology investment skills	0.539				0.574	.834
Factor 3: Lean and Green Paradigms						
Green and lean	0.621	1.324	10.185	55.249	0.519	.668
Green logistics expenditure	0.745				0.586	.677
Lean logistics practices	0.769				0.608	.661
"Extraction Method: Principal Component Analysis., Rotation Method: Varimax with Kaiser Normalisation., Reliability Statistics: Overall Cronbach's Alpha = 0.74, and Number of items = 13".						

The Kaiser-Meyer-Olkin (KMO) score of $0.75 > 0.6$ indicates sampling adequacy. KMO has a desirable value with a meritorious degree of variance. Large KMO values are good because correlations between potential factors can be explained by other variables, hence KMO values greater than 6 are desirable (Pallant, 2011).

Similarly, the Bartlett's test of Sphericity is used to verify the assumption of homogeneity of variance (Pallant, 2011:323). Bartlett's test yields a significant p-value of 0.000 at the 95% level of confidence, for factor analysis to be considered appropriate. The significance of Bartlett's test confirms there is some level of correlation among the variables, hence accept the alternate hypothesis and reject the null hypothesis (Pallant, 2011:326). Thus, the KMO score obtained in this factor analysis is suitable with Bartlett's Test of Sphericity (787.918) at degree of freedom (78). This means that the data matrix has sufficient correlation for the application of factor analysis.

Communality refers to the amount of variance that can be explained by common factors of a variable. Communality values range from 0 to 1, where '0' indicates that the common factors do not explain any variance and '1' means that the common factors explain all the variance (Pallant, 2011). Generally, values less than 0.3 indicate that the item does not fit well with the other items in its component. According to the table of communalities, all items have an extraction value greater than 3, therefore the items fit well with the other items in its component.

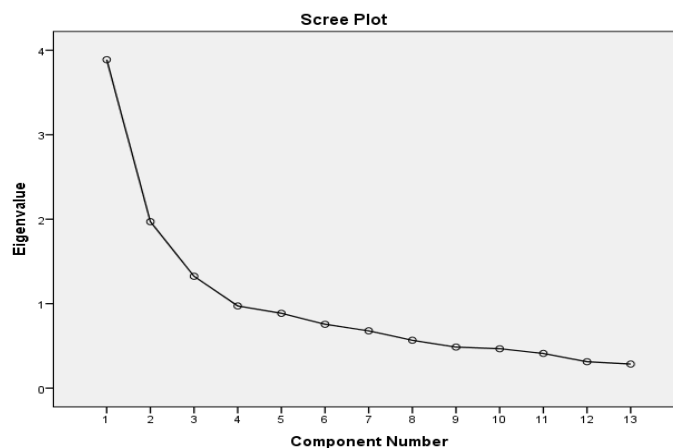
Factor extraction determines the smallest number of factors that can be used to represent the interrelationships among the set of variables. Principle component analysis is used to identify the underlying factors. According to Hatcher (1994:21), "principle component analysis converts a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables. This transformation is defined in such a way that the first principal component has the largest possible variance (that is, accounts for as much of the variability in the data as possible), and each succeeding component in turn has the highest variance possible under the constraint that it be orthogonal to (that is, uncorrelated with) the preceding components." One way to perform factor extraction is to use Kaiser's criterion or the eigenvalue rule. Using eigenvalue rule, only factors with a value greater than 1.0 are retained for further investigation. By rule of thumb, any factor that has an eigenvalue of less than 1.0 does not have enough total explained variance to represent a unique factor, and is therefore disregarded (Pallant, 2011).

Thus, using Kaiser's criterion, the researcher is only interested in components that have an eigenvalue of 1 or more. The factor matrix reveals only the first three components have an eigenvalue greater than 1 (3.88, 1.97, and 1.32). Factor 1 accounts, for 29.91% of the variance, factor 2 for 15.15% and factor 3 for 10.18%. These three components explain a total of 55.24% of the variance in the original 13 variables and slightly less than the traditional threshold of 60% total explained variance.

Another approach used for factor extraction in conjunction with Kaiser's criterion is Catell's Scree Test. The relationship between the eigenvalues and the scree test is important, as the scree test entails plotting each factor's eigenvalues and inspecting the point at which the shape of the curve changes direction, taking on a horizontal form. Catell recommends that all factors above the 'break' on the plot contribute to most of the explanation of the variance in the data set (Pallant, 2011).

Since the essential factors that explain the variance have been determined, the factors are 'rotated' to assist in the interpretation. The approach to rotation used is orthogonal, which results in the assumption that the underlying constructs are not correlated (independent). The orthogonal technique used will be varimax. The rotated component matrix will be used to report the factor loadings for each variable after the factors have been rotated. The rotated solution gives a clear indication of how each item correlates with each factor. In this study, items with a correlation value of greater than 0.5 are retained. Scores in this range are a good indicator of moderate to strong correlation (Bryman and Bell, 2007).

Figure 4.10: Eigenvalue Scree Plot



The purpose of the scree plot is to show variance segmentation of data. Points occur in descending order of magnitude of the listed eigenvalues. Hence, the scree plot provides the visualisation pertaining to the relative importance of the factors. This scree plot recognises

the first three components as the most important due to the positioning on the upper end of the slope. Components on the lower end of the slope contribute little to the solution so it is extracted.

4.3.2.1 Interpretation and labelling of factors

The ultimate goal of rotation is to resolve qualitative observations into distinct patterns of occurrence in order to define pattern delineation and interdependency among variables (Rummel, 2011). Data structures are clarified and simplified to understand the underlying occurrences among each factor loading. In this study the factor loadings generated are labelled categorically and interpreted according to the perceived imputations the loadings define. The following Glean model has been developed from the empirical results of 12 components linked to the categories of 3 factor loadings. The interpretation shows that these factor loadings can be tentatively viewed graphically in figure 4.11.

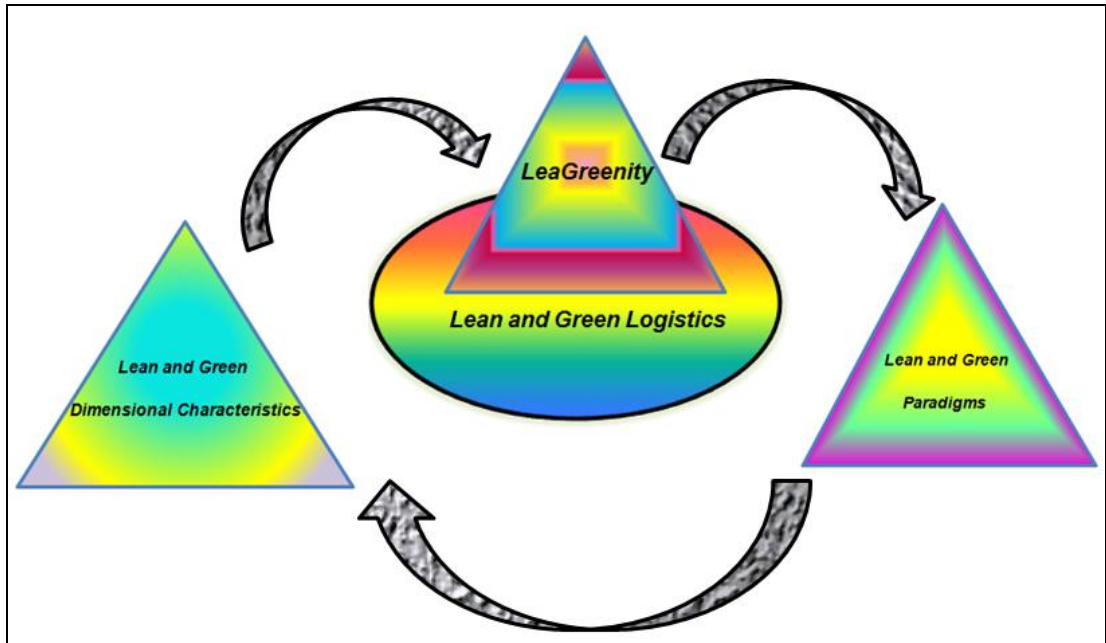
Factor 1: Factor 1 possesses the greatest variable loadings from the 3 factors extracted. Subsequently, the loadings on factor 1 have the highest variance of 29.910%. This factor is categorised according to items related to the combination of lean and green logistics; JIT deliveries and strategic warehousing, optimal delivery time and flexibility, green logistics initiatives, green diffusion, lean green dimension, green and lean logistics. The first two items focus on lean logistics, green diffusion taps into the range of green logistics initiatives, and the last three items cater for the combination of lean and green logistics. Hence these factors which form part of two independent dimensions are combined and grouped into a hybrid dimension - appropriately termed LeaGreenity. In essence, while lean and green can function well independently, the cumulative benefits of a hybrid system greatly outweigh the advantages of an existing isolated dimension. The cumulative benefits refers to those benefits such as cost savings, increase on the bottom line, improved business performance and efficiency, improved inventory management and transportation, and sustainable business solutions when lean and green is implemented concurrently (Gordon, 2009:109-119). Once again, supply chain collaboration that calls for the interaction of both lean and green conceptual applications can vastly generate more profitable earnings for logistics business than one that exists by itself.

Factor 2: The measurement of this factor was obtained by asking respondents if the implementation of lean logistics is impacted by technology, skills and knowledge; if value stream mapping enables time compression in logistics activities; if optimum delivery time and flexibility minimise wastes in transportation activities; and if financial burdens and lack of technological resource endowment constrain the adoption of green initiatives. Tentatively, this factor is interpreted as Lean and Green Dimensional Characteristics from items of lean logistics, value stream mapping, optimal delivery time and flexibility, technology, investment, skills. These items describe the characteristics of each concept when applied independently within its own dimension.

Factor 3: The critical component relates to items from Lean and Green, Lean logistics expenditure and Lean logistics practices, hence is interpreted as Lean and Green Paradigms. These items display the negative connotations of both lean and green. When combined, these items provide insight on why lean and green logistics implementation is a costly effort for companies. However by examining these factorial elements, businesses are able to strategically align their corporate financial goals that account for the implementation of lean and green initiatives and mobilise cost efficient methods that reduce wastage in the logistics system whilst simultaneously preserving the environment.

The GLean circular model demonstrates the transitional process of Lean and Green logistics dimensions to the hybrid dimension of LeaGreenity. It is a circular transition from the point where lean and green function within its own dimensional capacity arguing the negative aspects of lean and green implementation. However, while costly implications arise from such implementations, innovative managerial insight can realign business profitability that advocates long term business sustainability. Hence when the two dimensions interact, the focus shifts from lean and green paradigms to lean and green dimensional characteristics. The mutual benefits are thus attained from the association of a symbiotic relationship - developing into the dimension of LeaGreenity. The researcher therefore defines GLean as the process of creating an integrated supply chain system that is environmentally sound to eliminate non-value adding business activities whilst streamlining business processes.

Figure 4.11: Glean Circular Model – Factors influencing Green and Lean Logistics



Source: Designed by researcher

4.3.3 Multiple Regression

The purpose of multiple regression is to quantify the relationship between the dependant and independent variables. Pearson's correlation co-efficient can be used to define the relationship between two or more variables. However, this instrument is only an indicator of the strength and direction of the relationship and fails to state which variables possess predictive power over others.

Table 4.11: Pearson Correlation

Pearson Correlation	GD	LL	VSM	JDSW	ODTF	TIS	GLI	SCL	GL	GLE	LLP	LGD	GLL
GD	1.00	.178	.164	.488	.467	.408	.378	.141	-.032	-.188	.124	.428	.300
LL	.178	1.00	.554	.302	.356	.271	.247	.078	.268	.040	.045	.059	.118
VSM	.164	.554	1.00	.323	.439	.237	.189	.264	.212	-.006	.134	.167	.212
JDSW	.488	.302	.323	1.000	.587	.491	.460	.227	.123	-.147	-.007	.376	.279
ODTF	.467	.356	.439	.587	1.000	.604	.394	.149	.092	-.161	-.081	.326	.268
TIS	.408	.271	.237	.491	.604	1.00	.483	.072	.109	-.179	-.152	.283	.194
GLI	.378	.247	.189	.460	.394	.483	1.00	.304	.018	-.120	-.068	.270	.180
SCL	.141	.078	.264	.227	.149	.072	.304	1.00	.281	.118	.163	.148	.183
GLI	-.032	.268	.212	.123	.092	.109	.018	.281	1.00	.310	.301	.087	.020
GLE	-.188	.040	-.006	-.147	-.161	-.179	-.120	.118	.310	1.000	.455	-.090	.019
LLP	.124	.045	.134	-.007	-.081	-.152	-.068	.163	.301	.455	1.000	.062	.057
LGD	.428	.059	.167	.376	.326	.283	.270	.148	.087	-.090	.062	1.00	.445
GLL	.300	.118	.212	.279	.268	.194	.180	.183	.020	.019	.057	.445	1.000

LGD = Lean Green Dimension	LL = Lean logistics
VSM = Value stream mapping	JDSW = JIT deliveries and strategic warehousing
ODTF = Optimal delivery time and flexibility	TIS = Technology, investment , skills
GLI = Green logistics initiatives	SCL = Supply chain logistics
GL = Green and lean	GLE = Green logistics expenditure
LLP = Lean logistics practices	GD = Green diffusion
GLL = Green and lean logistics	

In most cases, there appears to be a weak to moderately positive relationship among the variables. Weak relationships are classified as having a correlation value between 0.3 and 0.1, whereas moderate relationships have a correlation value that lies between 0.4 and 0.6 (Cooper and Schindler, 2008). Variables that display a strong positive relationship possess correlation values greater than 0.7 (Cooper and Schindler, 2008). From the correlation table, it is evident that there exist some variables that have a moderately positive effect on each other. Table 4.12 provides a statistical summary, illustrating the moderately positive relationship between the variables that can be considered in this study.

Table 4.12: Correlation between variables

	JIT delivery and strategic warehousing	Technology, investment, skills
Optimal delivery time and flexibility	0.58	0.60

Now that the researcher is able to identify the strength and direction of the relationships between variables, the next step is to determine those variables that have a predictive influence over the dependant variable. From the analysis of the variables, seven model

predictors (independent variables) were generated, using SPSS statistics package, which influence the dependant variable (Green Diffusion).

Model 1: JIT deliveries and strategic warehousing – This model indicates that the adoption of green initiatives is influenced by JIT deliveries and strategic warehousing strategies that optimise cost savings.

Model 2: Lean Green dimensions – Model 2 confirms that green diffusion is influenced by the interplay between lean and green that enables the company to tap into both dimensions. The benefits of operating in a hybrid dimension is once again realised by cost savings, increase on the bottom line, improved business performance and efficiency, improved inventory management and transportation, and sustainable business solutions when lean and green operate concurrently.

Model 3: Optimal delivery time flexibility – Optimal delivery time and flexibility that serves to minimise waste is transportation, plays an influential role in the adoption of green initiatives.

Model 4: Lean logistics practices – According to the results from regression, lean logistics practices is significant in determining the adoption of green practices, in that lean logistics is able to reduce the distance travelled within the distribution network

Model 5: Green logistics expenditure – Model 5 shows a relationship between green logistics expenditure and green diffusion. This model recognises that the adoption of green logistics hinders company performance by increasing capital expenditure. Pearson correlation indicates a weak negative relationship between these two variable, however, correlation does not indicate causation hence one can only describe the nature of the relationship in terms of strength and direction.

Model 6: Green logistics initiatives - This model advocates that green diffusion is largely impacted by the tendency of green logistics to improve routing schedules that minimise wastage in the road freight network.

Model 7: Green and lean – Model 7 indicates that the dependant variable, green diffusion is influence by companies that seek to reduce costs in production and transport operations.

These seven models can be further analysed in terms of variation and model fit, and to evaluate the degree of explanatory power. An important point to consider regarding regression models is how well they can explain the variation in the dependant variable. Hence, the model summary table provided informs the researcher how much of the variance

in the dependant variable is explained by the model. The coefficient of determination (R^2) measures the degree of linear explanation provided by the model, namely, the proportion of variation in green initiative diffusion that can be explained by the regression model.

Table 4.13: Model Summary, ANOVA, Coefficients

Model Summary							
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson		
1	0.488	0.238	0.234	0.617	2.306		
2	0.555	0.308	0.301	0.590			
3	0.586	0.343	0.333	0.576			
4	0.600	0.360	0.347	0.570			
5	0.623	0.388	0.373	0.558			
6	0.635	0.403	0.386	0.553			
7	0.645	0.416	0.396	0.548			
Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions, Optimal delivery time and flexibility, Lean logistics practices, Green logistics expenditure, Green logistics Initiatives, Green and Lean							
ANOVA							
Model		Sum of Squares	df	Mean Square	F	Sig.	
7	Regression	43.293	7	6.185	20.585	.000	
	Residual	60.688	202	0.300			
	Total	103.981	209				
Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions, Optimal delivery time and flexibility, Lean logistics practices, Green logistics expenditure, Green logistics Initiatives, Green and Lean							
Coefficients							
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics
		B	Std. Error	Beta			Tolerance
7	(Constant)	1.117	0.301		3.718	0	
	JIT deliveries and strategic warehousing	0.173	0.062	0.2	2.79	0.006	0.56
	Lean Green dimensions	0.213	0.057	0.223	3.754	0	0.822
	Optimal delivery time and flexibility	0.192	0.057	0.229	3.348	0.001	0.617
	Lean logistics practices	0.183	0.045	0.25	4.024	0	0.751
	Green logistics expenditure	-0.108	0.043	-0.16	-2.531	0.012	0.723
	Green logistics Initiatives	0.113	0.052	0.136	2.192	0.029	0.753
	Green and Lean	-0.095	0.045	-0.125	-2.136	0.034	0.841
Residuals Statistics							
	Minimum	Maximum	Mean	Std. Deviation	N		
Predicted Value	2.57	5.19	3.68	.467	210		
Std. Predicted Value	-2.373	3.236	.000	1.000	210		
Standard Error of Predicted Value	.050	.263	.129	.039	210		
Adjusted Predicted Value	2.44	5.21	3.67	.469	210		
Residual	-1.797	1.331	.000	.528	210		
Std. Residual	-3.304	2.447	.000	.971	210		
Stud. Residual	-3.327	2.514	.003	1.004	210		
Deleted Residual	-1.822	1.410	.003	.565	210		
Stud. Deleted Residual	-3.415	2.549	.002	1.010	210		
Mahal. Distance	.787	47.677	11.943	8.396	210		
Cook's Distance	.000	.074	.005	.010	210		
Centered Leverage Value	.004	.228	.057	.040	210		

Table 4.14: One-Sample T-test

One-Sample Test						
	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
JIT deliveries and strategic warehousing	68.340	209	.000	3.848	3.74	3.96
Optimal delivery time and flexibility	66.828	209	.000	3.881	3.77	4.00
Green logistics Initiatives	60.679	209	.000	3.548	3.43	3.66
Green and Lean	50.024	209	.000	3.200	3.07	3.33
Green logistics expenditure	42.651	209	.000	3.062	2.92	3.20
Lean logistics practices	48.427	209	.000	3.214	3.08	3.35
Lean Green dimensions	73.312	209	.000	3.729	3.63	3.83

The model summary table depicts an increase in R^2 from 0.238 to 0.416 from model 1 to model 7, which explains the variation in green diffusion as more predictor variables are added to each model. For any model, as the number of explanatory (independent) variables increases, there is a subsequent increase in R^2 . Hence, a difference in comparison exists when regression models have the same dependant variable but a different number of explanatory variables. The value of R^2 in a multiple regression model can be misleading, as it captures only how well the model fits the data, but not how many variables the model contains. Thus instead of using R^2 , adjusted R^2 is used, which takes into account the number of variables used and how well the model fits the sample data. Hence model 1 to model 7 shows an increase in their adjusted R^2 values ranging from 0.234 to 0.396 for model 1 and 7, respectively. An improvement is noticed in the adjusted R^2 values where the seventh model has a higher value of adjusted R^2 ; therefore, it has a better degree of explanatory power (after controlling for the number of variables). Hence, model 7 is able to explain more of the variation in green diffusion than the rest of the models.

The Durbin Watson tests that residuals in a multiple regression are independent. The purpose of the test is to validate the absence of autocorrelation in time series data. The assumptions consider the error terms (ϵ_i) in the regression possess a zero mean, constant variance and is uncorrelated (Montgomery and Vinning, 2001). Thus:

$[E(\epsilon_i)=0; \text{Var}(\epsilon_i)=\sigma^2 \text{ and } E(\epsilon_i\epsilon_j)=0].$
--

This statistics ought to be in the range of 1.5 and 2.5. In this study, Durbin Watson is 2.306 which is within the stipulated range; this also confirms non-autocorrelation between the residuals in this regression. To assess the statistical significance of the result, the researcher needs to consult the ANOVA table. ANOVA tests that the multiple R in the population equals 0. The F statistics from ANOVA is 20.585 and significant at $p = 0.000$.

Hypotheses

Model 1: JIT deliveries and strategic warehousing

H₀₈: Green diffusion does not relate to JIT deliveries and strategic warehousing

H_{A8}: Green diffusion does relate to JIT deliveries and strategic warehousing

Model 2: Lean green dimensions

H₀₉: Green diffusion does not relate to lean green dimensions

H_{A9}: Green diffusion does relate to lean green dimensions

Model 3: Optimal delivery time and flexibility

H₀₁₀: Green diffusion does not relate to optimal delivery time and flexibility

H_{A10}: Green diffusion does relate to optimal delivery time and flexibility

Model 4: Lean logistics practices

H₀₁₁: Green diffusion does not relate to lean logistics practices

H_{A11}: Green diffusion does relate to lean logistics practices

Model 5: Lean logistics expenditure

H₀₁₂: Green diffusion does not relate to lean logistics expenditure

H_{A12}: Green diffusion does relate to lean logistics expenditure

Model 6: Green logistics initiatives

H₀₁₃: Green diffusion does not relate to green logistics initiatives

H_{A13}: Green diffusion does relate to green logistics initiatives

Model 7: Green and Lean

H₀₁₄: Lean green dimension does not relate to JIT deliveries and strategic warehousing

H_{A14}: Lean green dimension does relate to JIT deliveries and strategic warehousing

Since all seven models have a significance value of 0 at the 95% confidence level, the deduction is that model 1 to model 7 reach statistical significance. Thus the researcher can accept the alternate hypothesis and conclude there is a relationship between the variables of model 1, model 2 and model 3, model 4, model 5, model 6, and model 7.

Multicollinearity is one of the important problems in multiple regression analysis. It is usually regarded as a problem arising out of the violation of the assumption that the explanatory variation is linearly independent. However, the mere satisfaction of this assumption does not preclude the possibility of an approximate linear dependence among the explanatory variables and hence the problem of multicollinearity. When identifying if multicollinearity exists in the model, the researcher needs to look at the tolerance and VIF values.

All seven models have predictors with tolerance values greater than 1. Hence, the multicollinearity assumption is not violated. This is further supported by the VIF values, which for all respective models is less than 10, indicating that multicollinearity does not exist with other variables. These results are expected, given that the Pearson correlation coefficient between these independent variables is relatively low. An assessment of the beta value is important when evaluating the independent variables. The beta weight indicates the relative importance of a predictor in predicting the dependant variable. The larger the value of the beta weight, the more influence this factor has on predicting the dependant variable (lean green dimension).

JIT deliveries and strategic warehousing has the highest beta value of 0.488 between the seven models. Thus JIT deliveries and strategic warehousing make the strongest unique contribution to explaining the dependant variable when all other variables in the model are controlled. The significance value (p) is 0.000 at the 95% level of confidence. Since the p value is less than 0.05, JIT deliveries and strategic warehousing makes a significant contribution to the prediction of the dependant variable. The one-sample t-test further enhances the results from regression. The t-test procedure tests the mean value in a normal distribution. This study has t-statistics for all seven predictor variables that is significant at the $p = 0.000 < 0.005$ at the 95% confidence interval. Such significant p -values indicate that the average response from the sample population is indicative of the true population mean.

The above information thereby allows the researcher to derive a linear equation that factors in all seven variables in the model that impact on green diffusion:

$$\text{Green Diffusion} = 1.117 + 0.173 \text{JDSW} + 0.213 \text{LGD} + 0.192 \text{ODTF} + 0.183 \text{LLP} - 0.108 \text{GLP} - 0.113 \text{GLI} - 0.095 \text{GL}$$

Residual Statistics

The purpose of residual analysis is to 1) identify heteroscedasticity; 2) detect outliers and 3) spot stochastic errors that are associated with certain ranges of X variables. Hence model response is largely dependent on the deterministic portion of the model and stochasticity (Frost, 2012). The studentised and standardised residuals are similar in measuring outliers and influential observations that exist in the data. The standardised residual in this study (min = -3.304 and max = 2.447) within expected interval (-3.3 or ± 3) and studentised residual (min = -3.327 and max = 2.514). The model has a normal distribution mean of 0 (0.000) and standard deviation closer to 1 (0.971) from standardised. The measure of Cook's Distance (D) is an indication of the level of influence an observation has on the overall model – if $D > 1 \rightarrow$ this implies an outlier problem, that is, $D > 4/N \rightarrow$ where N is sample size) (Bryman and Bell, 2007). According to Karlaftis, Washington and Mannering (2011:101), "Cooks distance quantifies the impact of removal of each observation from the fitted regression function on estimated parameters in the regression function." This study illustrates Cook's Distance with (min = 0.000 and max = 0.074) and value of D less than 1, implying the observations do not have large influences on the regression analysis.

The leverage of an observation is a measure of the ability to impact the regression model coefficients by shifting the value of the observation on the y-axis. Leverage takes on values between 0 and 1; where a 0 value implies no leverage and no effect and the regression model, while values closer to 1 indicate problems (Statistics Columbia, 2012:2). This study reveals leverage values between 0 (no influence on the model) and 1 (completely determines the model) (min = 0.004 and max = 0.228).

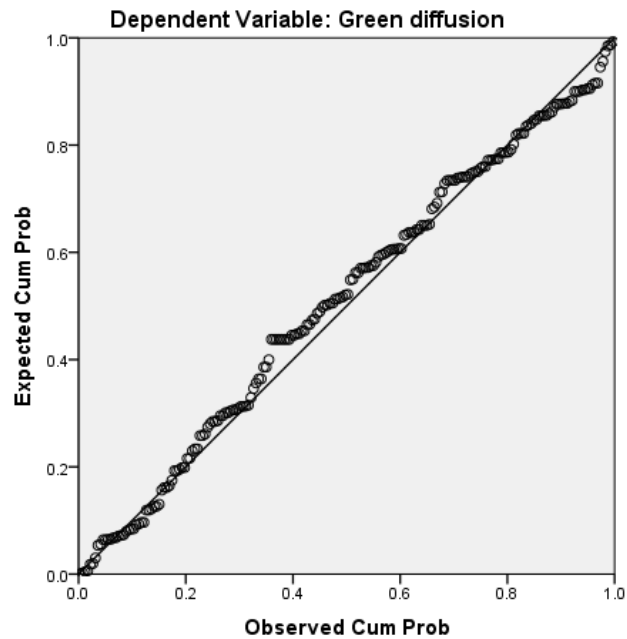
Mahalanobis distance is a scalar measure of where an observation lies within the multivariate parameter space of multiple regression used to detect outliers (Farhani and Hekmatfar, 2011:113). It examines how far scores lie from the centroid of all cases for the predictor variables. It serves the purpose for pattern recognition for the data distribution (Ekstrom, 2011:1). Mahalanobis distance take on values (min = 0.787 and max = 47.677). The higher the Mahalanobis distance for a case, the more that case's values on independent variables diverge from average values.

Data assessment is conducted to ensure that the assumption of common variance has not been violated. Hence, when analysing the data for outliers, normality, linearity, homoscedasticity, and independence of residuals, the Normal P-P plot of the regression standardised residual and the scatter plot is consulted.

Normality and Linearity

The normal P-P plot validates the assumption that residuals follow a normal distribution. The diagonal line represents the line of expected values and the points which coincide with this line are the expected values. In the normal P-P plot, points lie in a reasonably straight diagonal line from bottom left to top right, suggesting no deviations from normality.

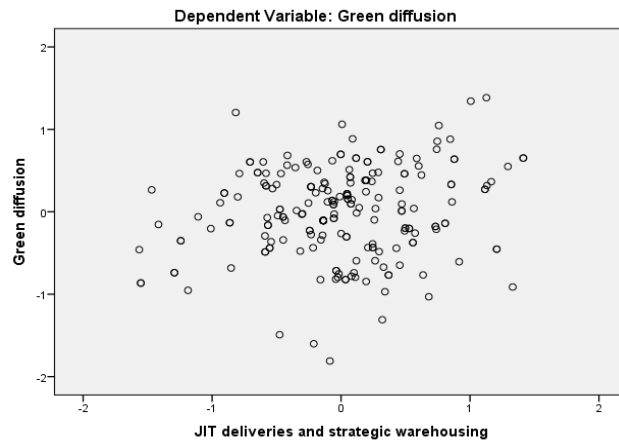
Figure 4.12: Normal P-P plot regression Standardised Residual



Homoscedasticity

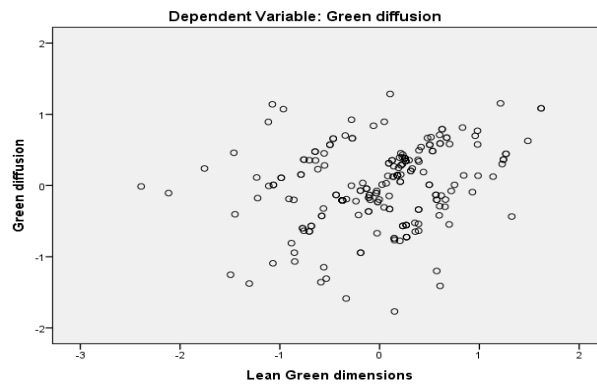
A model that is homoscedastic falls in line with the ordinary least squares (OLS) assumption that the variance of errors in the model is constant. When the assumption of homoscedasticity is violated, then further regression tests cannot be justified based on the OLS assumption. Homoscedasticity can be identified in the partial regression plots that show the effect of adding another variable to the model given that the independent variable already exists. The figures below illustrate the association between the dependant and independent variable/s. The effect of adding an additional variable is further illustrated in figures 4.13 to 4.19. In the scatter plot, residuals should be rectangularly distributed with the majority of values concentrated in the centre. Points should lie between -3 and 3.

Figure 4.13: Partial Regression Plot JIT deliveries and strategic warehousing (Model 1)



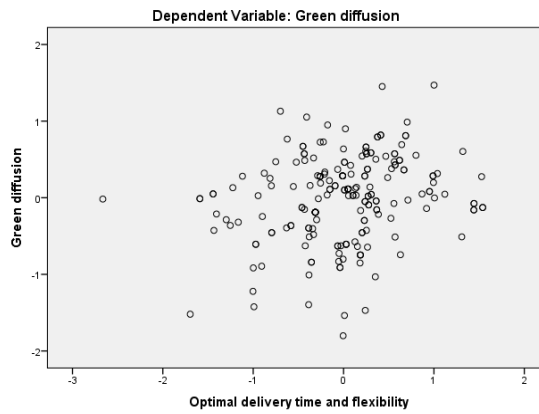
Tentatively from the scatter plot, the assumption of equal variance has not been violated in the model between JIT deliveries and strategic warehousing and green diffusion. Hence, the researcher infers that the model assumes homoscedasticity. The presence of an outlier (an observation that deviates considerably from the other values) should not be a problem due to the large sample size.

Figure 4.14: Partial Regression Plot Lean Green dimensions (Model 2)



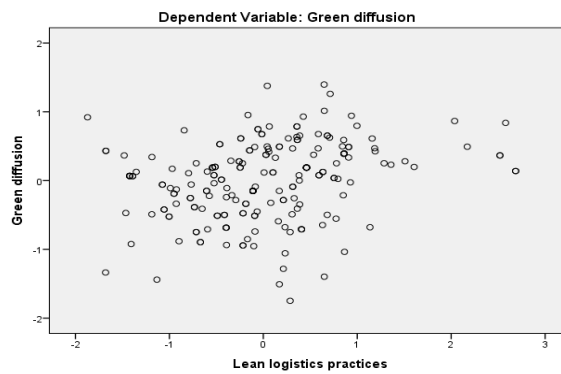
The regression plot for lean green dimensions and green diffusion illustrates homoscedasticity in the model

Figure 4.15: Partial Regression Plot Optimal delivery time flexibility (Model 3)



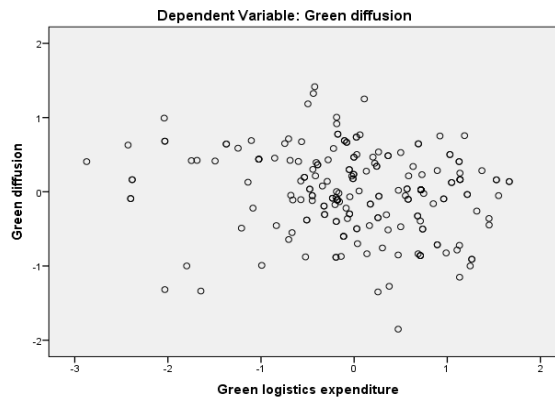
Similarly, in figure 4.15 homoscedasticity for optimal delivery time and flexibility and green diffusion can be witnessed in the regression plot.

Figure 4.16: Partial Regression Plot Lean logistics practices (Model 4)



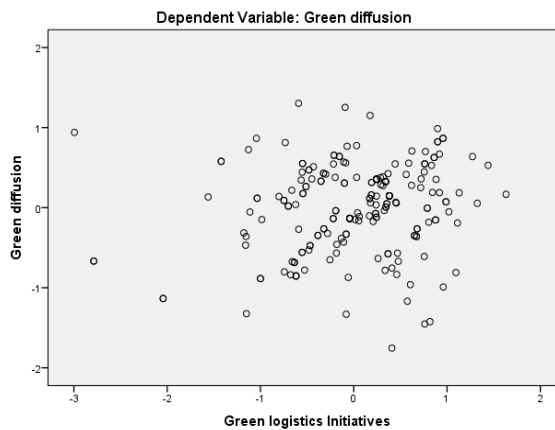
The data points in figure 4.16 lie between 3 and -3, thus confirming homoscedasticity in the model between green diffusion and lean logistics practices.

Figure 4.17: Partial Regression Plot Green logistics expenditure (Model 5)



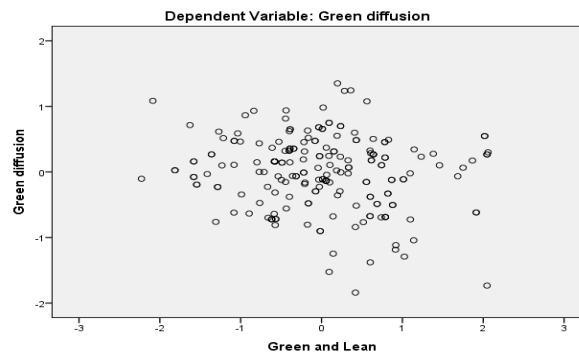
The scatter plot displays values that lie between 3 and -3; hence the researcher infers homoscedasticity in the model between green diffusion and green logistics expenditure.

Figure 4.18: Partial Regression Plot Green logistics initiatives (Model 6)



Similarly in model 6, homoscedasticity is present between green diffusion and green logistics initiatives.

Figure 4.19: Partial Regression Plot Green and Lean (Model 7)



One again, the regression plot for green diffusion and green and lean illustrate homoscedasticity in the model. Homoscedasticity is further confirmed in factor analysis where more than one item loads on the same factor.

4.3.4 Logistics Regression

While multiple regression assesses the impact the predictor variable has on the dependant variable for continuous data, logistics regression is used to test models to predict the outcome of categorical variables. In this analysis, binary logistics regression will be applied with the forced entry method utilising the dichotomous dependant variable – green initiatives.

In this instance, the research question to report against is: What factors predict the likelihood that respondents would report that their organisation strives to implement green logistics initiatives?

Table 4.15 and table 4.16 are most significant in this study as it provides information on how well the model predicted the outcome from the variables being tested. It is important to view the difference in the outcome when only one the dependant variable is used (green initiatives – refer to table 4.15) in comparison to the results obtained when all independent variables (table 4.15) are considered. The relevance of these tables sets the foundation to establishing the probabilities in predicting the correct outcome; the model fit which is established by the Omnibus tests of model co-efficient and model worthiness that is obtained using the Hosmer-Lemeshow goodness of fit test.

Table 4.15: Classification Table – Model 1 and Omnibus Tests of Model Co-efficient - Model 2

Classification Table – Model 1					
Observed			Predicted		Percentage Correct
			Green initiatives		
			No	Yes	
Step 0	Green initiatives	No	0	90	0
		Yes	0	120	100
	Overall Percentage				
Omnibus Tests of Model Co-efficient – Model 2					
		Chi-square	Df	Sig.	
Step 1	Step	149.08	7	0	
	Block	149.08	7	0	
	Model	149.08	7	0	

The classification table provides the results of the analysis with only the dependant variable included in the model (model 1). Hence from table 4.15, the overall percentage of correctly classified cases is 57.1%. Hence SPSS classified that all cases would implement green logistics initiatives (only due to the majority of the respondents answering yes to the question). The accuracy of this result will be observed in subsequent tests when the predictor variables are added to the model.

The Omnibus Tests of Model Co-efficient provides the overall goodness-of-fit test. The results obtained in this model supersede the results generated from the classification table because it includes the set of independent variables and provides an indication of overall model performance over and above the results generated when none of the predictors are considered in the model (Avery, 2007:61). A desirable result is achieved when the significance level (p) is less than 0.05. Since the p value is $0.000 < 0.05$, the researcher infers that model 2, which includes the set of predictor variables, is more valid than model 1 where SPSS assumed that everyone would report that the organisation strives to implement green initiatives. The Chi-square value is 149.80 with 7 degrees of freedom.

The Hosmer and Lemeshow Test also support the worthiness of this model. This is a statistical test reported as the most reliable test of model fit whose results are stated differently from the Omnibus test. The test assesses whether the observed matches outcome the expected outcome rates in the sample (Hosmer, Lemeshow and Sturdivant, 2013:112). The results from the Hosmer-Lemeshow goodness of fit test is interpreted as follows: A poor fit is indicated by a significance value of less than 0.05; hence to support the model with the set of predictors, a value greater than 0.05 is desirable.

Table 4.16: Hosmer - Lemeshow Goodness of Fit Test, Model Summary, Classification Table: Model 2

Hosmer - Lemeshow Goodness of Fit Test					
Step	Chi-square	Df	Sig.		
1	6.346	6	0.386		
Model Summary					
Step	-2 Log likelihood	Cox and Snell R Square	Nagelkerke R Square		
1	137.742 ^a	0.508	0.682		
Classification Table: Model 2					
Observed		Predicted			Percentage Correct
		Green initiatives		Percentage Correct	
Step 1	Green initiatives	No	Yes		Percentage Correct
		No	Yes		
		76	14	84.4	
		16	104	86.7	
	Overall Percentage			85.7	

From table 4.16 the chi-square value for the Hosmer-Lemeshow test is 6.34 with a significance level of 0.38. This value is greater than 0.05, indicating support for model 2. The amount of variation in the dependant variable explained by the model is illustrated by the model summary table. Cox and Snell R Square and the Nagelkerke R Square values are the two values ranging between 0 and 1 that report the level of variation. The variability range is 50.8% to 68.2% which is explained by the set of predictor variables illustrated by the model summary.

The result from the classification table model 2 can be compared with the result from table 4.15 to demonstrate the improvement when the set of independent variables is added to the model. The classification table - model 2 shows that the model makes a correct prediction 86% of the time overall. Of the 90 respondents that said the company does not adopt green initiatives, the model correctly identified 76 of them as unlikely to adopt green initiatives. Similarly, of the 120 respondents that were likely to agree the company adopts green initiatives, the model correctly identified 104 of them as like to agree.

Therefore the positive predictive value is 88.13%, indicating that of the respondents predicted to believe that their organisation strives to implement green initiatives, the model accurately picked 88.13%. Similarly, the negative predictive value is 82.61%. To establish which predictor variables contribute significantly to the model, table 4.16 is used

Table 4.17: Variables in the equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1	Green Policy	2.365	.526	20.231	1	.000	10.648	3.799	29.847
	Green warehouse optimisation	1.961	.573	11.733	1	.001	7.108	2.314	21.835
	Carbon reduction	-.397	.621	.410	1	.522	.672	.199	2.268
	Bottom line performance	.696	.538	1.674	1	.196	2.005	.699	5.753
	Optimum delivery frequency	.073	.578	.016	1	.899	1.076	.347	3.340
	Technological advancement	.065	.593	.012	1	.913	1.067	.334	3.409
	Green Logistics	1.374	.485	8.021	1	.005	3.952	1.527	10.231
	Constant (Green initiatives)	-2.676	.457	34.319	1	.000	.069		

Only three predictor variables make a statistically significant contribution to the model, namely, green policy, green warehouse optimisation and green logistics. These predictors are statistically significant at the 95% level of confidence with p values equivalent to 0.000, 0.001 and 0.005, respectively. That is, the company must develop a policy while optimising the greening initiatives so as to embrace green logistics diffusion. The Wald criterion by nature is a conservative approach in that it appeals to a cautious decision maker who chooses a strategy whose outcome is least bad under conditions of uncertainty (Thomas and Zhang, 2003:109). Wald criterion generates statistically significant results that correspond to 20.23, 11.73 and 8.02 for the three set of predictor variables, respectively. These variables have the most significant predictive power in the model and influence whether or not the respondents report that their organisation is striving to implement green logistics initiatives. Carbon reduction, bottom line performance, optimum delivery frequency and technological advancement do not contribute significantly to the model (as denoted by their statistically insignificant p values).

The direction of the relationship is indicated by positive or negative B values. The variable measuring whether company policy encourages the implementation of green practices has a positive B value (2.36). This means that the more companies encourage the implementation of green practices as part of their policy, the more they strive to implement green initiatives. The results illustrated in frequency distribution report that 56% of respondents did not believe that there is a comprehensive understanding of green logistics among employees in the organisation, although 60% of respondents noted that their organisation has set policies on greening. It is believed that belonging to forums that encourage greening initiatives among supply chain trading partners does in fact boost green supply chain adoption, hence, around 112 individuals did agree to the company belonging to a forum. However, the adoption of green supply chain is only fully embraced when a company extends green supply

chain activities to its policy making and strategic planning. When asked if the company policy encourages the greening of logistics activities, a convincing percentage of the respondents (81.9%) believed this to be true for their organisation.

Similarly, green warehouse optimisation has a positive B value of 1.96, which implies that if optimised warehouse activities result from the adoption of green methods, more companies will strive to implement green initiatives. The third predictor variable, green logistics also has a positive B value of 1.37. Thus the researcher concludes that, the more employees understand the concept of green logistics, the more green initiatives will be undertaken by logistics companies.

The odds ratio (OR) represents the change in the odds of being in one of the categories of outcomes, when the value of the predictor variable is increased by one unit. Hence, the odds of a respondent answering, 'Yes, the company strives to implement green logistics initiatives' are 10.64 times higher for someone who reports that company policy has encouraged the implementation of green practices, than for a respondent that answers otherwise, all else being constant.

Similarly, the odds of a respondent answering, 'Yes, the company strives to implement green logistics initiatives' are 7.10 times higher for someone who reports that the company has adopted green methods to optimise their warehousing activities, than for a respondent that answers otherwise, all other factors being constant. Once again, the odds of an individual answering, 'Yes, the company strives to implement green initiatives' are 3.95 times higher for a respondent who has a comprehensive understanding of green logistics initiatives than for a one who has no understanding of the term, all other factors being equal.

For each of the odds ratios, the 95% confidence interval confirms the range of values which the researcher can be 95% confident encompass the true value of the odds ratio. However, confidence that the odds ratio is an accurate representation of the true value is largely dependent on the size of the sample. In this sample of 210 respondents, the confidence interval for variable green policy (OR = 10.64) ranges from 3.79 to 29.84. Thus although the calculated OR is 10.64, the researcher can be 95% confident that the actual OR value of the population lies between 3.79 and 29.84. The confidence interval does not contain the value of 1; hence the result is statistically significant at $p < 0.05$.

The confidence interval for variable green warehouse optimisation (OR = 7.10) ranges from 2.31 to 21.83. Thus, although the calculated OR is 7.10, the researcher can be 95% confident that the actual OR value of the population lies between 2.31 to 21.83. The confidence interval does not contain the value of 1; hence the result is statistically significant at $p < 0.05$. Similarly, the confidence interval for variable green logistics (OR = 3.95) ranges from 1.52 to 10.23. Thus, although the calculated OR is 7.10, the researcher can be 95% confident that the actual OR value of the population lies between 1.52 and 10.23.

4.4 Reliability and Validity

Table 4.18: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.744	.760	13

Respondents were asked to rate 13 variables on the 1-5 point likert scale where 1 indicates 'strongly disagree' and 5 'strongly agree'. Cronbach's Alpha is used to test the reliability of the instrument and also depicts the internal consistency of the study. It generally ranges between 0 and 1, and a value closer to 1 indicates a higher degree of internal consistency. Internal consistency is discussed in terms of the interrelatedness among the items in the study. However, interrelatedness of items does not indicate unidimensionality and homogeneity. The dimensions of factors are only found when factor analysis is performed. Hence from the reliability statistics generated by SPSS, the instrument has a moderate internal consistency for reliability suggested by the Cronbach's Alpha value. The Cronbach's Alpha value is 0.74 and the Alpha coefficient is 0.76.

The Alpha coefficient for standardised items informs the researcher that when all scale items have equal mean and variances, internal consistency and reliability reach a value of 0.76, which is indicative of the good reliability of the instrument. Hence, the above data analysis provides insight into the variables being investigated. From the results and the conceptual and theoretical framework outlined in earlier chapters, the researcher is able to achieve the objectives stated at the beginning of this study. The factors that have the highest loadings in factor analysis still appear in multiple regression analysis. In addition, some of the hypotheses tested in bivariate data analysis produce the same results in multivariate data analysis. Similarly, the majority of the variables with the highest mean have appeared frequently in the factor loadings. This confirms validity of the scale measuring the underlying concept.

4.5 Conclusion

This chapter has analysed all the results using the various methods discussed in ‘Research Methodology’. Chapter four forms the basis of all discussions in relation to the theoretical framework. These results will provide supporting evidence against previous literary works. In some instances, the findings discovered in this study may not correspond to other scholarly works, which in such cases special attention must be given to the varying conclusions in order to understand the dynamics of lean and green logistics.

CHAPTER FIVE

Discussion of Results

5.1. Introduction

This chapter discusses the results obtained from the data analysis in relation to the researcher's conceptual framework and the study's objectives. The researcher will answer the research questions outlined in chapter one using the results of the study. The aim is to provide insight into the topic under investigation and compare this study's results with those reported in the literature.

The discussion will first address the biographical results, followed by the first two objectives which examine the effects and dynamics of lean logistics and the value-creation generated from the implementation thereof. The results of this study are compared with the findings of the relevant literature. Thereafter, objectives three and four are discussed against the conceptual framework of this study. The objectives are outlined as follows: 5.2.1 will discuss the empirical results and theory relating to objective 1 and 2; 5.2.2 will seek to answer objective 3 and 5.2.3 will answer objective 4.

5.2. Discussion relating to research objectives

5.2.1 The effects of lean logistics within the Durban road freight network and the dynamics of lean logistics and cost containment strategies

Discussion on the above two objectives will be discussed viewed in light of the four themes in this study, namely; warehouse layout optimisation, inventory management, network optimisation and logistics optimisation.

5.2.1.1 Warehouse layout optimisation and inventory management

According to the empirical findings, most of the respondents work in the transport and warehousing division, the majority agreed that lean warehousing that impact staging activities and lead times is the most important factor that drives companies towards the adoption of lean logistics. This was followed by optimum warehousing functions. This is confirmed by the frequency distribution, where the majority of the respondents confirmed that these two factors are the leading reasons for the adoption of lean logistics. Zuo and Li (2010:16) argued that the primary goal of warehouse layout is to optimise warehousing functions which result in the maximisation of space utilisation and efficiency. Zeng and Zang (2010) showed that optimum layout reduces transport mileage, improves shipping

accuracy and introduces cost savings. Hence companies view the layout of a warehouse as means to use resources more effectively, impacting business efficiency and service delivery.

However, in terms of inventory management, JIT strategies and lean profitability featured as the two most important factors that have driven companies to implement lean logistics practices. These results from frequency distribution are not surprising as inventory reduction and resource optimisation featured as the two most commonly implemented lean practices among the five options provided in this study. These results concur with the literature. Mchalski (2013:187-192) argues that inventory management alters the value of the firm by striking a balance between carrying too much and too little inventory. Studies have shown that the integration of distribution requirements and materials planning reduces inventory, reducing total carrying costs along the supply chain. Similarly, Bonney (1994:109) states that inventory alters the internal flexibility of a company by allowing production levels to change, which improves delivery to customers.

Thus the integration of the components in this logistics network is required to gain synergies that create and drive business value through optimal inventory management. Integrating logistics activities will mean less transportation and more efficient deliveries due to accurate forecasts of demand. Hamilton (2006:2) illustrates the cost savings realised from warehouse optimisation and appropriate inventory management. Lead time reduction between 30% and 70% implies significant shifts in the response time of the business to the market, improving customer service levels and fill rates by 30% to 60% (Hamilton, 2006:2). Furthermore, a 20% to 40% reduction in inventory in the business reduces overhead costs which translate into improvement of bottom line performance measurements, and expanded profit margins – evident from the frequency distribution on inventory management that considers lean profitability an influential factor. Reducing inventory also limits business's exposure to the risk of obsolescence and the carrying cost of holding too much inventory in the supply chain; the risk of ownership is further impacted when transportation companies move cargo as 3PL service providers.

Womack and Jones (2005:12-17) affirm that if the four core principles of lean thinking are applied to the supply chain, this can add significant value to a business with minimum wastage. Lean logistics requires frequent shipment of goods in small amounts at every point in the provision stream, as well as the compression of time and distance. Hence, organisations that, adopt lean logistics thinking in their supply chain stand to benefit from improved customer service levels, waste reduction and cost savings. Hence, lean logistics can be viewed as a means of creating business value through the seamless flow of activities

and functions within the internal structure of the organisation; the most formidable lean dynamics incorporate lean warehousing activities that reduce waste and improve time utilisation, an increase in staging activities that positively impact shipping lead times, JIT strategies that minimise inventories and the realisation of bottom line performance as a result of the application of lean inventory management techniques.

5.2.1.2 Network Optimisation and Logistics Optimisation

The study revealed that company policy is the main factor that influences the attainment of an optimal distribution network. However, the frequency distribution also reveals that technological advances are a driving force that directly impact network efficiency. Technology has been growing at exponential rates and the latest logistics systems software is able to plan the best possible routes with optimised loading schedules. Gibson *et al.*, (2013:101) observes that IT systems can promote efficiency by reducing resource usage and streamlining business processes. Similarly, TCS (2010:13) believes that technology provides visible solutions that can assist logistics players with asset tracking that enables companies to reduce their resource consumption while achieving higher service levels. Hamilton (2006:2) identifies the benefits and savings of an optimal network. These include increased asset utilisation, a reduction in transportation costs, reduced lead times and increased fill-rates. These benefits typically realise typical cost savings in the range of 5% to 15%.

Modrak and Seman (2013:342) believe that a pure lean supply chain will have no slack and zero inventories. Similarly, Mason *et al.*, (2007:190) regard waste elimination and a pull system as strategic lean thinking characteristics that address inventory reduction and transport optimisation. Zuo and Li (2010:16) argue that optimal distribution networks can increase efficiency whilst simultaneously achieving cost savings; the results of this study show that total cost optimisation is the most highly rated factor driving lean logistics in terms of a logistics optimisation strategy. Companies regard a centralised logistics system as means of minimising cost along the distribution network. Lin and Ho (2008) state that a centralised distribution system provides some competitive advantages to companies, such as a complete assortment of stock which leads to high availability; a smooth flow of products from the warehouse with standardised routines for material handling; reduced costs for the warehouse and administration; shorter lead times and a reliable service; increased flexibility and improved delivery performance.

This study found that demand-driven logistics is the second most important factor for logistics optimisation, with the perceived benefits of increasing order and shipment fulfilment whilst reducing inventory obsolescence and customer returns. This concurs with

the findings of Ashayeri and Kampstra's study (2011:4-9); they view demand driven logistics as a vision for leveraging management support systems and technology for automation that improves the logistics business. This premise is primarily based on the redesign of the distribution system that focuses on customer requests and purchasing information within the distribution centre. The literature notes a reduction in lead time to load trucks and a balanced workload of order picking and sorting operations. The coordination and support of these activities allow for efficiency from point of purchase to point of shipment which improves both the quality and the scale of the business whilst managing costs and resources. In line with the findings of previous studies, this study found that order consolidation, which increases capacity utilisation and reduces shipment frequency, was highly ranked in terms of importance to companies. This is seen as another motivating factor that plays an influential role in the application of lean logistics practices.

5.2.2 The opportunities arising from the implementation of green logistics within the Durban road freight region

Evangelista *et al.*, 2011; Geroliminis and Daganzo, 2010; and Evangelista *et al.*, 2010 conducted studies on warehouse layout, inventory management, network optimisation and logistics optimisation. The results of this study show the following relationship between lean and green logistics and the opportunities derived from implementing green logistics thinking in the Durban road freight network.

Firstly, in line with the literature is confirmation that organisational size does relate to employees' understanding of green logistics. The Pearson Chi-square matrix statistics yield significant results. Lin and Ho (2008) found that the quality of human capital and organisational knowledge has a positive influence on the adoption of green initiatives. These findings further support the recommendation that green logistics education and awareness could be a powerful tool to boost performance.

Secondly, the Pearson Chi-square matrix also confirms that the adoption of lean initiatives does relate to a company's policy on green initiatives adoption. This is an important finding as it supports the conceptual framework and the findings of previous studies that advocate for green implementation as an interplay with lean initiatives. Pieters, Glockner, Omta, Weijers (2012:107-110) show that logistics service providers participating in the Lean and Green scheme preferred solutions that involved cooperative strategies over third-party solutions. The frequency distribution also illustrated in support of the assertion that company policy is an influential factor in the adoption of green initiatives. The opportunities derived from implementing green logistics initiatives can also be witnessed in the results from the

logistics regression model, where only three factors present the likelihood that an organisation strives to implement green logistics initiatives. These factors are green policy, green warehouse optimisation and green logistics. The logistics regression model generated three influencers as predictor variables in the adoption of green logistics, and once again company policy features as a controlling factor.

The opportunities derived from these three factors on green logistics present significant solutions to green and lean thinking. As discussed earlier, the benefits obtained from lean warehousing are significantly proportionate to the benefits derived by implementing green warehousing solutions to optimise logistics performance. Similarly, Zheng and Zang (2010:115) argue that a reasonable warehouse layout can reduce transportation mileage while saving on costs. They argue that if the layout of the warehouse is too dense, this increases the number of transporters, resulting in increased fuel consumption and carbon emissions (Zheng and Zang, 2010:115). Hence, the design of storage facilities ought to meet the requirements of a non-polluted environment where the focus is the minimisation of wastage and the maximisation of resources. TATA Consultancy Services (2010:9) provides several methods by means of which an optimised warehouse layout can increase the efficiency of resource utilisation whilst simultaneously minimising the organisation's carbon footprint, such as; the use of skylight and clerestory windows to make use of natural light; reflective roof membranes to adjust to thermal conditions and green procurement engagements.

In line with the literature and in support of these findings, the Pearson Chi-square matrix shows that a relationship does exist between green logistics initiatives and lean warehousing that impacts staging activities and shipping lead times. This is evident in the researcher's previous finding that warehousing is a driving factor in companies adopting lean logistics practices in their internal operations. Although only three predictor variables confirmed statistical significance, the odds of creating opportunities from the implementation of green logistic initiatives is 10.64 times greater for a company that encourages green practices as part of corporate policy, 7.10 times greater for companies that use green methods to optimise their warehousing functions and 3.95 times greater for companies that promote a comprehensive understanding of green logistics initiatives and employee empowerment. These odds are significant and are mostly internal to the company. The finding concurs with previous studies on corporate governance that found that business growth and sustainability are triggered from the inside out (Nagel, 2012). However, the Pearson Chi-square matrix generated insignificant results that are deemed inconsistent with the literature. These include the lack of association between green logistics initiatives and network efficiency and total

cost optimisation in a centralised logistic system. Nevertheless, the results from factor analysis reveal the principle components that impact the relationship between green and lean logistics. With three factors contributing to the impact on lean and green logistics, factor analysis also confirms the relationship between the two concepts. LeaGreenity that has been identified as one of the factors consists of items that load on each lean and green characteristic to form a combination of the two dimensions, which would otherwise function in isolation.

The loadings on these factors include JIT deliveries and optimal warehouse strategies that initiate cost savings; optimal delivery time and flexibility that minimise waste in transportation activities; green logistics initiatives that enhance hub points and distribution centres with appropriate infrastructural development; green logistics initiatives that have a tendency to improve routing schedules that minimise wastage in the road freight network; the interplay between lean and green that enables a company to tap into both dimensions; and the reduced cost of production and transport operations as a result of lean and green logistics implementation.

Thus the opportunities from the relationship between lean and green are substantial. Logistics businesses could grow from strength to strength by internalising their lean practices through externalising the application of green. Sustainability is internationally acknowledged as a prerequisite for business and South Africa needs to play catch up. Given the current state of the country's economic climate, cost effective methods need to be in place, along with contingency plans that facilitate growth in a country well-endowed with natural resources to leverage trade.

5.2.3. The relationship between lean practices and green diffusion in logistics systems

In light of the findings discussed, the multiple regression model further confirms the factors that impact the relationship between lean and green logistics. Seven model predictors were confirmed that impact green and lean logistics. Once again the factors that appeared in factor analysis also appeared in multiple regression analysis.

Confirming the relationship between the two concepts and its mutual application, Straton (2013) explains that creating a viable and sustainable green strategy can be a challenge for companies that desire to be good corporate citizens, but also need to remain competitive. Demand-driven logistics practices are fast becoming a focal point to integrate green with lean, which helps reduce material and time wastage, ensure more accurate order and shipment fulfilment, and thereby eliminate inventory obsolescence and returns. Moreover,

shippers can offset frequent deliveries and higher transportation costs by working more collaboratively upstream in the supply chain, pooling shipments, rationalising assets, optimising loads, and achieving greater economies of scale (Straton, 2013). Hence, understanding the interplay between supply chain execution excellence and sustainability excellence is critical in order to develop a long-term strategy that strikes the proper balance and achieves success in going green and being lean.

Similarly, company policy which has a predictor effect on the adoption of green diffusion also impacts the implementation of lean logistics. This result has appeared in all three multivariate instruments. However, the analysis of the dichotomous results reveals that almost 60% of companies do not incorporate greening as part of company policy. In line with the literature, the findings confirm that lean produces an operational and cultural environment that is highly conducive to waste minimisation and pollution prevention, and that lean provides an excellent platform for environmental management tools such as life-cycle assessment and design for environment (EPA, 2013:1). The transportation sector already produces a quarter of all energy-related carbon dioxide emissions and these emissions are growing fast at about 2.5% per year (Venkat and Wakeland, 2006:4).

This has important implications for lean supply chains. Lean principles call for the distances on a supply chain to be as short as possible. However, in the age of global trade, very few supply chains can consist entirely of short transportation links. A typical supply chain is currently likely to have at least a few moderately long transportation links, increasing energy use and carbon dioxide emissions due to transportation being a significant contributor to negative environmental impacts. It can be argued that lean manufacturing has a positive impact on the environment, since its primary focus is waste minimisation. However, there are certain constraints that need to be taken into account in order to determine whether or not lean thinking has a positive impact on overall green supply chain performance. In order to mitigate the negative impact of transport on the environment, the integration of forward and reverse flows in the lean supply chain should be considered, so as to determine how supply chain companies and transport providers can integrate flows to holistically optimise transport movements and the entire logistics system.

5.3 Discussion relating to hypotheses

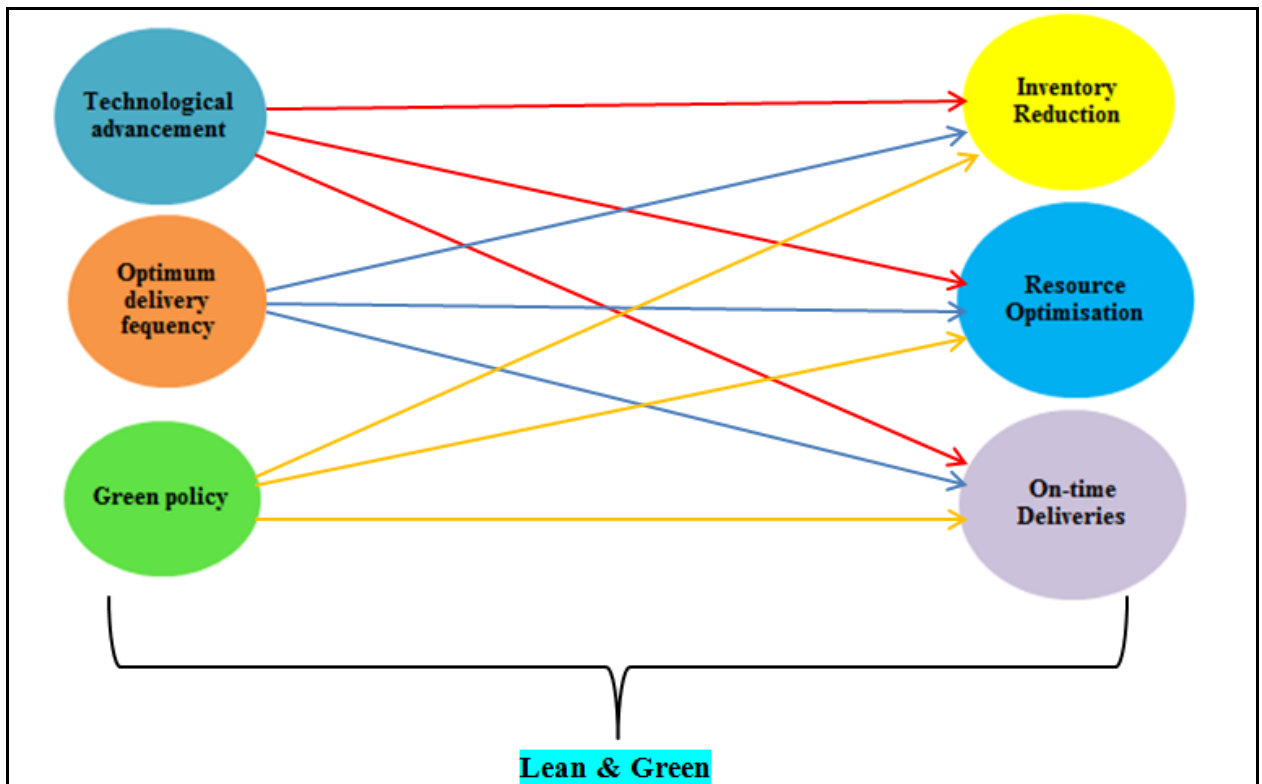
5.3.1 The size of the company determines the implementation of green initiatives.

The results show that company size has no influence on the implementation on green initiatives. However, these findings are in contrast to literary works in which Lin and Ho (2008:164-168) have shown that number of employee, company history, and capital size influence initiatives taken by companies. In general, size (in terms of both employees and turnover) is one of the most important firm characteristics expected to influence the adoption of green initiatives. In addition, differences between small and large logistics companies have been found by Evangelista *et al.*, (2011:15). For example, large companies show a higher level of awareness of environmental sustainability in comparison with smaller ones. A different approach has been detected between small logistics companies that show a focus on reducing the environmental impact of transport activities only.

5.3.2 The size of the company is relative to the understanding of green initiatives among employees.

The results reveal there is an association between company size and the understanding of green logistics. This falls in line with literature where the works of Lin and Ho (2008:169) reveal the quality of human capital and organisational knowledge accumulation has positive influences on the adoption of green innovative initiatives. The authors studied the influence of technological, organisational and environmental drivers on the logistics firms' willingness to implement green innovations. So while company size does not influence the decision to adopt green initiatives, the size of the company is certainly relative to the understanding of green logistics among employees. This can also be seen as a way for companies to become more environmentally conscious (without incurring high costs) by encouraging internal lean processes among employees that minimise wastage. Most respondents chose inventory reduction; resource optimisation and on-time deliveries as the top three lean initiatives implemented at their company; whereas technological advancement, company policy and optimum delivery frequency were the highest ranked variables that encouraged the adoption of green initiatives. Tentatively, these factors possess characteristics of interaction although they belong to an absolute dimension. In the relative dimension (lean and green), the initiatives adopted by companies can have overlapping benefits. Figure 5.1 shows the symbiotic relationships when lean and green interact based in the variables mentioned above.

Figure 5.1 Lean and Green symbiotic association



Source: Developed by researcher

5.3.3 The adoption of lean initiatives is linked to the company's policy in green initiatives.

The results illustrate that there is an association between the adoption of lean initiatives and green initiatives. Since inventory reduction is seen as the most popular practice among companies in this study, literary works show that lean supply chains who base their strategy on pull systems aim to minimise inventory within the chain. These systems require JIT delivery to minimise waste. However, Zhu and Sarkis (2004:268-273) note that the company to company relationships aspects of JIT and its focus on the movement of materials may have a moderating effect on the relationship between practices and such programmes may favour improved operational performance over environmental efficiencies. The more JIT strategies applied, the further the negative environmental consequences of the traffic it creates (Rodrigue and Slack, 2001:14). Thus company policies that base their operations on best practices, environmental consciousness and sustainability are likely to tap into the realm of lean processes and waste reduction.

5.3.4 *Green logistics initiatives relate to lean warehousing*

The statistics reveal that green logistics initiatives do influence lean warehousing that impact staging activities and lead times. Zuo and Li (2010:14) affirm that the primary goal of the warehouse layout is to optimise warehousing functions and achieve maximum efficiency and space utilisation. Zuo and Li (2010:16) discuss a range of techniques and technologies adopted by warehouse owners to green their buildings and reduce their carbon footprint. Zheng and Zang (2010:115) propose that proper warehouse layout can reduce transportation mileage while saving on costs. They also argue that if the layout of the warehouse is too dense, the number of transporters is increased; leading to increased energy consumption and carbon emissions (Zheng and Zang, 2010:17). Similarly, Garcia (2012) states that warehouses are becoming a strategic tool for competitive advantage. Warehouses today are distribution centres that support a JIT supply chain that is low cost, flexible, and efficient, especially in the rapidly growing world of e-commerce. E-commerce and system automation can eliminate the need to employ resources that can be used optimally in other areas of the business (Garcia, 2012).

Information technology plays an important role in the adoption and implementation of lean and green practices. It enables a company to achieve its goals. Using IT to optimise transportation routes ensures that goods are delivered in an energy efficient and cost effective manner (Zuo and Li, 2010). The automation of transportation planning processes allows transporters to mitigate the risks associated with unexpected events. Automation provides an optimal plan; it enables the organisation to identify waste processes through the implementation of dashboards and metrics, whilst simultaneously identifying complexity within the supply chain. Hence, through logistics and supply chain optimisation, organisations will be better positioned to reduce their carbon footprint, minimise wastage and ensure optimal resource utilisation, thereby achieving organisational goals. Thus, automation and technology is a driving force in successfully implementing green methodologies across the business – this ultimately affects both the warehouse and the inbound and outbound logistics that support the facility. Hence, technology that can assist in framing a lean warehouse can serve a dual purpose in the company that is not primarily geared to serve lean or green, but rather both.

5.3.5 Lean logistics initiatives relate to JIT benefits realised by logistics firms

The results show that lean logistics initiatives play an influential role in obtaining the benefits related to JIT. It is not surprising that JIT strategies featured as one of the drivers for companies implementing lean logistics initiatives. Recent research has shown that the successful implementation of the JIT philosophy can have significant benefits for companies, including improved quality that consistently and continually meet customers' requirements; minimising levels of inventory and improving relationships with suppliers (Aghazadeh, 2003:29-42). Similarly, Ozalp *et al.* (2010:1-7) found that the elimination of waste and improved service quality objectives of JIT fit well with business logistics. The application of the JIT philosophy to the logistics sector can result in the determination of the sources of waste, faster delivery to customers, improved processes by means of organising business requirements and manpower plans for logistics, and increasing harmony among suppliers and customers. These results further enhance the study's findings in understanding the effect lean logistics has on the Durban region.

5.3.6 The adoption of green logistics initiatives is related to network efficiency in the transport system

From the results, there is no association between green logistics initiatives and network efficiency in the transport system. Unfortunately, the literary works of Zuo and Li (2010:16) and TCS (2010), argue network optimisation is the most fundamental type of modelling to optimise interrelated transportation flows that can bring substantial cost savings and carbon reduction. According to TCS (2010:8), congestion can exacerbate carbon emissions directly and indirectly. Direct increase of carbon emissions can be caused when vehicles that move at unproductive speeds increase their carbon emissions per kilometre travelled. Indirect carbon emissions are increased during periods of congestion when vehicles are re-routed (Zuo and Li, 2010).

By restructuring the network, companies are likely to realise an 11% reduction in cost and carbon emissions (TCS, 2010:8). Methods to optimise the logistics route through greening include but are not limited to; reducing the distance travelled by a product in the supply chain; using superior vehicle technology and design to increase fuel efficiency and reduce total costs and developing a strategy that considers ecological factors apart from the costs of using carbon constraint-based solutions (Zharkis, 2009). Thus, by understanding further the mechanics of the transport sector in Durban and the complexities faced on a day to day basis, companies can better position themselves to reap the benefits associated with green initiatives provided green methodologies are implemented appropriately

5.3.7 Lean logistics initiatives relates to total cost optimisation in a logistics system

The evidence show that lean logistics initiatives is not associated to total cost optimisation. Interrelationships exist not only between the various elements of a logistics system, but between the costs of individual elements (DHL, 2006). A cost reduction in one logistics subsystem can trigger a cost increase in another subsystem. In some cases, it can boost the cost of the entire logistics system. Total cost orientation is a significant factor in logistics decisions because logistics systems are characterised by an array of cost conflicts and dependency between their elements (DHL, 2006). Thus, it is difficult to reduce cost only in one area, a holistic approach must be applied to the entire system in order to realise the cost saving benefits of implementing lean logistics.

5.4 Conclusion

This discussion is able to answer the research objectives set for this study. It is vitally important to obtain results that correlate with industry levels from different parts of the world in order to assess and benchmark the industry's performance; however it is even more important that there remain differences in this study's findings in relation to the literary framework. The difference help steer the industry toward improvement and subsequent reflection onto how and where improvements need to take place. Nevertheless, each company is different and has different philosophies, but moving toward a cleaner and cost efficient operations should be the basic goal of any company characterised by a large carbon footprint.

CHAPTER SIX

Conclusions and Recommendations

6.1 Conclusions on the major findings

The discussion of results notes several similarities between the findings in previous researches and this study. This can be viewed as an advantage to resolve some of the inefficiencies and constraints logistics systems face in efforts to develop a lean and green logistics model. Table 6.1 provides a summary on the discussion and the results obtained in answering the research objectives. A comprehensive picture on the findings from this study and major points that could possibly impact the logistics network is expressed. This is done in a concise manner to capture the main elements within the scope of this research.

Table 6.1 Conclusion on major findings of this study

Objectives	Major Findings
1. The effects of lean logistics within the Durban road freight network	<ul style="list-style-type: none"> I. The primary drivers in the adoption of lean initiatives relate to lean warehousing that impact staging activities and lead times and the attainment of optimum warehousing functions. An optimum warehouse is related to the layout of the facility that facilitates efficiency and savings. II. JIT strategies and lean profitability featured strongly in these findings confirming inventory management and resource optimisation as the most popular lean methods adopted by companies. III. Optimum transportation and logistics networks are driven by company policy and technological advances. Demand driven logistics also enhances logistics optimisation by leveraging management support systems and technology for automation that improves the logistics business. IV. Optimum layout reduces transport mileage, improves shipping accuracy and introduces cost savings. V. Lean inventory management alters the value of the firm by striking a balance between carrying too much and too little inventory. The integration of distribution requirements and materials planning reduces inventory, reducing total carrying costs along the supply chain.
2. The dynamics of lean logistics and cost containment strategies	<ul style="list-style-type: none"> VI. Total cost optimisation is the most highly rated factor driving lean logistics in terms of a logistics optimisation strategy. 20% to 40% reduction in inventory in the business reduces overhead costs which translate into improvement of bottom line performance measurements, and expanded profit margins – evident from the frequency distribution on inventory management that considers lean profitability an influential factor. Reducing inventory also limits business’s exposure to the risk of obsolescence and the carrying cost of holding too much inventory in the supply chain; the risk of ownership is further impacted when transportation companies move cargo as 3PL service providers. VII. Lean logistics in the Durban road freight industry is seen as a means of creating business value through the seamless flow of activities and functions

	<p>within the internal structure of the organisation; the most formidable lean dynamics incorporate lean warehousing activities that reduce waste and improve time utilisation, an increase in staging activities that positively impact shipping lead times, JIT strategies that minimise inventories and the realisation of bottom line performance as a result of the application of lean inventory management techniques.</p>
<p>3. The opportunities arising from the implementation of green logistics within the Durban road freight region</p>	<p>VIII. Green policy, green warehouse optimisation and green logistics are also among the opportunities arising from the implementation of green logistics. The opportunities derived from these three factors on green logistics present significant solutions to green and lean thinking. As discussed previously, the benefits obtained from lean warehousing are significantly proportionate to the benefits derived by implementing green warehousing solutions to optimise logistics performance. Thus the opportunities from the relationship between lean and green are substantial.</p>
<p>4. The relationship between lean practices and green diffusion in logistics systems</p>	<p>IX. Multiple regression model further confirms the factors that impact the relationship between lean and green logistics is also illustrated by the seven model predictors.</p> <p>X. Company policy which has a predictor effect on the adoption of green diffusion also impacts the implementation of lean logistics. This result has appeared in all three multivariate instruments. However, the analysis of the dichotomous results reveals that almost 60% of companies do not incorporate greening as part of company policy</p> <p>XI. The findings confirm that lean produces an operational and cultural environment that is highly conducive to waste minimisation and pollution prevention, and that lean provides an excellent platform for environmental management tools such as life-cycle assessment and design for environment</p> <p>XII. Logistics businesses could grow from strength to strength by internalising their lean practices through externalising the application of green. Sustainability is internationally acknowledged as a prerequisite for business and South Africa needs to play catch up. Given the current state of the country's economic climate, cost effective methods need to be in place, along with contingency plans that facilitate growth in a country well-endowed with natural resources to leverage trade.</p>

Source: *Designed by researcher*

6.1.1 Conclusions based on the literature review

In most cases, the results concur with the literary findings by the various international authors referenced in this study. This can be seen as an opportunity to benchmark the Durban road freight industry against international standards in order to understand areas that can be improved as well as apply and adapt improvement methods to this industry. South Africa has not advanced in the area of lean and green when compared to global competitors, however, being able to witness the similarities across global players clears the perception that the industry still operates under primitive thinking. Indeed, research such as this can provide

significant benefits that companies can use to further explore a range of initiatives tailored to their company's needs.

6.1.2 Conclusions on the empirical study

From a managerial perspective, this study has overwhelming implications on managers. Since this study is based on convenience and judgement sampling, a generalisation cannot be made across the population, however, with this study managers can use the information collated and analysed to understand the nature of lean and the green, by supplementing it with knowledge on his/her company. Through the creative thought process, there can be several benefits pricked up from this study which can help logistics companies improve on their operations and business performance, such as those companies geared towards cost savings; optimal resource utilisation; appropriate management of inventory and increased customer service levels.

6.2 Recommendations

After reviewing the findings of this study, the following recommendations are proposed within the confines of this research. Based on the results and previous research studies, the aim of these recommendations is to provide a platform for companies to build and establish a strong foundation in anticipation for an effective and successful lean and green logistics network. South Africa is far behind on such implementations, when compared to global counterparts. However, knowledge is key and through this study, the logistics industry could utilise such research as a basic framework for further, deeper, understanding into the dynamics of lean and green logistics within the Durban region.

Table 6.2 provides a list of recommendations:

Table 6.2: Recommendations

Recommendations	
1.	Provide employee skills training and awareness on greening and lean methodologies
2.	Empower staff through education on green supply and lean chains and support corporate social investment strategies, as these have ripple effects on an individual's productivity level.
3.	Management ought to devise cost-reduction strategies that will increase the asset utilisation ratio.
4.	Engage in supply chain re-alignment and streamlining of processes to help businesses reduce wastage at various stages in the supply chain.
5.	Aligning corporate goals with green and lean supply chain goals.
6.	Government must involve itself in the adoption of green technology and provide accessibility to technological advancements for the industry.
7.	Standardise basic ERP systems that focus on waste reduction and green systems across the industry; standardisation enables better control and measurement and companies can be equipped with the minimum requirements enabling them to assess their carbon footprint through technology.

6.2.1 Recommendations on the study conducted

Since logistics optimisation has a primary focus on cost containment and resource maximisation, corporate strategy ought to focus on total cost minimisation. The system comprises a set of integrated networks all which hold functional interactions among the various echelons. Since cost becomes difficult to quantify in a complex network, the obvious costs such as inventory carrying costs become implicit to the company and the explicit costs such as transport and material exacerbate. However to improve logistics systems and steer toward optimisation, companies should consider collaborative approaches that provide opportunities to shift focus from volume to total volume. This promotes flexibility within the total system and moreover collaboration between channel partners improve end to end visibility within the logistic system, further enhancing optimality. Better communication between functional units within the system facilitates less errors and the subsequent elimination of defects – this means the logistics system is able to gradually move toward perfection in a seemingly volatile global sphere.

The onset of any business must have clear defined goals and objectives that enable organisations to steer in the direction of the business's mission. Each functional division ought to have in place their own departmental strategy to achieve the overall organisation

goals. In this instance, the company policy must be driven from top down that incorporate the application of lean and green methods. This study has revealed the advantages associated with lean and green implementation which includes among others; cost savings, efficient use of resource, environmental preservation and total supply chain optimisation. Given the benefits and thematic landscape the researcher has chosen, it is imperative that industry leaders shift focus from bottom line maximisation and gear toward a holistic process orientated approach that enable the elements constrained within the logistics system to obtain the characteristics of flexibility, agility and responsiveness. Under these conditions, a logistics system is able to function and achieve the desired level of optimality where lean applications and green initiatives can initiate continuous improvement in the system to remove non-value adding activities. Businesses must be willing to calculate the risks and benefits inherent from under-taking a “do nothing” strategy to a strategy that builds a sustainable business for the future.

This also translates to measuring the effectiveness of current resources. Technology that has been an influential component to the adoption of green initiatives must be considered in the logistics system to achieve the standards of warehouse, logistics, distribution and network optimisation. Innovation is the new competitive weapon that differentiates good companies from the best; however innovation is also a costly affair that shies businesses away from furthering their true potential. In such instances, alternate measures must be in place to fully realise the benefits of new technology or green smart software that companies adopt. This means as great as it is to place new I.T systems in organisation, change management is a must for employees to fully grasp the landscape the organisation is shifting towards. This factor touches on employee empowerment and awareness as being the responsibility of the organisation. – An element that has revealed itself in the data analysis.

6.3 Contribution of the study to knowledge

This study is able to contribute to knowledge on the dynamics of lean and green logistics in the Durban road freight region. Previously there was no research supporting either concept exclusive to this industry, although the Durban region accounts for the highest volume of freight movement in South Africa. Now, with this new knowledge and awareness on a sensitive and costly topic such as environmental consciousness, the evidence show that lean operations can in fact tap into the dimension of green and further enhance the opportunities available for growth and sustainability. Green does not necessarily mean high costs if the mind-set and approach of industry leaders are changed. It is suggested that first lean thinking must be introduced in the company that is incorporated in the policy and culture of the

organisation. Once lean thinking is implemented, further efforts migrating towards green can be explored.

6.4 Limitation of the study

The study reveals possible research and methodological limitations. This includes lack of participation by every company operating in the Durban region that determines the size of the sample. The magnitude of logistics companies operating in this region does not permit the researcher to capture the responses of all representative parties. Some companies did not wish to participate in the study due to time availability of personnel participation and fear of revealing company sensitive information. Methodological limitations include the use of convenience and purposive sampling that will not permit generalisation over the entire population, however, this fits in with the intension of the research design that seeks to explore and understand the nature of lean and green logistics.

6.5 Direction for future research

It is suggested that in order to gain a holistic understanding of lean and green, these concepts must be viewed from the eyes of external stakeholders, namely customers and suppliers. Research must examine the extent to which customers and suppliers place pressure on companies to go green and how is this pressure impacting companies. Literary works show that customer/supplier involvement is one of the main external drivers for companies adopting lean and green initiatives. It would be interesting to understand how members in the upstream and downstream supply chain influence logistical operations.

Another area that can be considered is to examine how technology has been advancing businesses and providing competitive advantage to companies who can afford, have access to and correctly implement green and lean methodologies using I.T. Although I.T has featured as a significant driver in this study, it is also currently proving a new platform for companies to grow their businesses with long term cost reduction and sustainable offerings. Technology is creating opportunities for organisations across industries – thus it would be beneficial to understand how technology is being used to drive companies toward the precipice of business optimality.

6.6 Summary

This study is able to answer the objectives set at the beginning of the research. Now that information has been made available for understanding green and lean logistics, further research can be conducted to complement this study that will provide an overall perspective of lean and green in the logistics industry. The findings of this study have been highlighted along with recommendations to further obtain the benefits of lean and green.

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APPENDIX A

Questionnaire

Section A: Bibliographic Data and Organisational Profile

This section relates to the **biographical details** of the respondent and the company. All answers you provide are based on your experience, perceptions and knowledge. **Please tick (✓) or encircle the appropriate box.**

1. What is your managerial position in the company?

Top Management		Middle Management		Lower Management		Non-Manual	
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2. Gender

Male		Female	
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3. Number of years worked in the organisation?

Less than 1		1-3		4-6		7-10		Over 10	
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4. Which of the following options describes your department?

Warehousing		Transport		Other	
If other, please state:					

5. What is the size of the organisation?

Small (2-50 employees)		Medium (50 – 120 employees)		Large (greater than 150 employees)	
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6. Which of the following lean initiatives have been adopted by the company?

Inventory reduction	
Resource optimisation	
On-time deliveries	
Waste reduction	
Other	
If other, please state:	

7. What is your interpretation of green supply chain management?

It is the application of eco-friendly techniques used at specific stages in the supply chain	
It is a tool adopted by managers to improve their performance at managerial level and hence does not apply to my job function within the company	
It is the use of environmentally friendly materials and practices that are inherent at all tiers in the supply chain to ensure delivery of the final product to the consumer	

Section B: Dichotomous Questions

This section relates to the **objectives** of the study being investigated. All answers you provide are based on your experience, perceptions and knowledge. **Please tick (✓) or encircle the appropriate box.**

<i>Items</i>	<i>Yes</i>	<i>No</i>
8. There is a comprehensive understanding of green logistics amongst the employees	Yes	No
9. The organisation strives to implement green initiatives	Yes	No
10. Company policy encourage the implementation of green practices	Yes	No
11. The company has adopted green methods to optimise their warehousing activities	Yes	No
12. The company actively aims at reducing carbon emissions from operational activities	Yes	No
13. The logistical greening initiatives can enhance the organisation’s performance targets and bottom line	Yes	No
14. The optimum delivery frequency is linked to environmentally friendly activities	Yes	No
15. Technological advances play a vital role in adopting green logistics initiatives	Yes	No

Section C: Ranking Questions

This section relates to the **dynamics** of lean logistics. The adoption of lean logistics is primarily driven by the factors listed below:

Select three under each sub-heading and rank them from 1 to 3 in order of importance to your company. 1 indicates “least important”; 2 indicates “moderately important”; 3 indicates “most important”

<i>Items</i>	<i>Ranking (1;2;3)</i>
Warehouse Layout Optimisation	
16. Lean warehousing reduces waste and improve time utilisation	
17. Value stream mapping enhances material, information and demand flows in the warehouse	
18. Lean warehousing increase staging activities that impact positively on shipping lead times	
19. Lean provides for optimum warehousing functions by achieving maximum efficiency and space utilisation	
Inventory Management	
20. Just-in-time (JIT) strategies minimise inventories	
21. The benefits of JIT philosophy includes improved customer service levels, quality, inventory cost savings and optimised inventory management	
22. The company realises significant improvements on bottom line performance from the application of lean inventory management techniques	
23. Applying lean inventory methodologies improves business performance from a service level perspective	
Network Optimisation	
24. An optimal distribution network significantly adds value to the business	
25. Network optimisation is constrained by cost containment strategies	
26. Company policy advocates the achievement of an optimal distribution network	
27. Advances in I.T affects route planning and load optimisation that directly impacts network efficiency	
Logistics Optimisation	
28. Order consolidation increases capacity utilisation and reduces shipment frequency	
29. Total cost optimisation is achieved through centralisation of logistics activities	
30. Demand-driven logistics increase order and shipment fulfilment, and reduce inventory obsolescence and customer returns	
31. A logistics systems thinking approach will enhance warehousing, inventory and network optimisation strategies	

Section D

This section relates to the **combination** of lean and green elements. It taps into the objectives of the study being investigated. All answers you provide are based on your experience, perceptions and knowledge. **Please tick (✓) or encircle the appropriate box.**

Select the number you find most appropriate relative to the question

5= strongly agree; 4= agree; 3= neutral; 2= disagree; 1= strongly disagree

32. The implementation of lean logistics practices is impacted by technology, skills and knowledge	5	4	3	2	1
33. Value stream mapping is an enabler for time compression in logistics activities	5	4	3	2	1
34. JIT deliveries and optimal warehousing strategies initiate cost savings	5	4	3	2	1
35. Optimum delivery time and flexibility minimise the waste in transportation activities	5	4	3	2	1
36. Access to technological advances, high investment costs in green assets and lack of green skills is a primary challenge in the adoption of green initiatives	5	4	3	2	1
37. Green logistics initiatives enhance hub points and distribution centres with proper infrastructural developments	5	4	3	2	1
38. Supply Chain logistics is not a major contributor to the company's carbon footprint	5	4	3	2	1
39. Going green does not necessarily mean going lean	5	4	3	2	1
40. Green logistics hinders company performance by increasing capital expenditure	5	4	3	2	1
41. Lean logistics practices reduce transportation miles but not carbon footprint due to highly integrated logistics networks that facilitate long-distance trade	5	4	3	2	1
42. Green logistics initiatives have the tendency to improve routing schedules which minimise wastage in the road freight network	5	4	3	2	1
43. The interplay between lean and green enables the company to tap into both dimensions	5	4	3	2	1
44. The company has tried to reduce costs in production and transport operations by implementing green and lean logistics	5	4	3	2	1

Thank you for your participation!!!

APPENDIX B

Frequency Distribution

Section A: Bibliographic Data

Managerial Position

		Frequency
Valid	Top management	10
	Middle management	38
	Lower management	57
	Non-managerial	105
	Total	210

Green Supply Chain Management

		Frequency
Valid	Eco-friendly techniques	86
	Performance improvement tool	24
	Eco-friendly materials and practices throughout the SC	100
	Total	210

GenderLean Initiatives Adoption

		Frequency
Valid	Male	118
	Female	92
	Total	210

		Frequency
Valid	Inventory reduction	119
	Resource optimisation	39
	On-time deliveries	32
	Waste reduction	12
	Other	8
	Total	210

Work Experience

		Frequency
Valid	Less than 1 yr	14
	1-3 yrs	35
	4-6 yrs	64
	7-10 yrs	54
	Over 10 yrs	43
	Total	210

Company Size

		Frequency
Valid	Small (2-50 emp)	17
	Medium (50-120 emp)	145
	Large (< 150 emp)	48
	Total	210

Section B – Dichotomous Questions

Green logistics

		Frequency
Valid	Yes	92
	No	118
	Total	210

Green initiatives

		Frequency
Valid	Yes	120
	No	90
	Total	210

Green policy

		Frequency
Valid	Yes	125
	No	85
	Total	210

Green warehouse optimisation

		Frequency
Valid	Yes	107
	No	103
	Total	210

Carbon reduction

		Frequency
Valid	Yes	105
	No	105
	Total	210

Bottom line performance targets

		Frequency
Valid	Yes	112
	No	98
	Total	210

Optimum delivery frequency

		Frequency
Valid	Yes	120
	No	90
	Total	210

Technological advancement

		Frequency
Valid	Yes	131
	No	79
	Total	210

Section C – Ranking Questions

Lean warehousing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	32	15.2	15.2	15.2
	Moderately important	90	42.9	42.9	58.1
	Most important	88	41.9	41.9	100.0
	Total	210	100.0	100.0	

Value stream mapping

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	36	17.1	17.1	17.1
	Moderately important	102	43.6	48.6	65.7
	Most important	72	39.3	34.3	100.0
	Total	210	100.0	100.0	

Staging activities and lead times

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	27	12.9	12.9	12.9
	Moderately important	99	47.1	47.1	60.0
	Most important	84	40.0	40.0	100.0
	Total	210	100.0	100.0	

Optimum warehousing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	29	13.8	13.8	13.8
	Moderately important	92	43.8	43.8	57.6
	Most important	89	42.4	42.4	100.0
	Total	210	100.0	100.0	

JIT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	21	10.0	10.0	10.0
	Moderately important	96	45.7	45.7	55.7
	Most important	93	44.3	44.3	100.0
	Total	210	100.0	100.0	

JIT benefits

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	29	13.8	13.8	13.8
	Moderately important	89	42.4	42.4	56.2
	Most important	92	43.8	43.8	100.0
	Total	210	100.0	100.0	

Lean profitability

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	28	13.3	13.3	13.3
	Moderately important	90	42.9	42.9	56.2
	Most important	92	43.8	43.8	100.0
	Total	210	100.0	100.0	

Increased service levels

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	27	12.9	12.9	12.9
	Moderately important	91	43.3	43.3	56.2
	Most important	92	43.8	43.8	100.0
	Total	210	100.0	100.0	

Optimal distribution network

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	27	12.9	12.9	12.9
	Moderately important	88	41.9	41.9	54.8
	Most important	95	45.2	45.2	100.0
	Total	210	100.0	100.0	

Cost containment strategies

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	103	49.0	49.0	49.0
	Moderately important	105	50.0	50.0	99.0
	Most important	2	1.0	1.0	100.0
	Total	210	100.0	100.0	

Company policy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	103	49.0	49.0	49.0
	Moderately important	105	50.0	50.0	99.0
	Most important	2	1.0	1.0	100.0
	Total	210	100.0	100.0	

Network efficiency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	103	49.0	49.0	49.0
	Moderately important	105	50.0	50.0	99.0
	Most important	2	1.0	1.0	100.0
	Total	210	100.0	100.0	

Order consolidation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	103	49.0	49.0	49.0
	Moderately important	105	50.0	50.0	99.0
	Most important	2	1.0	1.0	100.0
	Total	210	100.0	100.0	

Total cost optimisation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	103	49.0	49.0	49.0
	Moderately important	105	50.0	50.0	99.0
	Most important	2	1.0	1.0	100.0
	Total	210	100.0	100.0	

Demand-driven logistics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	103	49.0	49.0	49.0
	Moderately important	105	50.0	50.0	99.0
	Most important	2	1.0	1.0	100.0
	Total	210	100.0	100.0	

Logistics systems thinking

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least important	103	49.0	49.0	49.0
	Moderately important	105	50.0	50.0	99.0
	Most important	2	1.0	1.0	100.0
	Total	210	100.0	100.0	

APPENDIX C

Multiple Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.488 ^a	.238	.234	.617	
2	.555 ^b	.308	.301	.590	
3	.586 ^c	.343	.333	.576	
4	.600 ^d	.360	.347	.570	
5	.623 ^e	.388	.373	.558	
6	.635 ^f	.403	.386	.553	
7	.645 ^g	.416	.396	.548	2.306

a. Predictors: (Constant), JIT deliveries and strategic warehousing

b. Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions

c. Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions, Optimal delivery time and flexibility

d. Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions, Optimal delivery time and flexibility, Lean logistics practices

e. Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions, Optimal delivery time and flexibility, Lean logistics practices, Green logistics expenditure

f. Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions, Optimal delivery time and flexibility, Lean logistics practices, Green logistics expenditure, Green logistics Initiatives

g. Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions, Optimal delivery time and flexibility, Lean logistics practices, Green logistics expenditure, Green logistics Initiatives, Green and Lean

ANOVA

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.715	1	24.715	64.854	.000 ^b
	Residual	79.266	208	.381		
	Total	103.981	209			
2	Regression	31.977	2	15.988	45.964	.000 ^c
	Residual	72.004	207	.348		
	Total	103.981	209			
3	Regression	35.656	3	11.885	35.834	.000 ^d
	Residual	68.325	206	.332		
	Total	103.981	209			
4	Regression	37.404	4	9.351	28.794	.000 ^e
	Residual	66.577	205	.325		
	Total	103.981	209			
5	Regression	40.386	5	8.077	25.910	.000 ^f
	Residual	63.595	204	.312		
	Total	103.981	209			
6	Regression	41.922	6	6.987	22.855	.000 ^g
	Residual	62.059	203	.306		
	Total	103.981	209			
7	Regression	43.293	7	6.185	20.585	.000 ^h
	Residual	60.688	202	.300		
	Total	103.981	209			
b. Predictors: (Constant), JIT deliveries and strategic warehousing						
c. Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions						
d. Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions, Optimal delivery time and flexibility						
e. Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions, Optimal delivery time and flexibility, Lean logistics practices						
f. Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions, Optimal delivery time and flexibility, Lean logistics practices, Green logistics expenditure						
g. Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions, Optimal delivery time and flexibility, Lean logistics practices, Green logistics expenditure, Green logistics Initiatives						
h. Predictors: (Constant), JIT deliveries and strategic warehousing, Lean Green dimensions, Optimal delivery time and flexibility, Lean logistics practices, Green logistics expenditure, Green logistics Initiatives, Green and Lean						

Co-efficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (Constant)	2.054	.206		9.981	.000		
JIT deliveries and strategic warehousing	.421	.052	.488	8.053	.000	1.000	1.000
2 (Constant)	1.394	.244		5.710	.000		
JIT deliveries and strategic warehousing	.329	.054	.380	6.089	.000	.858	1.165
Lean Green dimensions	.273	.060	.285	4.569	.000	.858	1.165
3 (Constant)	1.155	.249		4.640	.000		
JIT deliveries and strategic warehousing	.219	.062	.253	3.524	.001	.617	1.620
Lean Green dimensions	.246	.059	.257	4.168	.000	.842	1.188
Optimal delivery time and flexibility	.197	.059	.235	3.330	.001	.643	1.555
4 (Constant)	.849	.279		3.040	.003		
JIT deliveries and strategic warehousing	.215	.062	.249	3.494	.001	.617	1.621
Lean Green dimensions	.234	.059	.245	4.002	.000	.836	1.197
Optimal delivery time and flexibility	.211	.059	.252	3.592	.000	.636	1.573
Lean logistics practices	.096	.041	.131	2.321	.021	.984	1.016
5 (Constant)	1.179	.294		4.014	.000		
JIT deliveries and strategic warehousing	.200	.060	.232	3.312	.001	.613	1.631
Lean Green dimensions	.221	.057	.231	3.851	.000	.831	1.203
Optimal delivery time and flexibility	.203	.058	.242	3.521	.001	.635	1.576
Lean logistics practices	.160	.046	.219	3.523	.001	.777	1.287
Green logistics expenditure	-.131	.042	-.194	-3.093	.002	.766	1.306
6 (Constant)	1.019	.300		3.402	.001		
JIT deliveries and strategic warehousing	.161	.062	.186	2.579	.011	.565	1.771
Lean Green dimensions	.209	.057	.218	3.645	.000	.823	1.215
Optimal delivery time and flexibility	.183	.058	.219	3.179	.002	.620	1.612
Lean logistics practices	.166	.045	.226	3.672	.000	.775	1.290
Green logistics expenditure	-.130	.042	-.192	-3.093	.002	.766	1.306
Green logistics Initiatives	.117	.052	.140	2.242	.026	.754	1.326
7 (Constant)	1.117	.301		3.718	.000		
JIT deliveries and strategic warehousing	.173	.062	.200	2.790	.006	.560	1.787
Lean Green dimensions	.213	.057	.223	3.754	.000	.822	1.217
Optimal delivery time and flexibility	.192	.057	.229	3.348	.001	.617	1.620
Lean logistics practices	.183	.045	.250	4.024	.000	.751	1.332
Green logistics expenditure	-.108	.043	-.160	-2.531	.012	.723	1.383
Green logistics Initiatives	.113	.052	.136	2.192	.029	.753	1.327
Green and Lean	-.095	.045	-.125	-2.136	.034	.841	1.189

APPENDIX D

Ethical Clearance



28 August 2013

Ms Kubeshree Pillay 207500481
School of Management, IT and Governance
Westville Campus

Protocol reference number: HSS/0811/013M
Project title: The Dynamics of Lean and Green Logistics Systems within the Durban Road Freight Network

Dear Ms Pillay

Expedited Approval

I wish to inform you that your application has been granted Full Approval.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. Please note: Research data should be securely stored in the discipline/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....
Dr Shenuka Singh (Acting Chair)

/px

cc Supervisor: Mr PT Mbhele
cc Academic Leader Research: Professor B McArthur
cc School Administrator: Ms Hasvinei Muteswa

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INSPIRING GREATNESS



APPENDIX E

English Specialist Report

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27 November 2013

This is to confirm that I have edited the dissertation, "The Dynamics of Lean and Green Logistics Systems within the Durban Road Freight Network" by Kubeshree Pillay, student number 207500481.

Yours sincerely,



(Ms) Deanne Collins (MA)

Professional Editor