GREEN LOGISTICS PRACTICES IN BOTSWANA: CHALLENGES AND PROSPECTS FOR THE LARGE CONSTRUCTION COMPANIES.

BY

PRISCILLA FUNGAI MPONDORI

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DECLARATION

UNISA university of south africa

DECLARATION

Name: MPONDORI PRISCILLA FUNGAI

Student number: 42818222

Degree: MASTER OF COMMERCE IN LOGISTICS

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I declare that the above dissertation is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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I further declare that I have not previously submitted this work, or part of it, for examination at UNISA for another qualification or at any other higher education institution.

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8 APRIL 2020
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ABSTRACT

The construction industry is generally characterised by limited implementation of green logistics. With that in mind, this study aimed to examine the nature and extent of green logistics practices in large construction companies in Botswana. Although empirical studies have analysed green supply chain in the construction industry, most of them have not addressed the challenges and prospects of adopting green logistics by construction companies in a developing country like Botswana. Project Managers were interviewed after which a thematic analysis was used to interpret the qualitative results. Thereafter, a comparative analysis was done between the results obtained from the interviews and from extant literature. The findings showed that the adoption of the green logistics strategies was aligned more to economic reasons than environmental ones. The findings further showed that until and unless the construction, technical and administration issues are addressed, the adoption of green logistics will continue to be a challenge for the construction industry in Botswana.

KEY TERMS:

Green Logistics; Large Construction Companies; Green Logistics Practices; Construction Logistics; Sustainability; Tripple-Bottom-Line; Construction Consolidation Centres; Dry Ports; Paradoxes; Construction Industry; Green Logistics Challenges; Green Logistics Prospects.

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LIST OF ABBREVIATIONS AND ACRONYMS

3Rs: Reduce, Re-Use, Recycle

AIS: Aquatic Invasive Species

BIUST: Botswana International University of Science and Technology

BOU: Botswana Open University

BMVI: Bundesministerium für Verkehr und digitale Infrastruktur

BWP: Botswana Pula

CBD: Central Business District

CC1: Construction Company 1

CC2: Construction Company 2

CC3: Construction Company 3

CC4: Construction Company 4

CC5: Construction Company 5

CC6: Construction Company 6

CC7: Construction Company 7

CC8: Construction Company 8

CC9: Construction Company 9

CC10: Construction Company 10

CC11: Construction Company 11

CC12: Construction Company 12

CC13: Construction Company 13

CC14: Construction Company 14

CC15: Construction Company 15

CCC: Construction Consolidation Centre

CCTV: Closed Circuit Televisions

CIPA: Companies and Intellectual Property Authority

CO_2: Carbon dioxide

CSCMP: Council of Supply Chain Management Professionals

DBEDT: Department of Business, Economic Development and Tourism

DBES: Department of Building and Engineering Services

DEFRA: Department for Environment, Food and Rural Affairs

GHG: Greenhouse Gases

EDI: Electronic Data Interchange

ERP: Enterprise Resource Planning

FIFA:	Federation of Internation Football Association
FOIS:	Freight Operation Information System
GDP:	Gross Domestic Product
HF:	High Frequency
ICT:	Information Communication Technology
ITOPF:	International Tanker Owners Pollution Federation Limited
JIT:	Just In Time
LCCC:	London Construction Consolidation Centre
LEDs:	Light Emitting Diodes
LOTO:	Lockout/Tagout
LPG:	Liquefied petroleum gas
MDGs:	Millenium Development Goals
MIST:	Ministry Of Infrastructure, Science And Technology
NGOs:	Non-Governmental Organisations
NDP:	National Development Plan
NIP II:	National Innovation Programme
NO_2:	Nitrogen
PPADB:	Public Procurement and Asset Disposal Board
RF:	RadioFrequency
RFID:	Radio Frequency Identification
SADC:	Southern African Development Community
SAP HRM:	Systems Application and Products in Data Processing – Human Resources Management
SAP MM:	Systems Application and Products in Data Processing – Materials Management
SAP PP:	Systems Application and Products in Data Processing – Production Planning
SAP QM:	Systems Application and Products in Data Processing – Quality Management
SCM:	Supply Chain Management
SDGs:	Sustainable Development Goals
SHEQ:	Safety, Health and Environmental Quality
SMEs:	Small and medium-sized enterprises
SO_2:	Sulphur

TKC:	Trans-Kalahari Corridor
UB:	University of Botswana
UKGBC:	United Kingdom Green Building Council
UNDP:	United Nations Development Programme
UNISA:	University of South Africa
VOCs:	Volatile Organic Compounds
WCED:	World Commission on Environment and Development

CHAPTER 1

1 INTRODUCTION TO THE STUDY

1.1 INTRODUCTION

This study investigated green logistics practices of large construction companies in Botswana and the challenges they experienced. In view of that, this chapter highlights the research problem, aim and objectives, research questions and the significance of this study.

1.2 BACKGROUND TO THE STUDY

Third world nations are under pressure to fully engage themselves in matters concerning the green environment. This pressure comes from world leaders in commerce who have accepted the idea and are realising profound benefits for adopting green logistics practices (McKinnon, 2010). According to Albekov, Parkhomenko and Polubotko (2017), the greening of logistics services is developing at a quickening pace globally, confirming the scientific view that a successful business is not only a nominally cost-effective mechanism, but also an eco-efficient technology.

Literature indicates that Europe is one of the earliest regions to introduce the concept of logistics (Xia and Wang, 2013); and to apply the modern technology for logistics management and improvement (Xia and Wang, 2013). Similarly, United States of America is also one of the earliest countries to develop the logistics industry in the world (Xia and Wang, 2013); and to focus on green supply chain management; although it paid more attention to reverse logistics, green packaging and advanced green technology (Xiu and Chen, 2012; McKinnon, 2010). On sustainability considerations, Xiu and Chen (2012) highlighted that Germany has established a transport network of low carbon emissions and has a collaborative transport mode of the green intermodal. It also has a perfect green logistics training model and advanced green logistics technologies (Xiu and Chen, 2012). Because the logistics industry was treated as the lifeline of the national economy in Japan, its importance could not be ignored (Xia and Wang, 2013).

Contrary to the above developments, the sustainability of construction projects in

developing economies like Botswana has become a major issue faced by decision-makers, developers, city and urban planners as well as designers (Ayman and Shaaban, 2012). It has been noted that most construction companies operating in Botswana follow the South African green policies because that is where their headquarters are located (Anyango, 2019). Most construction companies in South Africa are fighting for survival because of penalties charged after the construction of the international stadiums in South Africa. According to Robust (2012), the South African construction industry has experienced the worst decline in decades, primarily due to penalties related to the World Cup infrastructure investment. Robust (2012) further highlights that the financial down fall of the South African construction industry emanates from a combination of slow economic recovery challenges such as delays in promised public sector and fixed investment spending (Robust, 2012). With a view to the above challenges, it could be concluded that the deployment of resources for green logistics initiatives among the South African construction companies has become of secondary importance and is therefore compromised.

Environmental issues associated with implementation of construction projects include disposal of construction vehicles; construction of temporary transport networks, operations of transport vehicles; and packaging of construction materials and its impact on warehouse and transport size. They also include lack of quality construction raw materials; waste from expired products; waste due to packaging of construction material; and layout, design and capacity of construction warehouses (Kumar, 2015). Botswana, besides being mostly occupied by the desert , as shown in Figure 1.1, is under pressure to move from great reliance on diamonds to economic diversification (Mishra, et al, 2012). To support the move towards economic diversification, Botswana is compelled to undertake construction of roads, dams, bridges, malls, and to upgrade terminals and other construction infrastructure that facilitates service delivery and optimisation of land use and other resources. The unavoidability of construction activity exposes the environment to destruction and disturbance.

As a landlocked country, Botswana's physical infrastructure is an integral part of its regional and international competitiveness. Productivity in almost every sector of the economy is affected by the quality and performance of the country's transportation, water, sanitation, power or electricity supply and other types of infrastructural developments. The

infrastructural development processes cannot be done without logistical work in the form of transportation, warehousing, packaging, procurement and waste management; hence, the need for green logistics practices if sustainability is to be realised.

Figure 1. 1: THE EXTENT OF AREA COVERED BY KALAHARI DESERT IN BOTSWANA

Source: http://justsaygood9.blogspot.com/2010/01/kalahari-desert.html

Botswana is one of the countries suffering from the "Dutch Disease" where money from mineral revenue is usually channelled into vigorous and conspicuous infrastructure building (Ssegawa, 1999). It has been found that construction activities in Botswana span from road construction and upgrading of residential housing to construction of large shopping malls and its iconic central business district. Such developments imply more engagement in transportation, warehousing, packaging, waste management, data collection and management, procurement and materials management (Dadhich, et al, 2015). These activities usually affect the environment. On a similar note, it is important to relate that typically, taking part in such infrastructural development are large construction companies and small companies working mainly as sub-contractors on construction projects graded as indicated in Table 1.1 below. Large construction companies fall under Grade D and E.

Table 1. 1: CONSTRUCTION CONTRACTOR DEMOGRAPHY BY TENDER THRESHOLD

Categories	Grade D	Grade E
Tender Threshold	**P14 000 000**	**UNLIMITED**
Roads	8	22
Bridges	8	11
Infrastructure Macro	10	27
Building Construction	80	84
Airfields	5	5
Aerodromes	5	5
Water Supplies – Major	8	19
High rise buildings	12	31
Pre-fabricated buildings	17	29
Dams	11	4
Irrigation	7	5

Source: http://ipms.ppadb.co.bw/registerdcodes

Evidence in Fig 1.2 shows that Botswana experienced a phenomenal growth in Gross Domestic Product (GDP) with a corresponding increase in activities including construction projects.

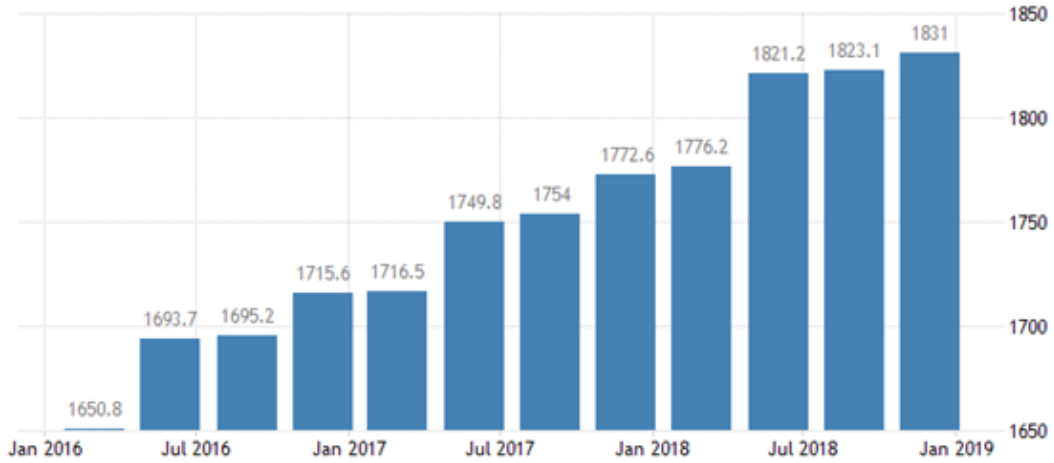

Figure 1. 2: GROSS DOMESTIC PRODUCT (GDP) OF BOTSWANA

Source: Tradingeconomics.com, 2019

It is also evident that the growth of the construction sector in Botswana has been driven largely by government projects initiated by ministries, albeit their implementation has been the responsibility of the Department of Building and Engineering Services (DBES) (MIST, 2011). To date the Department has, all in all, implemented over three hundred construction projects at various stages of development.

The contribution of construction to GDP in Botswana has averaged 1185.98 BWP Million from 2003 until 2018, reaching an all-time high of 1831 BWP Million in the fourth quarter of 2018 and a record low of 553.40 BWP Million in the third quarter of 2003 (Trading Economics, 2019). Furthermore, the trading statistics further highlight that the contribution of construction in Botswana to the national GDP has increased to 1831 BWP Million in the fourth quarter of 2018 from 1823.10 BWP Million in the third quarter of 2018 (Trading Economics, 2019). Moreover, government's development expenditure was projected at P5.8 billion for the financial year 2008/9 by the then Minister of Finance and Development Planning revealed that (Mokgobone, 2006).

According to Mokgobone (2006), in 2009/2010 the government development expenditure was allocated P4.86 billion, while in 2010/11 the allocation was P6.31 billion, showing an increaseof P1.45 billion. Furthermore, a total of P12.93 billion was proposed for the development budget for the financial year 2018/2019 (Matambo, 2018). Such budgetary trends indicate increase in the monies budgeted for development, which includes construction.

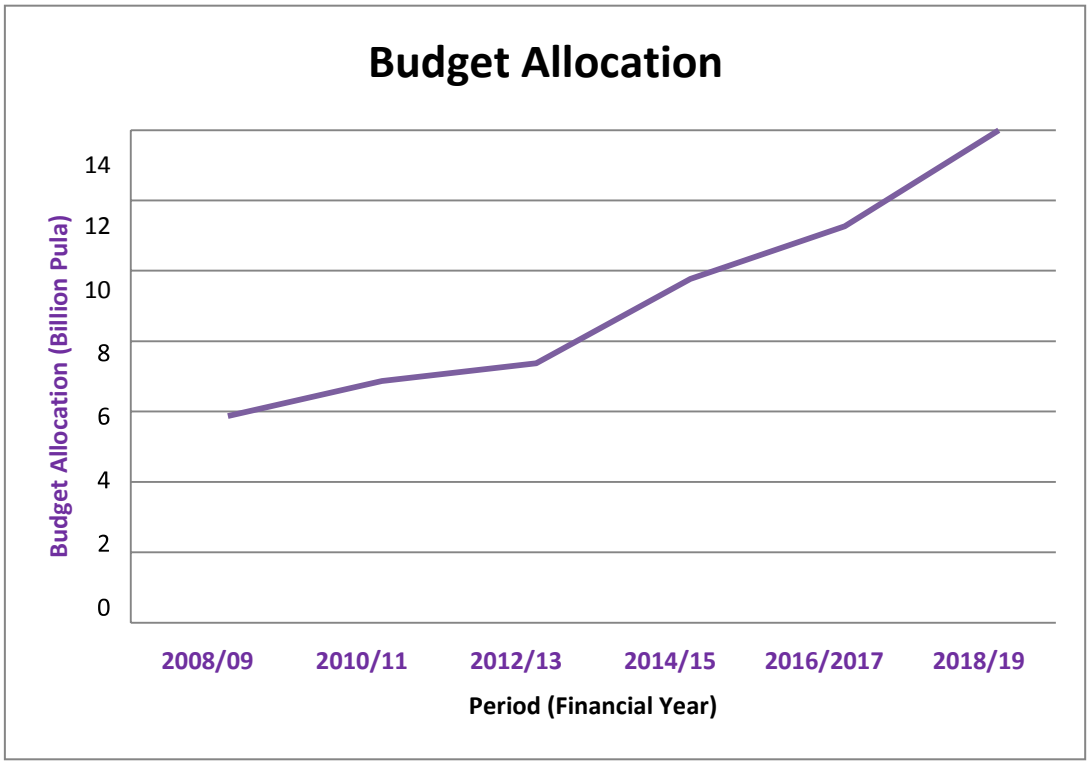

Figure 1. 3: INFRASTRUCTURAL DEVELOPMENT BUDGET ALLOCATION FOR PERIOD 2009 TO 2019

The monetary allocation shown in Figure 1.3 indicates a growth trend in infrastructural

development in the past ten years (Central Statistics Office, 2019). The trends show that the share for building has increased over time. The statistics indicate that such trends have been able to stand the inflation rate in Botswana which averaged 7.63% from 1997 until 2016, reaching an all-time high of 15.06% in November of 2008 and a record low of 2.70% in January of 2016 with a projected trend of 3.80% for 2020 (Central Statistics Office, 2019). Reasons for a sudden rise of investment into infrastructural development emanates from government objectives. "The NDP 10 prioritised the water and electricity infrastructure sectors to serve the growing private sector demand. The Ministry of Minerals, Energy and Water Resources received the largest development budget to cater for electricity production through the expansion of power stations and the construction of dams. Key projects include the construction of strategic water-resource infrastructure at Dikgatlhong, Lotsane and Thune dams, at a cost of BWP7 1.13 billion ($114.4 million), BWP 128 million ($13 million) and BWP 543 million ($55 million), respectively. Other projects include the Morupule B Generation and Transmission and the Botswana/Zambia–Kazungula Bridge projects." (Sekakela, 2018). This therefore implies that, more funds were allocated as the government embarked on a massive infrastructure development program aimed at improving general service facilities.

Notwithstanding the positive impacts of growth presented by increased monetary allocation, it is imperative to note that such growth is usually associated with negative impacts to the environment (European Commission, 2004). This is because construction naturally contributes to destruction of land through land clearance, use of heavy machinery, poor waste disposal, and release of gases into the atmosphere. Furthemore, the construction industry is characterised by exposure to danger or compromised safety, exposure to dirty or dust, and a relatively high demand and use of input resources. Inspite of all negative contributions of construction to the environment, limited consideration and investment is taken to incorporate green logistics during construction, particularly in Botswana. Therefore, this study sought to examine the nature and extent of green logistics practices in the large construction companies in Botswana.

1.3 PROBLEM STATEMENT

The construction industry is characterised by limited implementation of green logistics, especially during construction of projects (Boadu, 2014). Construction involves a great

deal of material procurement, bulk material movement, warehousing, packing and packaging of the construction materials, and bulk waste. The urbanisation of Botswana provides evidence of the accelerated construction works demonstrated by construction sites in most urban centres like Gaborone and Francistown. Such accelerated construction works are a good representation of the danger that is posed on to the environment as materials required move and get stored at various sites across the country. To cater for such danger, green logistics practices could be an answer but the implementation is relaxed.

The slow implementation of green logistics is further exacerbated by accelerated construction works taking place in areas that are already built-up and in use by the public. Other challenges include dumping of construction materials on the roadsides, old construction trucks, and pollution within the perimeters of construction areas. It has been noticed by the author that most of the time the materials being transported are sometimes not well packaged for transportation and warehousing; thus, posing a threat to the populace and the environment.

Generally, countries characterised by accelerated urbanisation like Botswana are prone to high possibilities of dumping of poor quality products such as construction materials and fittings (Palalani, 2001). Similarly, due to some of the construction projects taking too long before implementation, some procured materials are likely to expire prior to their use (Sunday Standard Commentary, 2010); hence contributing negatively to the already compromised dumping sites. Despite a significant number of empirical studies analysing green supply chain management in the construction industry (Ojo, et al, 2014), few studies have addressed the adoption of green logistics practices by companies in developing countries like Botswana. Therefore, this study examined the nature and extent of green logistics practices in large construction companies of Botswana and related challenges.

1.4 AIM AND OBJECTIVES OF THE STUDY

1.4.1 Aim of the study

This study examined the nature and extent of green logistics practices in large construction companies of Botswana. The green logistics practices include green

transportation, green warehousing, green packaging, green procurement, as well as green data collection and management of waste. The survey went further to investigate challenges faced by large construction companies in adopting the green initiatives and the underlying causes of the same. Consequently, this study sought to probe the prospects of implementing the green logistics .

1.4.2 Objectives of the study

The specifically addressed objectives of this study were to:.

- Identify the green logistics practices in large construction companies in Botswana.
- Ascertain the challenges in adopting green logistics practices in large construction companies in Botswana.
- Investigate causes of the challenges experienced by large construction companies in adopting green logistics practices in Botswana.
- Establish the opportunities available for future operations of the large construction companies in Botswana.

1.4.3 Research questions

This study endeavoured to achieve the above set objectives through answering the following questions:

- What are the green logistics practices adopted in the large construction companies in Botswana?
- What are the challenges faced by the large construction companies in adopting green logistics practices in Botswana?
- What causes the challenges faced by the large construction companies in adopting green logistics practices in Botswana?
- Which opportunities or options are available for future operations of the large construction companies in Botswana?

1.5 SIGNIFICANCE OF STUDY

The findings of this study are expected to inform company policies and strategies that would reduce the challenges associated with green transportation, green warehouse gases, green packaging, green procurement and waste management. Furthermore, it is hoped that the study findings will form the basis for decision

making in the construction and logistics industry, and stimulate more research in these areas in order to save the environment. This study can also be used as a benchmark by organisations and construction companies intending to implement green practices in construction. The findings of this study are also expected to provide the construction industry with opportunities to protect the environment in the long run, as well as to increase environmental, economic and social value through implementation of enviro-friendly construction practices.

1.6 SCOPE OF THE STUDY

Green logistics and green practices are diverse in the built environment, particularly the construction industry. Therefore, this study limited itself to examination of the nature and extent of green logistics practices implemented by large construction companies in Botswana. Despite construction projects taking place across the whole of Botswana, headquarters for the companies making up the population of this study are located in the major cities. For that reason, the scope of this study was limited to Gaborone.

1.7 DESCRIPTION OF THE STUDY AREA

1.7.1 Geographical Location and Demographics of Gaborone

Botswana is located approximately on the 24°39′29″S latitude south of Equator and longitude 25°54′44″E east of the Greenwich Meridian (Google Earth, 2018). According to the Department of Statistics Botwana (2012), Gaborone, the 2011 population census shows that Gaborone had a population of 231,592 and has reportedly experienced a growth rate of 3.4% from the previous population census. The city is reported to be one of the fastest growing urban centres in Botswana and in Africa, experiencing an increasing rate of infrastructural developments especially agglomerated at the famous Central Business District (CBD) which notably houses the Square Mart Mall, The I-Tower, SADC headquarters, National monument of Three Chiefs as well as government offices such as Industrial court, Central Transport Organisation and CIPA. The ongoing construction processes are an indication of the growth and engagement of construction companies, which are visibly seen from afar. Such a characteristic of intensified construction activities particularly contributed to the decision to select Gaborone as a site for this research.

1.8 RATIONALE FOR CHOICE OF STUDY AREA

This study was conducted in Gaborone from the 9th of September 2018 to the 30th of October 2019. It is important to note that the majority of the companies participating in this study had their administrative operational offices based in Gaborone. Furthermore, the location of the main offices of Public Procurement and Asset Disposal Board (PPADB) in Gaborone made it convenient for verification of the industries under study. Moreover, Gaborone has been a beehive of activities relating to reconstruction and upgrading of various infrastructure; and by extension a concentration of large construction companies. This therefore meant that the respondents of this study could be accessed with ease.

1.9 ECONOMIC ACTIVITIES OF THE STUDY AREA

Gaborone is characterised by various economic activities ranging from formal to non-formal work. The city houses both governmental (public) and non-governmental (private) organisations that serve as a source of employment to the populace. Due to the fact that urban agriculture is significantly limited in Gaborone, residents purchase food from small scale farms located in the northern part of the city; which enjoy proximity to water from Notwane river located downstream of Gaborone Dam. The construction industry has been very busy with a number of projects running concurrently across the city from road upgrading, shopping malls being erected, conversion from round-abouts to the robot system, and the iconic buildings in the CBD to mention but just a few. New suburbs are being opened and a number of tertiary institutions are constructing blocks to accommodate students and tutors. This has resulted in the industry being one of the biggest employers in the city.

1.10 THE STRUCTURE OF THE DISSERTATION

This dissertation is presented in five (5) chapters as shown in Table 1.2 below .

Table 1. 2: CHAPTER SUMMARY OF THE DISSERTATION

Chapter	Description
Chapter 1	Introduction This chapter presents the background of the problem, statement of the problem, objectives, limitations, significance of the study, delimitations and chapter summary.
Chapter 2	Literature Review. This chapter presents the theoretical literature, conceptual framework of the study and the empirical of the study.
Chapter 3	Research Methodology. This chapter presents the research design, research approach, population, sampling, sample size, data collection procedure and data analysis, strategies for ensuring trustworthiness, ethical considerations and finally chapter summary.
Chapter 4	Data presentation and analysis. This chapter provides the demographics, research findings and results, data analysis and discussion of results.
Chapter 5	Conclusion and recommendations. This chapter presents the conclusions and recommendations of the study and areas for further research.
The dissertation will end with the list of references and appendices.	

1.11 CHAPTER SUMMARY

This chapter introduced the aim of this study which was to examine the green logistics practices implemented by large construction companies in Botswana. The chapter reflected on the significance of this and outlined the scope of this research. Data collection for this study used the inductive and interpretative research approaches to collect qualitative data. The research sought to establish the green logistics practices in the construction industry that are key to lessening of the impact of construction logistics activities on the environment. It also indentified the challenges experienced in implementing the mitigative measures and the prospects thereof.

CHAPTER 2

2 LITERATURE REVIEW

2.1 INTRODUCTION

The literature review in this study emphasises the importance of creating conditions that will preserve and protect the environment wisely and effectively to make it possible for future generations to find it intact (Albekov, Parkhomenko and Polubotko, 2017). The term sustainability has become common in the development, trade and commerce agendas. Organisations are mandated to recognise sustainability if they are to move in line with the business currents whose drive is to achieve sustainable development. Economies have become more customer driven than supplier driven; and hence, the need for them to be as responsive as possible to escalating environmental demands and needs from the general public and the government who are major stakeholders. Furthermore, research highlights that environmental sustainability should be guided by industry-set-standards set by associations and other important stakeholders (Delmas and Toffel, 2004; Molla, 2008).

It is important to note that most private and public eco-friendly organisations, successfully distinguish themselves from the traditional, primitive and destructive ones through expressing increasing preferences for green practices. The same applies to governments through the establishment of statutory instruments which foster environmentally friendly processes and strategies for every industry (Dedrick, 2010; Molla, 2008; Lee et al, 2013). Interestingly in recent years more attention has been given to green logistics as indicated in the number of studies that have dealt with this concept such as: McKinnon, et al, 2012; Kutkaitis and Zuperkiene, 2011; McKinnon, 2010; Emmet and Sood, 2010; Palmer and Piecyk 2010, Guochuan 2010; Sbihi and Eglese, 2010; Cherrett, et al, 2009; Bagdoniené, et al, 2009; Monnet 2008; Srivastava 2007; Rodrigue et al, 2012.

With the above in mind, this chapter reviews literature on the dynamics and benefits of green logistics and the theories that back it. Green logistics in this study refers to all efforts whose aim is to minimise the ecological effects of any projects or any construction process which takes into account environmental consideration while maximising the proceeds without compromising the environment for the future generations. This definition is in line with observations made about “Our Common Future” in the Brundtland Report

(WCED, 1987). Green logistics acknowledges that economic growth has influence on the economic practices that in turn affect the environment. See Figure 2.1. It is therefore imperative for project implementers to enhance green practices that will reduce environmental pollution. They should take into account the triple bottom line process which ensures that projects take into account three key spheres or elements of green logistics namely social, environmental and economic sectors.

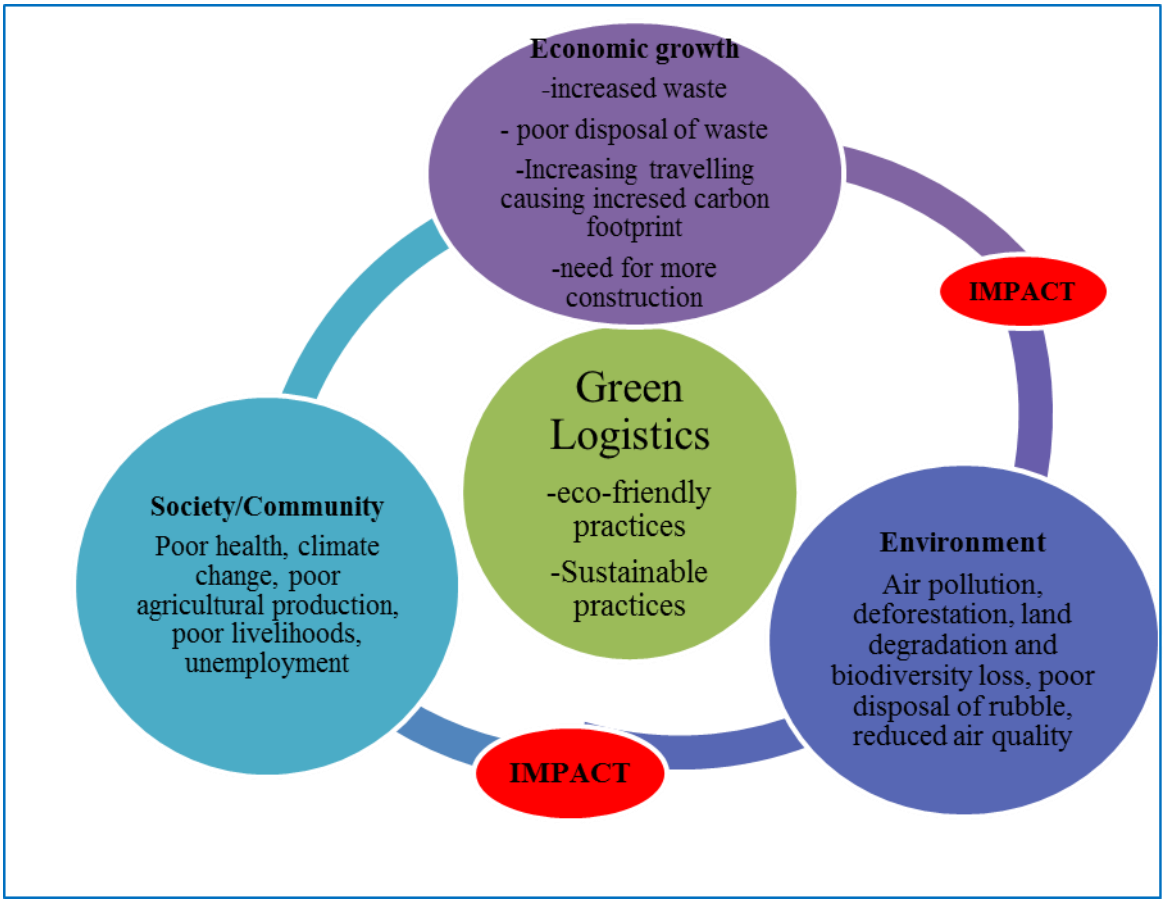

Figure 2. 1: THREE KEY SECTORS OF GREEN LOGISTICS

Source: Adopted from White, 2015

2.2 SUSTAINABILITY AND THE TRIPLE BOTTOM LINE

The concept of 'sustainability' has been used in conjunction with that of 'green logistics'. The overall aim of these concepts is to use the environment at a rate at which it can replenish itself using practices that do not compromise its ability to benefit the future generations 'Our Common Future' Brundtland Report (WCED, 1987).

It should however be noted that the terms ‘sustainability’ and ‘green logistics’ have different meanings when used in different contexts. In the context of the triple bottom line concept, both sustainability and green logistics are premised on economic, environmental and social goals (Vasiliauskas, et al, 2013). The three goals of sustainability are “ecological social equity, health, and economic welfare” (Salmane, 2015; WCED, 1987). Firms are increasingly engaging in self-appraisal and public assessment according to the degree to which they address the environmental impacts of their projects (Ozanne et al, 2016). Recent research shows that at the top of executive management’s agenda is the importance of sustainability (Kiron, et al, 2015, WCED, 1987).

Sustainability has a long term economic and social value. Economic value is in the form of improved customer satisfaction, good relations with stakeholders, green image, higher reliability of delivery through optimized route planning, and less truck downtime, higher productivity, higher motivation of the employees, reduced liability risk, reduced taxes and improved financial performance (Kumar, 2015). On the other hand, according to Kumar (2015), social value is manifested in reduced environmental impact or reduced carbon dioxide emissions and noise levels, better utilisation of natural resources such as fuel, development in harmony with cultural practices and available resources, reduced social cost or community health problems, access to clean water and clean energy, creation of jobs and enhanced quality of life (Kumar, 2015).

In line with ‘green logistics’, The Brundtland Commission defines sustainable development as a type of development that satisfies the current needs without reducing the availability and quality of resources to allow future generations to satisfy their needs (Borowy, 2013). This corroborates the definition of green logistics by Kumar (2015). From a corporate perspective, this definition suggests that sustainability should focus on the economic aspects of one’s business, as well as on natural resources and the people that these companies serve (Kumar, 2015). In other words, sustainability should take the Triple Bottom Line approach that all the stakeholders are not merely influenced by and concerned with economical gain, but by environmental and social consideration as well (Markley and Davis, 2007). All in all, sustainability advocates for planned responsibility which will produce quality life today without compromising that of future populations. This can only be achieved through change in consumption patterns, assumption, decision making and economic policy (Salmane, 2015).

The Brundtland Report definition of sustainability was critiqued because it focused on future needs at the expense of the needs of the present populations. For example, Kilbert, et al, 2010 in Salmane, 2015 points out that:

> "*M.P. Golding addressed this problem in 1972 when he suggested that a moral community can be organised only in one of two ways – either by a clear contract between its members or by a social arrangement in which each member benefits from the efforts of other members. With respect to future generations neither an explicit contract nor social arrangement is possible and thus rights cannot be attributed to future generations as a result of a contract or social arrangement*" (Kilbert, et al, 2010 in Salmane, 2015).

The importance of sustainability in industry and commerce is indispensable and therefore compels companies to implement green logistics or to offer services that satisfy marketing and environmental demands. It is important to note that modern consumers prefer green products and they are conscious of every kind of activity in the supply chain that can promote green living to protect the planet earth (Weber, 1990; Kumar, 2015; Xia and Wang, 2013; Zhu, Sarkis and Lai, 2007). With the above in mind, a sustainable construction company creates a balance between the three dimensions of sustainability. However, evidence suggests that several factors influence sustainability in the construction industry and some of them are presented in Table 2.1.

Recent studies show that companies are faced with the challenge of balancing the three legged concept of sustainability, or to manage environmental, social, and economic concerns (Ozanne, et al, 2016). These inconsistencies or challenges are regarded as paradoxes by several researchers (Kumar, 2015; Saroha, 2014; Gechevski, et al, 2016). According to Smith and Lewis (2011) a paradox approach postulates that tensions are integral to complex systems and that sustainability depends on attending to contradictory yet interwoven demands simultaneously. These scholars argue that this process on its own poses tensions and that managing the three dimensions of sustainability is complex given their opposing nature .

Table 2. 1 GREEN LOGISTICS PRACTICES INFLUENCING SUSTAINABILITY

Practices	Sources which impact the sustainability	Practices for removing the negative impact
Green Transport	The construction of transport network; The operations of transport vehicles; The disposal of transportation vehicles	Modal Choice; Freight Consolidation; Clean Vehicles/Fuel Efficiency; Reuse of Pallets and Containers Standardization of Trucks Sizes
Green warehousing	Layout, design and capacity of the warehouse may impact the sustainability.	Clean material handling equipment; Process optimization; Automatic warehousing systems; Inventory minimization programs and Just-in-time system; Product disposition; On-site recycling.
Green packaging	The elements of the packaging which have an impact on warehouse and transport costs are size, shape and materials.	To sort out the packaging issues, innovative packaging technologies and environmental certifications can be introduced.
Green Procurement	Lack in quality raw material	Quality check monitoring tools
Waste management	Different kind of waste generate during the logistics like waste from expired product or due to packaging.	Waste contractor, Trade waste recycling

Source: (Kumar, 2015)

(Hahn, et al. 2010; Phipps, et al. 2013; Van der Byl and Slawinski 2015). Therefore, Slawinski and Bansal (2015) argue that organisations must manage paradoxical tensions and O'Driscoll (2008) advocates for the address of organisational self-interest versus societal responsibility. Margolis and James (2003) state that in order for true sustainability to be embraced shareholders and other stakeholders'demands should be met and all the three dimensions should be attained.

It will not be complete to discuss about sustainability without infusing corporate social responsibility (Sen and Bhattacharya, 2001) under which green logistics and other environmental initiatives could be implemented. It is advisable that these should be done without ignoring the obstacles of pursuing the three dimensions concurrently (Mish and Scammon, 2010). Studies suggest that the paradoxical tensions which stand as obstacles to sustainability are derived from the organisations' primary activities (Lewis 2000; Luscher and Marianne 2008; Smith and Lewis 2011). According to Lewis (2000) the need for group affiliation and self-expression by organisations trigger belonging tensions as stated

by Smith and Lewis, (2011). The challenge is usually realised when managers try to bring together their sustainability identity with their organisational identification (Wright, Nyberg and Grant, 2016; Luscher, Marianne and Ingram, 2006).

With reference to Smith and Lewis (2011) competing strategies and goals as well performance measurement create performing tensions given that financial performance indicators are, for example, quantitative in nature and well-structured whilst social-environmental goals are difficult to measure given their varied, subjective and non-standardised nature (Ozanne, et al, 2016; Delmas and Blass, 2010). This influences competitiveness and compromise of the two, which are financial and social-environmental goals where sustainability falls under. Nonetheless, in a bid to cope with change in the environment, it is important to acknowledge that tensions are bound to arise thereby leaving beliefs and assumptions to task (Lewis, 2000).

Liu, (2013) indicates that sustainable development is not studied or dealt with as an individual entity but rather as a three dimensional subject that addresses economic development, social development and ecological development. It is summatively referred to as ecological-economic-social development in a three-dimension system. Ecological sustainability is the leading dimension amongst these three because it is fundamental for social sustainability.

In summary, Sbihi and Eglese (2010) observe that literature on sustainable development gives green logistics a new definition which encompasses the production and distribution of goods. In the construction industry sustainable development can for example include increased project efficiency; reduced construction waste, and energy conservation. All these need an effective framework and adoption of latest technologies and tools such as Lean, BIM (Building Information Models) (Azis et al, 2012).

2.3 CONCEPTUALISING GREEN LOGISTICS

Bowersox et al, (2010) define logistics as the responsibility to design and administer systems to control movement and geographical positioning of raw materials, work-in-process and finished inventories at the lowest total cost. The administration process consists of order processing, inventory management, transportation and the combination of

warehousing, materials handling and packaging (Chopra and Meindl, 2010). All these activities are evident in the construction industry; hence, the concept construction logistics.

The concept of 'greenness' in green logistics or in construction, according to Goransson and Gustafsson (2014), is usually employed to suggest compatibility between the construction logistics and the environment. In a nutshell, McKinnon (2010) states that green logistics refers to the movement and delivery of goods with the aim to of having as little impact on the environment as possible. Green logistics can also be defined as supply chain management practices and strategies that reduce the environmental and energy footprint of freight distribution, which focuses on material handling, waste management, packaging and transport (Rodrigue, et al, 2012). The above activities are prevalent within the construction industry and are implemented to promote sustainability and to protect the triple bottom line. As previously indicated, the triple bottom line consists of economic, environmental and social elements which indicate the essence of sustainability (Mintcheva, 2005). Hence, the incorportation of sustainability in green logistics is inevitable.

Some scholars define the term 'green logistics' as reverse logistics (Dowlatshahi, 2000; Rogers and Tibben-Lembke, 1998; Tibben-Lembke and Rogers, 2002). They argue that the flow of materials up the stream of supply is tantamount to reverse logistics, and hence their use of the term green logistics. However, Liu (2013) views green logistics as a form of new logistics management manifesting green action towards the environment. On the other hand, Vasiliauska et al (2013) and McKinnon et al (2012) emphasized that the green logistics concept interfaces intensively with the policy on sustainability because of its nature of being socially friendly, environmentally accommodative, and economically functional.On a similar note, organisational, national, regional and global strata also mention green logistics although they expect environmental management principles and initiatives to be driven by the business as part of trade and commerce (Meiduté and Paliulis 2011). Their implementation is used to rate businesses' ability in running its activities in line with economic, social and environmental elements which take into account sustainability (Balkyte and Tvaronavicienė, 2010; Bagdonienė, et al 2009).

Liu (2013) stipulates that green logistics embraces the management of economics as a guiding principle for research that enhances mutual relations between economic behaviour,

legal regulatory systems, and the ecosystems in the logistics processes that seek to achieve the best combination of ecology and economy and the coordinated development in the ecological balance. Green logistics is therefore a system designed in line with human needs but taking cognisance of the future needs or that is addressing the current needs with sustainability in mind (Guochuan, 2010). Correspondingly, its basis is on efficiency in energy consumption and reduced pollution by all sectors that deal with production or service provision (Kutkaitis and Zuperkiene, 2011; Srivastava, 2007).

Vasiliauskas, et al, (2013) argue that the fields of mining, manufacturing, construction and distribution should spearhead mainstream sustainability, and green logistics, supported by social, economic and ecological principles, because they do most of the construction. It goes without saying that these industries should therefore in accordance with green logistics employ environmentally-friendly and efficient transport, distribution, storage, packaging, procurement, waste management systems together with data collection and management.

For the purpose of this study green logistics refers to all environmentally and economically viable efforts by construction firms to minimise the ecological impact of all activities of the forward and reverse flows of services, products and information between the point of production and that of consumption which are transportation, warehousing, packaging, procurement, waste management and data collection and management.

2.4 THEORETICAL FRAMEWORK

Several theories have been propounded to explore green logictics and their benefits to local communities and the environment in general. Liu (2013) indicates that Sustainable Logistics theory consists of three subsystem theories namely Sustainable Development Theory, Ecological Ethics and Ecological Economics Theory (Elhedhli and Merrick, 2012) all of which form the theoretical framework of this study as in Figure 2.2 below.

The theory of Sustainable Development includes ecological, economic and social sustainability (Hu et al, 2016, Goransson and Gustafsson, 2014), and these are perceived to be three pillars which resemble the triple bottom line of the environment (Kumar, 2015).

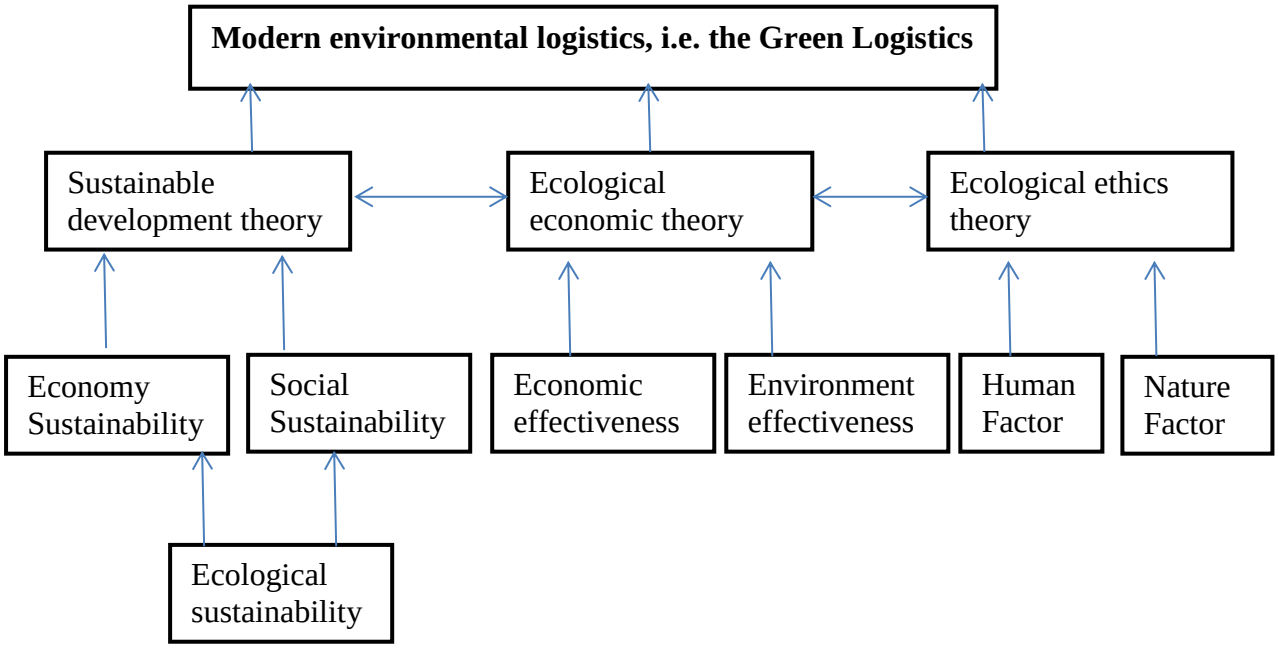

Figure 2. 2: THE THEORY STRUCTURE OF GREEN LOGISTICS SOURCE: LIU, 2013

Ecological Sustainability underscores respect for the environment with more emphasis on control and recovery of a compromised environment, thereby giving hope to sites and areas which have been degraded with different wealth generation processes (Liu, 2013) such as construction. Furthermore, the Economic Sustainability theory also focuses on technological development, a move that is expected of the industry so that sustainability can be achieved and the set environmental targets can be met. It advocates for the saving of energy and reduction in consumption thereby leading to an increase in efficiency and reduced waste all of which protects the future (Hu, et al, 2016; Rodrigue ,et al, 2012). On the other hand, the Social Sustainability Theory in line with the Millenium Development Goals (Sachs, 2012; UNDP, 2000) and Sustainable Development Goals focuses on the improvement of human quality life through population control, development of health and education, eliminating inequality and polarisation, and having a seamless social security system.

In his report entitled From Millenium Development Goals (MDGs) to Sustainable Development Goals (SDGs), Prof Jeffrey D Sachs (2012), emphasises the need for an equal inclusion of the triple bottom line. In his justification on SDGs, he elaborated that "sustainable development embraces the so-called triple bottom line approach to human wellbeing and almost all the world's societies acknowledge that they aim for a combination of economic development, environmental sustainability, and social

inclusion…with a shared focus on economic, environmental, and social goals being a hallmark of sustainable development and represents a broad consensus on which the world can build" (Sachs, 2012). With most of the consumption taking place in the modern logistics system, the application of sustainable development to logistics is a requirement in order to restrain logistics from causing harm to the environment hence the term green logistics (Hu, et al, 2016).

The development of ecological ethics has been necessitated by people's response to ecological crisis which forced them to revise their accountability to the ecological environment and to have a thoughtful consideration of logistical environmental challenges all of which lead to a solid sense of duty (Liu, 2013). Ethics are a reflection on nature and a definition of "the good"; and in order to have sustainable socio-political and economic processes and systems, ethical sustainability needs to be appreciated. Furthermoore, in order for sustainability to be achieved, its ethical dimensions have to be given consideration (Salmane, 2015). The advancement of ethical rules compels people to follow "the right path", and so the goal of ecological ethics is to guide people in their determination to address real world problems which will result in more environmentally sustainable practices, organisations and societies (Salmane, 2015). The ethics of sustainability are not limited to the realm of theory; which is why Kant famously declared that *ought* implies can (Kilbert et al., 2010). All forms of sustainability in society depend on human conduct. Therefore, the ethical aspects of reality are more important in ensuring sustainability. Ethical sustainability needs to be realized in order to have sustainable political and social systems and processes (Salmane, 2015).

2.5 GREEN LOGISTICS SYSTEM FRAMEWORK

The general feature of the green logistics system is employing advanced technology and equipment to minimise environmental damage and increase the utilisation of the resources (Rogers and Timben-Lembke, 1998). Fig 2.3 below shows the green logistics framework. The framework shows the logistics activities where sustainability is applied. This conceptual framework defines green logistics as the sum of five pillars: green transport; green warehousing; green packaging; green logistics data collection and management; waste management. Waste management from the environmental perspective supports environmentally sound practices such as recycling, remanufacturing, reuse and recall

(Kumar, 2015). Logistics centres in construction can therefore be configured to provide a wide range of functions such as storage, transport, distribution, assembly, direct shipment, shipment with milk runs, cargo consolidation, sorting, break-bulk, distribution network management or vehicle routing, delivery, package tracking and e-commerce services (Hamzeh, et al 2007). This framework assists in assessing green logistics practices in construction works.

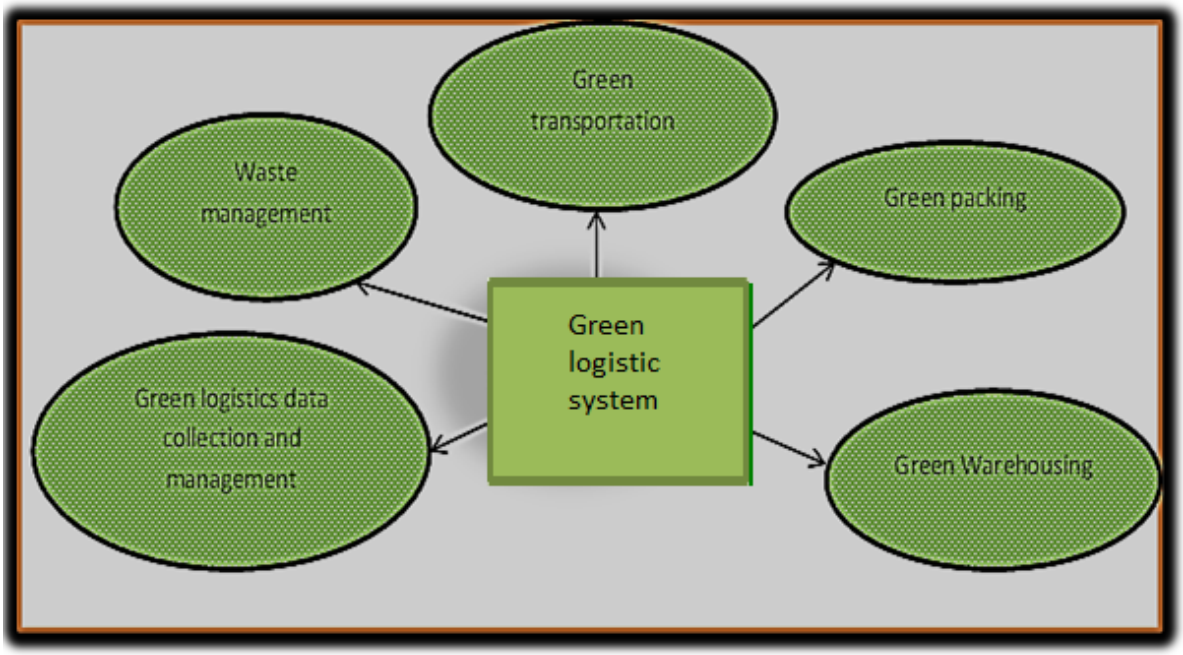

Figure 2. 3: FRAMEWORK OF GREEN LOGISTICS SYSTEM
Source: Thiell etal, 2011

The above model did not incorporate green procurement which was later adopted by Kumar (2015). Kumar however left out green logistics data collection and management in his 2015 model. This pillar is included in the new model as indicated in Fig 2.4 below to fully address the concept of logistics management as given by the Council of Supply Chain Management Professionals (CSCMP) (2019). They considered it to be "… that part of supply chain management that plans, implements and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements." (CSCMP, 2019) The flow of information means that there is need for data collection and management.

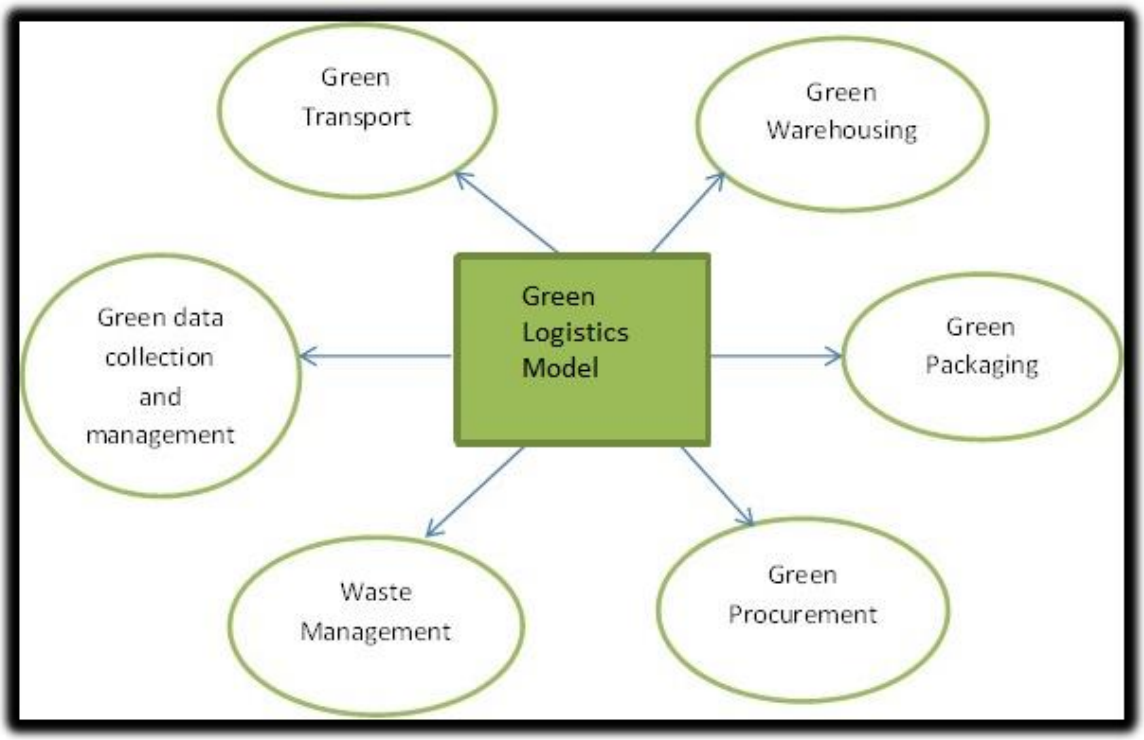

Figure 2. 4: GREEN LOGISTICS MODEL ADOPTED FOR THIS STUDY

In line with the above framework, the application of Information Communication Technology (ICT) practices, shown in Fig 2.5, in logistics can be an effective way of reducing carbon footprint, and helping to reduce dependency on fossil fuels and to reduce air and noise pollution (Vasiliauskas' et al, 2013). It is all about adaptation to a continuously changing environment (Hitt, et al, 1998; Koste and Malhotra, 1999). Some of the practices include: Information Management Systems, Cold Chain Logistics, Freight Operation Information System (FOIS) and Electronic Data Interchange (EDI), for information flow between ports, customs, shipping lines, and users (Kumar, 2015). Thus it could be concluded that ICT practices are helpful in sustainable development; and that the basic principle of sustainability is that the longer the life of the product the more it will benefit the environment.

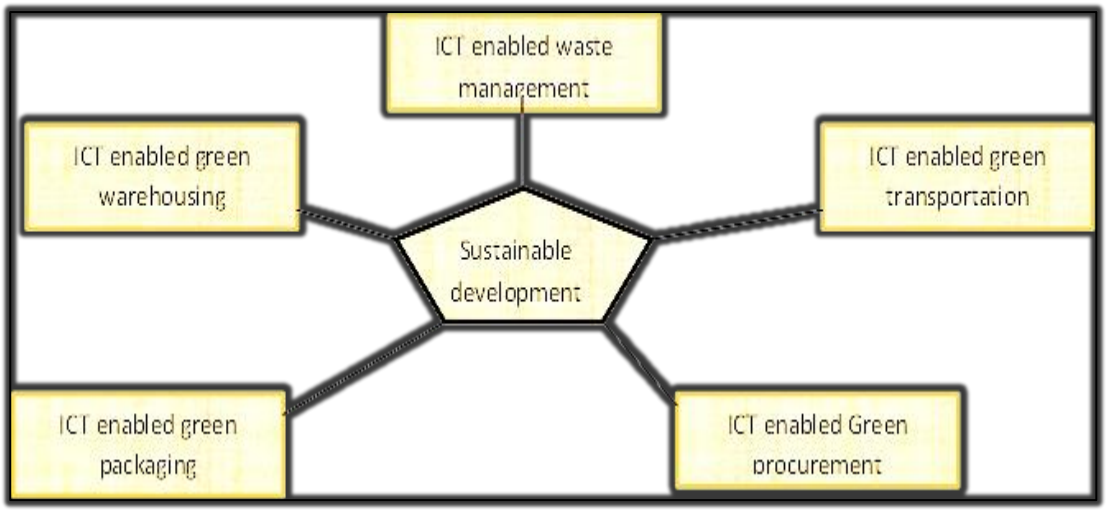

Figure 2. 5: INFORMATION COMMUNICATION TECHNOLOGY (ICT) GRID CONCEPTUAL MODEL

The survival and efficiency of an organisation depends upon flexibility of information distribution (Hitt, et al, 1998; Kuo, et al, 2006). ICT allows for information distribution which is crucial especially in waste management activity. Furthermore, the management of information relies on information systems which improves decision making through efficient data processing (Swafford, 2003). For example, the food supply chain uses the Internet for management of the environment, transportation, distribution and warehousing of its goods(Kumar, et al, 2012; Liu, 2013). Through ICT, the green logistics integrates companies, people and nature into a flexible management system (Liu, 2013).

2.6 GREEN LOGISTICS PRACTICES

Logistics has become one of the most important elements of any business and with the globalisation of trade; its importance has increased, along with its complexity (Cullinane, 2014). Green logistics practices within companies, once considered proactive measures (Wu and Dunn, 1995), now influence entire value chains; and their presence has become a requirement for doing business. Thiell, et al, (2011) proposes a green logistics matrix which subdivides the practices into strategic, tactical and operational. Rensburg (2015) extends the list to include organisational best practices, technical best practices and internal best practices, the six of which she used to explore green logistics practices of transport and logistics companies located in Gauteng, South Africa. The supply chain consists of different players that include producers, manufacturers, distributors, retailers, customer and or consumers (Chopra and Meindl, 2010); and these form relationships to

help realise aggregated goals (Monczka et al, 2009). In line with environmental protection, industries such as the construction industry formulate norms, ethics and standards that manufacturers and customers should follow so that every party becomes responsible and answerable in issues such as disposal, recycling and reuse (Daly and Butler, 2009). This forms the basis for their supply chain decision making.

Green logistics practices include reverse logistics, packaging optimisation, measurement of carbon emissions and fuel efficiency (Bowersox, 2010), target zero defect, halving waste to landfill, waste management and carbon foot printing (Looney, 2012). Other practices include emission data sharing in the supply chain; network optimization, packaging reduction, warehouse layout optimization and sustainable procurement; logistics network optimization and aligning sustainable practices in supply chain (Dadhich, et al, 2015; Palanivelu and Dhawan, 2010). All the above can prevent high failure rates in the building construction sector. Furthermore, Kumar (2015) identifies green logistics practices such as green transportation, green warehousing, green packaging, green procurement and waste management. On each of the practices, he identified the sources which impact sustainability and the respective practices for removing the negative impact as shown in Table 2.1 above.

2.6.1 Green Transport

Green transportation is one of the activities that pose a threat to the environment. In particular, transportation sustainability is affected by construction of a transport network; the operations of transport vehicles and the disposal of transport vehicles (Kumar, 2015). “In the atmosphere, the more carbon dioxide accumulates the more is the decrease of the oxygen levels and the increase of emissions falling as residue on the plants and soil. These are unavoidably inhaled by people, and are consumed with food. Transport operating on the territory of the Russian Federation for example, burns approximately 110-115 million tons of fuel and 1.2-1.5 million tons of lubricants annually” (Albekov, Parkhomenko and Polubotko, 2017). Other pollutants include crankcase gases, battery acid, lubricants and coolants, as well as other operational materials (Parkhomenko, 2015). Practices which can be adopted to remove the negative impact of transportation thereby greening it include clean vehicles or fuel efficiency; reuse of pallets and containers, and the standardisation of truck sizes; joint distribution/freight consolidation; adoption of a composite transport mode

and development of the third-party logistics (Kumar, 2015; Liu, 2013). Fig 2.6 below shows the goals for implementing the green logistics concept especially with the road freight industry.

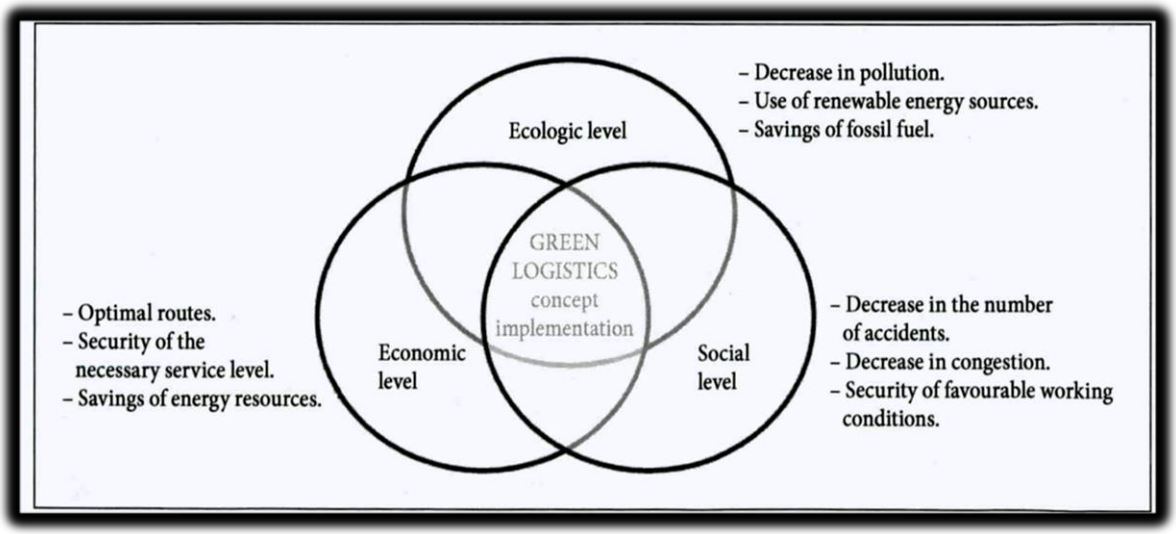

Figure 2. 6: GOALS FOR IMPLEMENTING GREEN LOGISTICS CONCEPT

"With the increasing emphasis on supply chain management, more companies are exploring the third-party option" (Stock and Lambert, 2001:334). The benefits experienced from the use of integrated logistics services include "overall logistics efficiency and effectiveness; optimised capacity utilisation; extended global network; inventory reduction, early problem detection and a proactive information technology approach" (Bowersox, et al, 2010:418). Having a vibrant and specialised team of third party logistics assists in meeting the pressing needs of logistics. These simplify the distribution network, ensure justified allocation and utilisation of scarce logistics resources, relieve pollution by allowing decongestion in large cities, and promotes the use of liquefied gas, solar energy and clean energies in order to save the environment (Liu, 2013) from emissions.

By considering each individual shipment, actual operational data and credible sources for emission factors, DHL is able to give the best-in-class carbon dioxide calculation (Saroha, 2014). DHL provides two services which are a carbon report and an advanced online carbon dashboard. Carbon report maps emissions generated from transportation within the DHL network whilst online carbon dashboard has all the benefits of the carbon report. It also maps emissions from the entire transportation supply chain – including third part

networks; maps emissions to individual shipment level; flexible views on different carbon reports enabling simple measurement of emission improvements; ability to simulate and assess carbon footprint and efficiency and assists in supply chain optimization and strategic decision making (Saroha, 2014).

DHL Express is making strides in incorporating energy saving strategies in collaboration with Ford and electric vehicle maker StreetScooter. The vehicle named "H2 Panel Van" will become the first 4.25 tonne electric vehicle with an added fuel cell, which will provide additional power and enable a range up to 500 kilometres (Logistics and Material Handling, 2019). For Markus Reckling, CEO DHL Express Germany, the new van fits in to the Group's larger environmental goals. "With the H2 Panel Van, DHL Express becomes the first express provider to use a larger number of electric vehicles with fuel cells for last-mile logistics. This underscores our aspiration to be not only the fastest and most reliable provider on the market, but also the most climate friendly," he says (Logistics and Material Handling, 2019). The project is funded by the German Federal Ministry of Transport and Digital Infrastructure (BMVI) as part of its National Innovation Programme Hydrogen and Fuel Cell Technology (NIP II) (Logistics and Material Handling, 2019).

Figure 2. 7: DHL EXPRESS ELECTRIC DRIVEN VEHICLE

Source: http://mhdsupplychain.com.au/2019/05/29/dhl-and-ford-to-develop-new-electric-drive-vehicle-with-hydrogen-technology/

Consolidation allows multiple enterprises, especially the small scale ones, to enjoy economies of scale whilst reducing the environmental impact since by joint distribution, the deliverer can implement a few distributions, and the receiving party can make unified inspection so as to achieve the aim of improving logistics service level (Vasiliauskas, et al, 2013). From the perspective of logistics enterprises, especially some small and medium-sized logistics enterprises, due to the restriction in capital, talent and management of the

vehicle capacity, the logistics rationalisation and efficiency would be restricted. If they cooperate with each other through joint distribution, then these problems can get a better solution. As a result, the joint distribution can maximise the efficiency of personnel, goods, capital, time and other resources, to achieve maximum economic benefits. At the same time, it can remove redundant staggered transport and enhance environmental protection and other social benefits" (Liu, 2013). For the success of joint distribution, representation bodies may be set with one having to stand for the shippers whilst the other represent logistics companies (Liu, 2013).

Liu (2013) also advocates for a composite transportation mode which can also be termed inter-modalism so that construction companies can maximise on the advantages of each mode and also bring in containerisation which reduces packaging costs and minimises damages in the transport process all of which if not monitored adds to waste in the supply chain. The other advantage of adopting composite transportation mode is that more links are created leading to efficiency and thereby "solving the space and time separation of goods in the production and consumption. This is due to differences in geography, climate, infrastructure construction and other market conditions to promote the effective operation of the enterprise's production and operation" (Liu, 2013)

Green transportation is facilitated by the right selection of modes of transport. Rail transport, among all the other modes of transport, is a "green inland mode", in that its consumption of energy per unit load per km is lower than road modes (Aditjandra, et al, 2016). This makes it much preferable for the accomplishment of green logistics goals. The establishment of the dry port, which is linked to rail transport, is desirable for green logistics. Its implementation can be defined from an environmental perspective where calculated carbon dioxide emissions are lower while truck waiting times at the terminal are significantly reduced and congestion from numerous lorries is avoided. For example, one train can substitute around thirty lorries, especially at the seaport gates and along the main routes (Roso, 2007). An increased number of trucks result in road congestion, increased local pollution, increased road maintenance costs and accidents (Roso, 2007).

Though considerably more environmentally friendly than road transport, sea transport impacts the environment through air pollution (Cullinane and Cullinane, 2013; Eyring, et al., 2010), emission of GHG (Crist, 2009), release of ballast water containing aquatic

invasive species (AIS) (Bailey, Chan, and MacIsaac, 2015; DiBacco, Humphrey, Nasmith, and Levings, 2012; Scriven, DiBacco, Locke, and Therriault, 2015), and release of cargo residues (Grote, et al, 2016). It also impacts the environment by spilling oil from ships (Kim, 2002; ITOPF, 2017), being a source of plastic debris (Pettipas, Bernier, and Walker, 2016; Walker, Grant, and Archambault, 2006; Walker, Reid, Arnould, and Croxall, 1997), underwater noise (Pine, Jeffs, Wang, and Radford, 2016), ship-strikes on marine megafauna (Vanderlaan and Taggart, 2009), and through ship groundings or sinkings (Choi, Kelley, Murphy and Thangamani, 2016). Furthermore, widespread sediment contamination in ports and harbours during transhipment or ship breaking activities (MacAskill, Walker, Oakes, and Walsh, 2016) are experienced. Compartively, air transportation is so much associated with air pollution and noise pollution most of which takes place at the airports (Jakubiak, 2015)

All the commercial modes of transport and equipment are propelled by fuels which are non-renewable scarce resources. Alternative fuels, if available in sufficient quantities, offer the potential to reduce price, mitigate the effects of supply disruptions, and reduce the environmental impacts of aviation (Hileman, et al, 2008). “The use of either low sulfur content conventional fuels or low sulfur content synthetic fuels, which are also low in aromatic compounds, could yield benefits of reduced emissions that contribute to airborne particulate matter.” (Hileman, et al, 2008).

A number of strategies can be adopted to push the green transportation agenda. For example, good construction logistics management through the use of technology improves order processing, reduces lead times, proper scheduling for the availability of cranes and skips, improves coordination (Almohsen, and Ruwanpura, 2013) and improves driver safety. Construction consolidation centre quite significantly reduces noise especially in cities. It also reduces fumes and guarantees full-truckloads-delivery than frequent-small-deliveries which make the sites unnecessarily much busier (Lundesjo, 2011). Preventive maintenance, whose guiding principle is “the regular and systematic application of engineering knowledge and maintenance attention to equipment and facilities, ensure their proper functionality and reduction in their rate of deterioration” (online). Vehicular exhaust is the worst type of exhaust as it is emitted at ground near the breathing level, and it gives maximum human exposure and traffic exhaust contains different noxious oxides of sulphur (SO_2), nitrogen (NO_2), carbon (CO_2), volatile organic compounds (VOCs) and

suspended particulates (Ahmad, et al 2016). Pallets are part of the distribution process assisting in movement and storage of construction materials. They often represent a significant investment and, once at their destination, an end-of-life disposition (reuse, recycle, down cycle, incineration or discard) must be made (Bilbao, et al, 2011:1223).

2.6.2 Green Warehousing

Warehouses seek ways to minimise operational costs while maintaining productivity and efficiency, for example by cutting waste and lowering energy costs. "Eco-friendly warehouse initiatives can range from the simple to the exceedingly complex; but implementing green innovations holds tremendous promise both in terms of cost reductions and other non-financial perks, such as branding and vendor relations" (Pointus, 2017). This implies that, whether one is building a new warehouse or redesigning an existing one, it is important to keep the welfare of employees and the environment in mind.

"A warehouse has traditionally been viewed as a place to hold or store inventory but however, in contemporary logistical systems, warehouse functionality is more properly viewed as mixing inventory assortments that meet user requirements and storage of products is ideally held to a minimum" (Bowersox et al, 2010:246). The sources which impact sustainability in case of warehousing include the layout, design and capacity of the warehouse. However, several practices can be adopted to remove the negative impact of warehousing. These include clean material handling, process optimisation, automatic warehousing systems, inventory minimisation programs and Just-in-Time system together with product disposition and on-site recycling (Kumar, 2015). Green warehousing focuses on the design of warehouses and depots. There are many examples of how to improve the design of warehouses to make them less environmentally damaging, that is, green roofs and waste water use (Cullinane, 2014), energy efficient lighting, energy efficient heating and energy efficient insulation (Arden, 2012). There is also need to identify inbound and outbound freight lanes that minimise transportation routes, resulting in less fuel, fewer carbon emissions, and faster delivery times. (Atkinson 2017).

In line with the previous authors, Pointus (2017) described ways in which warehouses are going green to reduce costs. These include eco-friendly lighting alternatives, warehouse identification, optimised warehouse layouts, water saving initiatives, energy efficient

equipment and recycling programs. While there's an upfront cost associated with replacing traditional lighting with LEDs (light-emitting diodes) and other energy-saving alternatives, the cost savings over time is well worth the investment. Warehouse identification is a treasured investment for warehouses, providing data that helps to reduce waste and streamline operations through more effective and well-organised picking and stocking. Options such as multi-level warehouse rack labels make it faster and stress-free for workers to identify the proper racks and shelves, expediting order fulfilment and minimising labour costs (Bartholdi and Hackman, 2016). Hanging warehouse signs and long-range retroreflective signs and labels make the whole navigation seamless. Data gained through asset tracking can be used to design optimised facility layouts, which in turn can cut down on labour and energy costs by making fast-moving stock more accessible and reducing travel time throughout the facility (Pointus, 2017). By making better use of vertical space, warehouses can store more stock, directly impacting the bottom line. From installing low-flow toilets and faucets, one can cut down on water waste from everyday use, whether from toilets and sinks in restrooms or hoses used for cleaning and maintenance (Stauffer, 2019).

Currently, warehouses have more options when it comes to equipment such as forklifts. As the industry is increasingly becoming aware of environmental concerns, more warehouses are choosing to invest in electric forklifts rather than gas-powered ones (Pointus, 2017). The use of electric forklifts eliminates tail-pipe emissions produced by gas forklifts resulting in less impact on the environment.

Most warehouses already reuse items such as pallets and crates or totes, but it's worth conducting an audit to determine what items a facility continuously disposes of and if there are reusable alternatives to reduce waste (Bilbao, et al, 2011; Pointus, 2017). A number of warehouses are minimising waste by reusing packaging materials such as cardboard and packing instead of disposing of it. In construction, waste that cannot be reused such as concrete, wood, drywall, asphalt shingles, asphalt pavement, metal and cardboard should be recycled when possible. Recycling can benefit a construction business's bottom line, and the environment at large.

The operation of pneumatic systems does not produce pollutants and the air released is also processed in special ways; and therefore, pneumatic systems can work in

environments that demand high level of cleanliness (online). Using different waters instead of oils in hydraulic systems brings environmental safety, fire safety, explosion safety, low cost fluid, good availability of the fluid and easy storage of the fluid (Koskinen, 2008). The data collected by Nordelof, et al. (2014) demonstrates a reduction in GHG emissions with an increasing degree of electrification, although different vehicle categories overlap with regard to minimum and maximum values.

Noise pollution is rife in storage and construction sites and this has effects on the inhabitants. The receivers of such noise fall into four groups viz. views from residences; views from workplaces; views from recreational landscapes and views from riverside access, public roads and railways including vehicle travellers with transitory views (online). Noise affects the people and animals surrounding the site which are part of the environment. Noise leads to loss of concentration, sleep disturbances, hypertension, increased stress levels and hearing loss.

2.6.3 Green Packaging

"Packaging materials (glass and plastic bottles, cans, paper and plastic wrappings) are indeed the main constituents of litter. Direct packaging-related emissions arise from landfill sites, as a consequence of decomposition of wood and paper, releasing CO_2, and methane" (Pongracz, 2007). "Packaging helps loading, collection, and transportation of the product and the distribution of bulk and liquid products needed in the construction industry is virtually impossible without packaging. Protective packaging such as bubble wrap ensures safe journey whilst corrugated paperboard and polystyrene foam hold expensive electronics equipment securely in their cartons and cushion them against falls, shifts, and bumps. Before loading materials onto ships, trucks, or planes, these cartons are stacked on pallets and wrapped with a sheet of self-clinging stretch wrap. This very strong, yet thin, film stabilizes the load, keeping it from shifting and falling. Fewer falls mean reduced damage and breakage, keeping both waste and related disposal costs to a minimum" (Pongracz, 2007).

In order to achieve the objective of green packaging, there should be focus on the elements of packaging that have an impact on warehouses and transport costs which are size, shape and materials. These can be addressed by sorting out the packaging issues, using

innovative packaging technologies, introducing environmental certifications (Kumar, 2015), simplifying production packaging and using biodegradable materials (Liu, 2013). There should also be use of modular packaging, large-scale and unitised packaging, recycled packaging and development of new packaging materials and packaging equipment (Liu, 2013).

Modulus packaging is good for transportation and storage as it unifies the size in transportation and warehouse facilities. Unitisation expedites the logistics activities as it allows for speedy handling, removal, transportation and storage of inventory and this therefore reduces packaging materials and costs. Packaging material should also be recyclable. Multi-used bags for example and waste packing materials can be converted to other materials (Liu. 2013).

Kumar, 2015 and Lui, 2013, (Besch and Palsson, 2016) indicate that packaging should be user-friendly and informative. They however argue that besides some success stories pertaining to reduction in packaging waste in the European Union, environmental problems related to packaging are still being experienced in the areas of households waste. Plastic packaging waste is contributing to marine debris all of which can be minimised by increasing the weight and volume efficiency of packaging. In response to public's resource depletion and waste generation concern, international legislation has been introduced to ensure that producers become responsible and to minimise packaging waste disposed at landfills (Besch and Palsson, 2016).

In the furniture industry, Ikeas company's view of green logistics is firstly to remove the wooden pallets from the entire supply chain. Instead of wooden pallets they are using paper/cardboard pallets and the so called ledges (Saroha, 2014. Because of this approach they are dramatically decreasing transportation, CO_2 emissions and doing packing with less space than that required with normal wooden pallets.

As for the truck fleets, the current green logistics activities identified related to the logistics environment management, green storage and packaging, green transportation, fleet management, alternative fuel implementation and logistics innovation. The three most popular green logistics practices activities found were; choosing the right mode of transport, optimizing transport routes and monitoring vehicle driving mileage (Zhang, et

al, 2014) all of which contribute to energy and cost savings and promote sustainability. The analytical framework in Table 2.2 below captures one of the major activities of green logistics which is green packaging (Kumar, 2015), whose impact to the environment is related to product waste, logistics and packaging material (Besch and Palsson, 2016).

Table 2. 2: THE ANALYTICAL FRAMEWORK OF PACKAGING APPROACHES TO REDUCE ENVIRONMENTAL IMPACT

(Source Nilsson etal, 2011; Besch and Palsson, 2016)

Product waste-related	Logistics-related	Packaging material-related
Developing protective packaging.	Maximising fill rate under transport and storage.	Optimising material use.
Optimising apportionment.	Optimising unitisation.	Avoiding hazardous substances.
Developing user-friendly packaging.	Minimising cooling/heating needs.	Environmentally responsible sourcing of packaging materials.
Developing informative packaging.		Developing packaging for efficient reuse, recycling or recovery.

Under the given categories are different approaches to minimise the impact of packaging on the environment. These include; developing protective packaging, optimising apportionment, developing user-friendly packaging, developing informative packaging, maximising fill rate under transport and storage, optimising unitisation, minimising cooling/heating needs, optimising material use, avoiding hazardous substances, environmentally responsible sourcing of packaging materials, and developing packaging for efficient reuse, recycling or recovery (Besch and Palsson, 2016; Nilsson, et al, 2012).

There is also need for environmental certification as a strategy for reducing waste. Eves (2016) indicates that the real benefit of a program comes not from the certification on the wall, but from the positive behaviours that the process reinforces and organisations that have successfully completed the program journey find that it results, not only in efficiency in manufacturing processes, but also savings in physical and financial resources through energy conservation and reuse of raw materials. Even more, “the spirit of sustainability,

the attitude of efficiency, and the culture of continuous improvement, experienced by internal and external stakeholders alike, has a powerful effect on the long-term success of these organizations." (Eves, 2016)

2.6.4 Green Procurement

Green procurement refers to the sourcing of materials that does not compromise the environment. One of the sources which impact on sustainability is lack of quality raw materials, a negative impact which can be removed by quality checks and monitoring tools (Kumar, 2015). According to Construction Excellence (2008):

> *"the procurement of goods, services and buildings has traditionally been based on two overriding considerations: price and quality. However, the choices people make about what they buy and how they buy it can have a huge impact on all aspects of sustainable development. Sustainable procurement is not just a question of choosing the most environmentally friendly products but also about achieving the best possible value for money over the long term and should include economic and social, as well as environmental, considerations."*

Green procurement is done for financial, environmental, social and economic reasons. Investors together with the government have a duty to make efficient use of resources (Construction Excellence, 2008). Green procurement eases regulatory burden, reduces the life cycle cost of procured goods, reduces cost of waste, emissions and disposes less material, and improves employee productivity. Cost savings are realised if less material go to the landfill. Economic benefits lie in the creation of sustainable suppliers who recognise that goods with positive environmental aspects have a competitive advantage and those with negative environmental aspects have a disadvantage.

Green procurement reduces the negative human health, well-being and safety impacts of procuring and using goods and services. It creates sustainable consumption and markets for sustainable products. Collaboration in procurement and delivery of materials has its own economic and environmental benefits. Joint procurement means that parties enjoy quantity discounts and that economies of density are gained in the transportation of the materials (Bowersox, et al, 2010). The Just-In-Time method of delivery is the best strategy for waste efficient procurement.

“Engineers and scientists dealing with construction materials and geo-materials are required to understand their characteristics as well as their performance upon completion of construction. In order to ensure that materials are performing as expected and also to obtain the strength and compressibility of such materials to be used as input parameters in the design process, several types of laboratory tests are required to be carried out in a controlled environment” (DST Consulting Engineers, 2019). One of the requirements of the Construction Products Directive concerns “Hygiene, Health and the Environment”. It covers emissions from hazardous substances and their monitoring in places where construction products are used (European Concrete Platform, 2007).

Opponents of green procurement argue that it comes with huge environmental costs such as specialized storage space for hazardous materials, compliance with hazardous material regulations, employee exposure to hazardous materials, waste disposal costs and hidden costs borne by society.

2.6.5 Green Data Collection and Management

A recent study “SMART 2020”, conducted by the non-profit organization called The Climate Group, (2008) indicates that with support from new information and communication technologies up to 2020, it is possible to reduce carbon dioxide emissions worldwide by 15% and save 600 billion euros worth of energy (Albekov, Parkhomenko and Polubotko, 2017). Supply chains form the backbones of the world’s most successful products requires the newest technology to operate smoothly and efficiently. They have to be fast and agile to compete globally (Supply & Demand-Chain Executive, 2014). Fig 2.8 shows that the supply chain includes all the pillars of green logistics and transport includes activities such as tracking, freight optimisation and product delivered to end user on time and budget. It also packaging under assembly and marketing, warehousing under fulfilment, procurement and waste management under reverse logistics.

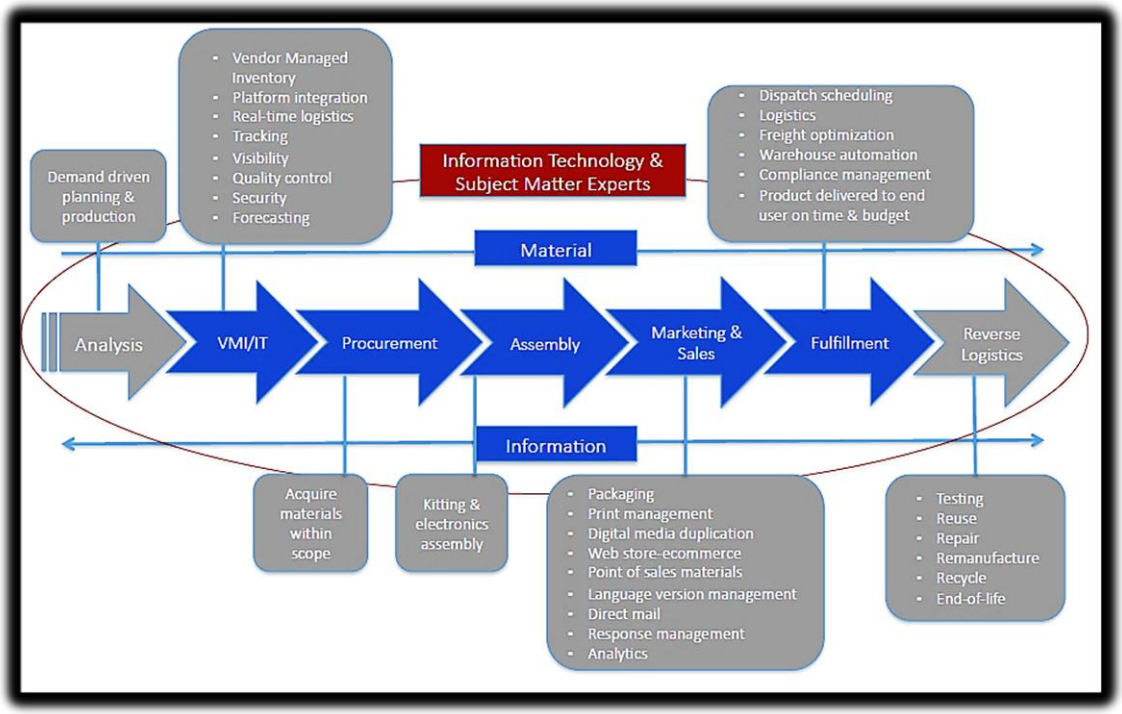

Figure 2. 8: SUPPLY CHAIN MANAGEMENT (SCM) IS ABOUT BIGDATA
Source: http://2020vet.com/what-is-a-supply-chain/

In order to maximise the performance of the whole green supply chain, much technical and information support such as decision-making support system, information management system and green evaluation system should be put in place. The challenge is how to get meaningful information out of the data. Furthermore, greening the supply chain can be seen as a common objective of all parties involved in terms of sharing information and developing the system. (Popovski, et al, 2009). Radio frequency identification (RFID), for example, can enable the gathering of data about environmental emissions and energy efficiency in different parts of the supply chain. Such information could be used in re-planning and re-designing of different processes in the supply chain as a whole with the aim of reducing resource consumption and GHG emissions (Popovski, et al, 2009).

Furthermore, in logistics, a trade-off between warehouse size and increased transportation needs to be evaluated and RFID can help in diagnosing different situations. Although the general logic has been towards decreasing stocks at different points, such philosophy leads to increased inventories in transport, which is affecting the environment negatively (Popovski, et al, 2009). RFID can enable significant reductions in logistic-related costs by eliminating unnecessary transportation and finding the optimal mode of transportation for

all shipping. This can provide significant carbon benefit and can be perceived as being "green", and thus contribute to the price of the product or the carbon tax of the product.

"Active RFID technology and systems can identify, communicate, update and process data and environmental characteristics such as time, temperature, shock, product location and weight on tags on remote products. Another advantage of RFID is the potential for information visibility and automation of information processing to all the participants throughout the supply chain" (Popovski, et al, 2009). Besides active and passive technology, RFID also use different frequencies for different purposes. Radiofrequency (RF) radiation includes radio waves and microwaves, is at the low-energy end of the electromagnetic spectrum. It is a type of *non-ionizing radiation* which has enough energy to move atoms in a molecule around or cause them to vibrate, but not enough to ionize (remove charged particles such as electrons). (American Cancer Society, 2019).

Modules such as Human Resource Management (SAP HRM), Production Planning (SAP PP), Materials Management (SAP MM) and Quality Management (SAP QM) speak to a number of green logistics initiatives discussed in this research. Decision support systems are effective right from the tendering process (Mohemad etal, 2010) to the engineering works (Zavadskas and Kaklauskas, 2004).

The use of paper for collecting and managing data contravenes greening the environment where the emphasis now is on paperless operations. Paper, as has been seen in green packaging contributes to the overall litter in the environment. Electronic waste or e-waste which includes cast-off electrical and electronic equipment is quite a fresh addition to the ever-growing hazardous waste stream. Developing countries are facing challenges related to e-waste generation and management, which are either internally generated or imported illegally causing serious threat to human health and the environment (Bortharkur and Singh, 2012).

2.6.6 Waste Management

Waste which can be reduced by establishing a waste recycling system comes from both consumption and production and the related logistical activities such as collection, classification, packaging, storage and distribution (Liu, 2013). Waste management is one of the green logistics practices which deal with the residue in the form of waste from

expired products and/or due to packaging. The negative impact of waste can be removed by engaging a waste contractor and practicing trade waste recycling (Kumar, 2015). A consideration of a reverse flow or waste management in the logistics function strengthens the competitive abilities of the company (Kenne, et al, 2012).

Waste management is one of the functions of reverse logistics and the former is becoming more important to enterprises because of the realisation that the recovery of disposed materials leads to a source of raw material requiring fewer resources (Rogers and Tibben-Lembke, 1998). Reverse logistics is associated with the return of damaged, unsold or returned raw materials, in-process inventory, and finished products (Cullinane, 2014). It important to note that companies send unused, faulty and recyclable materials back upstream of the supply chain to the manufactures in a process called reverse logistics (Sanchez, et al, 2018).

Waste management practices include waste quantification, waste segregation, and the implementation of 3Rs (reduce, recycle, and reuse) (Arif, et al, 2012; Harker, 2007). In Europe and Japan, attention is now given to the identification of waste streams as resources. The coordinated removal (reverse logistics) of waste can reduce vehicle movements and help to ensure reuse when possible and otherwise safe recycling or disposal (Mossman, 2008). This is another role for the logistics team and a potential source of income for a project. Over-packing is a major source of waste for the supplier who buys the packaging material, for the installer who has to remove it, and for the trade it obstructs and for removing it. Some companies are already working with suppliers and manufacturers to eliminate some or all packaging and to create re-usable packaging (Mossman, 2008) thereby controlling waste; which is one of the goals of green logistics.

2.6.6.1 Logistical Waste Management Techniques In Construction

Logistical waste management techniques used in construction include just-in-time delivery, demand smoothing, on-site marketplaces, pre-assembled and offsite fabrication, information and communication technology systems, inventory management optimisation and Construction Consolidation Centres (CCC) (Harker et al 2007) in Figure 2.9 below.

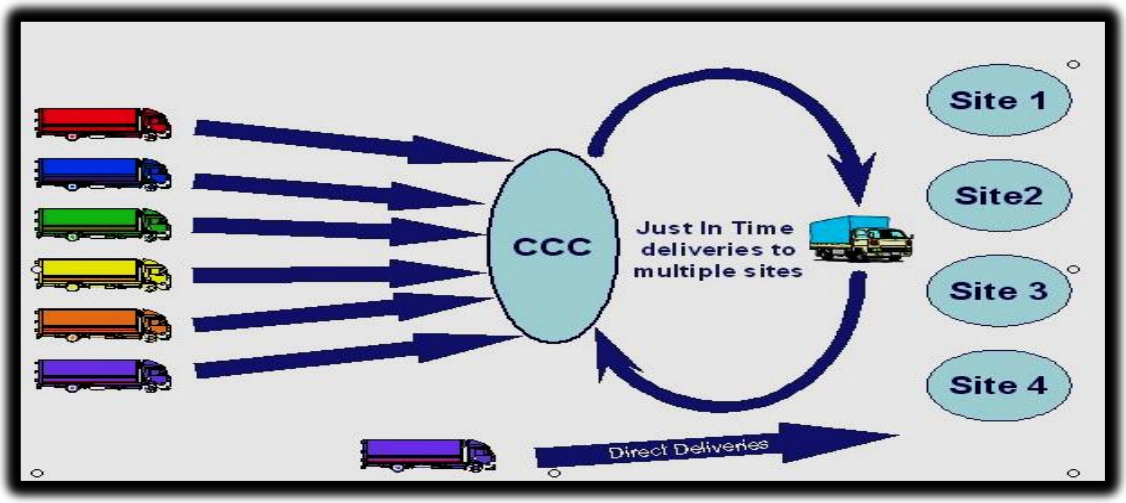

Figure 2. 9: CONSTRUCTION CONSOLIDATION CENTRES (CCC)

Source: Harker etal, 2007

The CCC's main benefits include improved certainty of supply, reduced site deliveries, reduced site stock holding and reduced waste and losses.

2.7 CHALLENGES OF ADOPTING GREEN LOGISTICS PRACTICES IN THE BUILDING CONSTRUCTION SECTOR

Major challenges associated with the implementation of green logistics practices include congested construction sites; sites in heavily built-up areas with no ability to have an alternative storage or staging location for materials; lack of ownership of waste due to the presence of multiple contractors on the construction site; and lack of awareness and education among the construction workforce (Arif, et al 2012). Other challenges include lack of information about the green logistics practices, lack of tools to optimise the supply chain with environmental management, and the advent of global sourcing make tracing of carbon footprint difficult (Palanivelu and Dhawan, 2010). On the social side the challenges include low literacy rates, poverty, cultural changes, indiscriminate and often irresponsible use of technology, lack of sufficient educational programmes at school and college levels and lack of research and development (Arif, et al, 2009) to promote green.

Challenges of sustainable construction in a global context include construction waste; excessive consumption of resources; adverse effect on the environment; time overrun

(construction schedule delay) and cost overrun (excessive budget) caused by lack of contractor's experience. They also include poor site management and supervision, inaccurate time and cost estimates, schedule delay, frequent design changes, fluctuation of prices of materials, cash flow and financial difficulties faced by scarcity of environmental experts. Furthermore, the challenges include lack of financial resources, inadequate stakeholder support, lack of top management support, government regulations, control mechanisms, troubleshooting mechanisms, information asymmetry, pressure from competitors and partners, lack of internal and external ICT skills and doubtful payback period (Azis, et al, 2012; Isaksson and Huge-Brodin, 2010; Berns, et al, 2009).

The above challenges are derived from the environment itself, the nature of the product being produced, and the external and internal business environment. The adoption of green logistics practices remains a challenge without ICT skilled personnel to assist with setting up systems which can help with enabling waste management, green procurement, green packaging, green transportation and green warehousing (Kumar, 2015).

The construction of buildings and infrastructure affects the environment in mainly two ways, that is, by consuming resources and by creating pollutants and wastes. The major issues experienced in construction projects include construction waste, excessive resources consumption, adverse effect to the environment, construction schedule delay and excessive budget (Asmi, et al, 2012). The industry contributes 23% of air pollution, 50% of climate change gases, 40% of drinking water pollution and another 50% of landfill wastes (Salih, 2013). So, the environmental issues include waste management, energy and water, emissions to air, discharges to water and land, use of raw materials, and environmental planning.

Companies coordinate their logistics activities comprising freight transport, warehousing, packaging, materials handling and data collection and management to meet customer requirements at a minimum cost (Nowakowska-Grunt, 2008). All the above are profit making activites. The current situation is that the environment has become a concern and is treated as a factor of the cost. Some companies have already taken external costs of logistics associated especially with the environmental issues such as climate change, pollution and noise into account (Kumar, 2015).

As previously indicated, green logistics is made up of two words green and logistics and showed that the green and logistics are in conflict with each other. Logistics are used to manage its different activities strategically through cost minimization but this cost minimization comes at the expense of the environment (Rodrigue, et al, 2012). Thus there is a kind of paradox between the "green" and "logistics" which becomes a challenge to the enterprises. These paradoxes occur in the following key areas: Cost (cost effective operations versus going green); time/availability (integrated supply chains and JIT versus extended production, distribution and retailing models); network (increased efficiency of the system versus concentration at major huns and along corridors impacting local communities); reliability (delivering freight on time with the least threat of breakage or damage versus slow and least polluting modes). They also include warehousing (a reduction in warehousing demands versus inventories actually in transit); and e-commerce (changes in physical distribution systems by e-commerce versus higher levels of energy consumption) (Kumar, 2015; Saroha, 2014 and Gechevski, et al, 2016). The above paradoxes or war between green and logistics discourage small enterprises from going green.

Other challenges of green practices include lack of information about the green best practices; lack of tools to optimize the supply chain with environmental management; and global sourcing. These challenges make tracing of carbon footprint difficult (Palanivelu and Dhawan, 2010). In a study conducted by Rensburg (2015), the respondents rated lack of knowledge and experience as the main barrier for implementing green logistics practices.

Emerging markets such as South Africa, India and China, are characterised by government’s lack of maturity; planning horizon often limited by legislative period, high inflation rates, poverty and inequality (underdevelopment of rural areas), high cost of technology and low logistics performance indexes (Thiell, 2013). The governments, enterprises and consumers still do not have a clear idea about effective coordination and internal connection of the logistics systems (Zhang and Wang, 2015). Emerging markets (Thiell, 2013) are also challenged by political, legal, economic, social as well as technological and logistical systems.

In China, the logistics infrastructure has been greatly enhanced although it is not commensurate with the country's economic development (Zhang and Wang, 2015) and with developed countries in Europe and the United States. The improvement of logistics operation efficiency and service quality is restrained particularly by the severe shortage of logistics-of-talents (Zhang and Wang, 2015).

Generally, it is becoming apparent that the implementation of sustainable logistics policies is fraught with 'green-gold'challenges which make the policies good for the environment and business. One example is fuel efficiency gains from better fuel usage monitoring. However, some sustainability interventions are not directly cost effective and may require substantial investment with little financial benefit, which compels the management team to decide on the best practice for the company (Cullinane, 2014) taking into account the other company objectives. Some of the challenges faced by companies in adopting green logistics practices such as green packaging emanate from lack of internal and external collaboration and lack of guidance on how to handle the trade-offs between marketing, production, purchasing requirements, varying supply chain conditions and customer demands. (Besch and Palsson, 2016).

In a study that diagnosed problems of implementing the concept of green logistics in Lithuanian road freight transport enterprises, Vasiliauska, et al, (2013) realised that policy documents pertaining to sustainable development of transportation exist but do not address the implementation of green logistics. They also faced challenges such as lack of practical and theoretical models aligned to road freight which can then be used for implementing the green logistics that embraces all the elements of the triple bottom line.

Other challenges specific to green procurement include life cycle cost calculations; separation of budgets between capital and operating costs; lack of commitment from senior management; and organisational change. They also include perception of higher price for sustainable products; lack of specifications or knowledge; insufficient market; environmental claims and many more (Wilde, 2007).

2.8 CAUSES OF CHALLENGES FOR ADOPTING GREEN LOGISTICS PRACTICES

In their study of green packaging, Besch and Palsson, 2016 realised that gaps between theory and practice exist within companies. Their first proposition was that the theoretically suggested approaches are not being fully utilised but instead, practices focus on clear economically beneficial approaches. This then implies that sustainability can only be a success if economic gains are realised (Verghese and Lewis, 2007). The issues of cost, time, reliability and warehousing (Saroha, 2014; Kumar, 2015; Gechevski, et al, 2016) were also found to be contributing to challenges for adopting green logistics practices by large construction companies because the companies maximise profits but minimise green logistics (Ozanne, et al, 2016). The other source of the challenges was found to be lack of collaboration, marketing requirements and varying supply chain conditions which are the general barriers to green logistics practices (Besch and Palsson, 2016).

Sustainability has been found to be another challenge as far as the implementation of the triple bottom line is concerned; which demands the balance between economic, social and environmental elements. Smith and Lewis (2011) found that there was lack of balance between these interrelated demands. When viewed separately, the contradictory elements seem very rational but the moment they are brought together they cause a conflict of interest (Smith, Binns, and Tushman 2010). These are not trade-offs as other scholars argue but interrelated contradictions and inconsistent tensions which companies face in the quest for achieving sustainable goals (Van der Byl and Slawinski 2015). The causes of challenges for adopting green logistics are therefore summarised as follows;

- Maximisation of profits versus green logistics practices
- Lack of collaboration
- Marketing requirements
- Varying supply chain conditions
- Sustainability demands

The implementation of green logistics practices may need to follow particular steps as indicated in Fig 2.10 below:

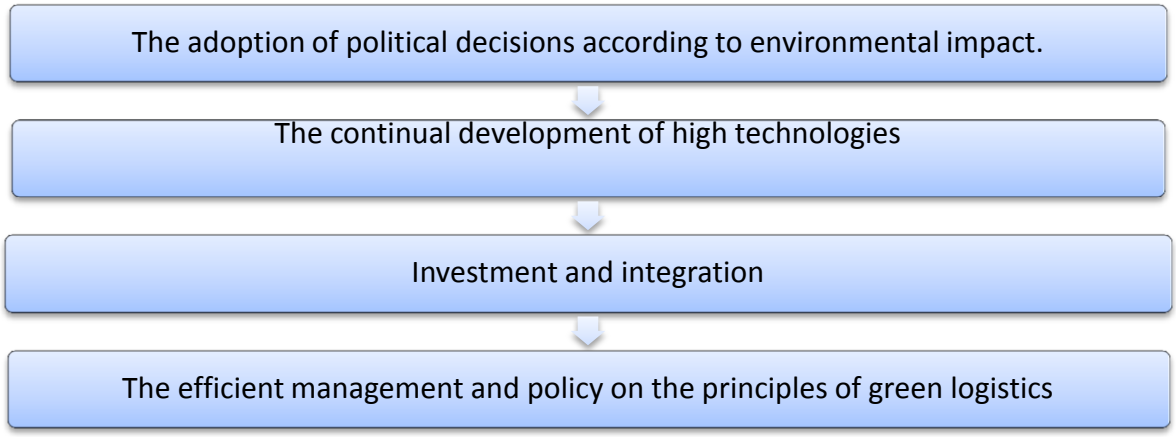

Figure 2. 10: STEPS IN IMPLEMENTING THE CONCEPT OF GREEN LOGISTICS

The implementation of green logistics concept requires certain actions at the company level which include the reengineering of components of logistics systems in accordance with the environment and social factors; and the rejection of services provided by suppliers who do not cater for environmental problems. Other actions include the training of staff; collaboration with governmental institutions; public reports about the initiative and success of the company in the field of environment protection; the audit of environment control; collaboration with foreign countries in the field of environment protection; and the promotion of social responsibility among the employers (Murphy and Poist, 2003).

2.9 PROSPECTS OF GREEN LOGISTICS PRACTICES

The objective of green logistics is to provide economic and ecological benefits which include time-space transformation (Pfohl, 2004). This definition disregards the need to take into account both the customers to whom this transformation good is addressed, and others who actively and passively participate in the movement. Green logistics can thus become an attractive source of new opportunities and of the development of new competencies for the purpose of creating added value in the “green supply chain” (Jedlinski, 2014). For example, China could learn from other developed countries to establish the concept of green logistics; accelerate infrastructure construction; develop multimodal greatly and establish green logistics recycling network system (Xiu and Chen, 2012) all of which contribute to cost savings.

Environmental benefits of green logistics best practices include energy reduction, reduced packaging, reduced GHG emission and waste reduction (Palanivelu and Dhawan, 2010; Rensburg, 2015; Saroha, 2014; Gechevski, etal, 2016; Azis, etal, 2012). In a study conducted by Rensburg, 2015, the respondents rated improving fuel efficiency as the main benefit for implementing green logistics practices. This benefit was found to be encouraging companies to implement green logistics practices. Business benefits of green logistics best practices include distribution efficiency, compliance, risk management, differentiate services and distribution cost (Palanivelu and Dhawan, 2010).

Many businesses today are on the lookout for smart ways of easing supply chain waste and carbon impact. Over the next several years, there are trends which could transform logistics operations. Hopefully green logistics will facilitate creative and collaborative planning between emerging markets, industry, government and civil society working together to design regulations that enable positive change and good business, green rail and air initiative; 3D-printing use, e-commerce expectations, automated vehicles, the move to closed-loop manufacturing and growing consumer awareness (Clary, 2013). According to the State of Hawaii Department of Business, Economic Development and Tourism (DBEDT, 2015), evidence from the London Construction Consolidation Centre (LCCC), suggests that, in a dense urban environment, logistics planning is good for the environment. In many cases, the resulting beneficiary is not just the environment but can also be the financial bottom line as environmental accounting can often lead to efficiency gains to the logistics operator and the consignors themselves (Cullinane, 2014).

By taking full advantage of new technologies, construction companies are able to turn waste into valuable resources. According to Defra (2007), companies should look at ways to increase trade waste recycling and the waste should be processed via new technologies such as mechanical biological treatment. Lots of waste is produced in construction logistics. Murphy and Poist (2000) found that the green logistics strategies of recycling materials, reducing consumption and reusing materials were universally popular among western industrialised nations.

It should be noted that waste management plans have gained improved attention under the concept of a circular economy (EllenMacArthurFoundation 2017; European Commission 2015; Ghisellini, et al. 2016). The attention is not only ascribed to the circular economy's

probability to increase resource efficiency of the economic system, but also to its economic plea as circular approaches are intended to conserve the residual economic worth of resources (Cooper and Gutowski 2017). Companies in a circular economy can profit from resources' residual value by initiating value-adding activities around sustained useful life of resources (Bakker, et al. 2014). To grab these economic and environmental benefits, the construction sector has been recognised as one of the three high-potential sectors (EllenMacArthurFoundation 2017). However, moving the construction sector towards a circular economy requires systemic innovation throughout the value chain (Ness and Xing 2017). The resources recovered at the end-of-life need to be re-integrated into the value chain. To realise this, companies need to collect and recover components and materials in sufficient quantity and quality in an economic manner.

The construction sector is one of the world's largest waste generators. The circular economy appears as a helpful solution to diminish the environment impact of the industry. The UK green Building Council (UKGBC) has published the circular economy guide for the construction sector which is helpful for those in the supply chain looking to support construction clients on their journey concerning specifying and practically applying circular economic principles (UKGBC, 2019). The African Circular Economy Network in Fig 2.11 is also envisioning a circular continent with several countries already establishing sustainable and environmental roadmaps, operating single use plastic ban, setting up e-waste decrees and formulating green economy plans (African Circular Economy Network, 2019).

China's intensified efforts to develop green logistics provide important opportunities for dealing with future challenges and seizing advantages amid competition. One of the efforts include establishing the brand new operation philosophy of green logistics through improved government laws (Zhang and Wang, 2015). The country could also accelerate the public infrastructure planning and construction in green logistics through the government attaching great importance to utilisation and modification of current logistics infrastructure.

Opportunities to minimise negative impacts along the supply chains vary from one jurisdiction to another. These include local packaging adaptation which addresses transport, waste management and handling conditions. Unfortunately companies are not

taking full advantage of such (Besch and Palsson, 2016). However, the effectiveness an internationally standardised packaging from an economic perspective can be evaluated case by case (Nilsson, et al, 2012).

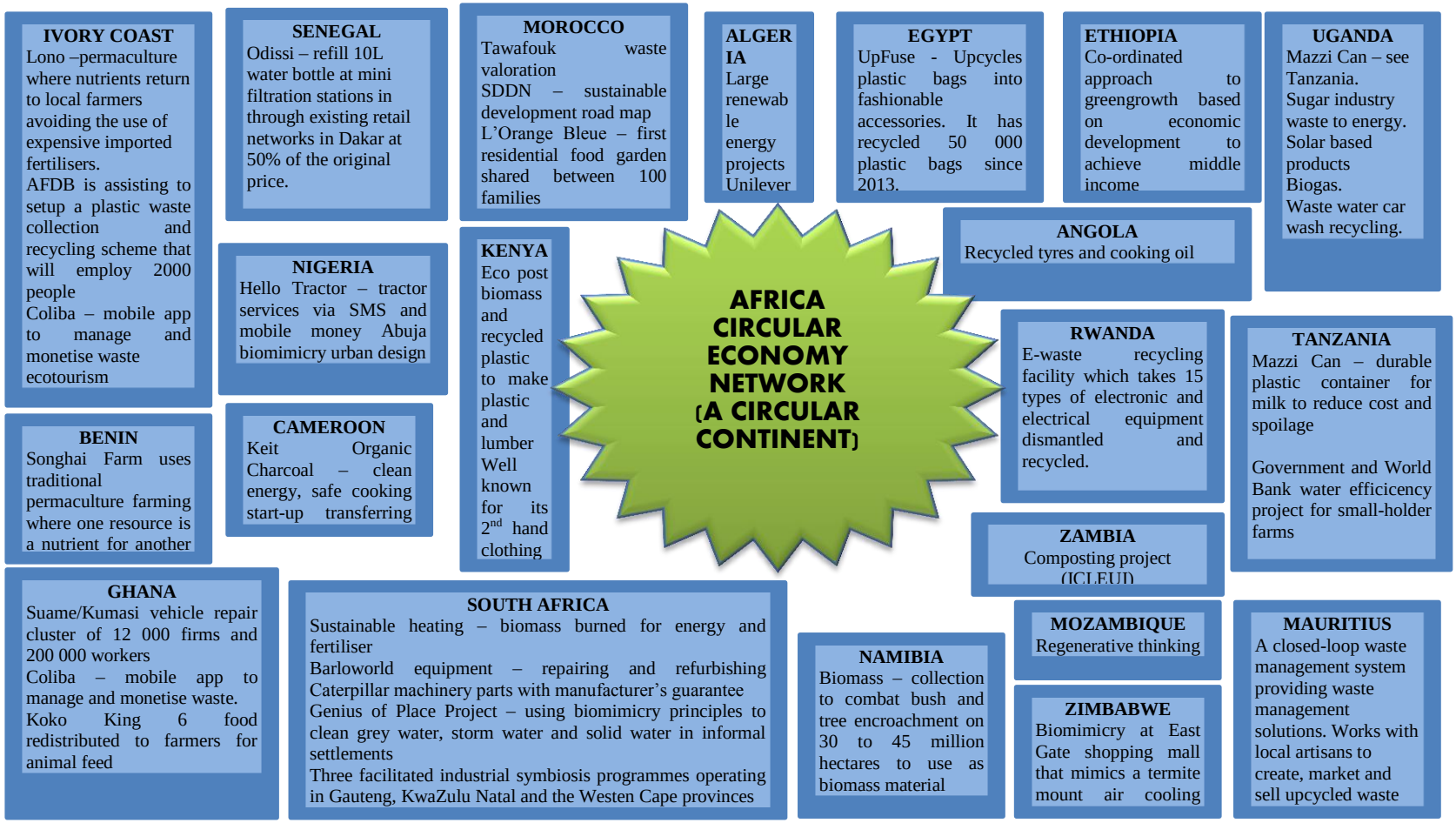

Figure 2. 11: AFRICA CIRCULAR ECONOMY NETWORK

Source ; Author, 2019 Adapted from Africa Circular Economy Network Map 2019)

Going green requires an upfront investment that more companies are finding worthwhile (Pointus, 2017). It does not cost much to start a reuse and recycle initiative. Other efforts such as energy-efficient lighting alternatives and equipment, are to a large extent initially costly but cost effective in the long run. It could therefore be argued that if a warehouse operation is not as eco-minded as it should be, an audit could be coordinated to identify eco-friendly initiatives that could save the company's money but at the same time benefit the environment (Pointus, 2017).

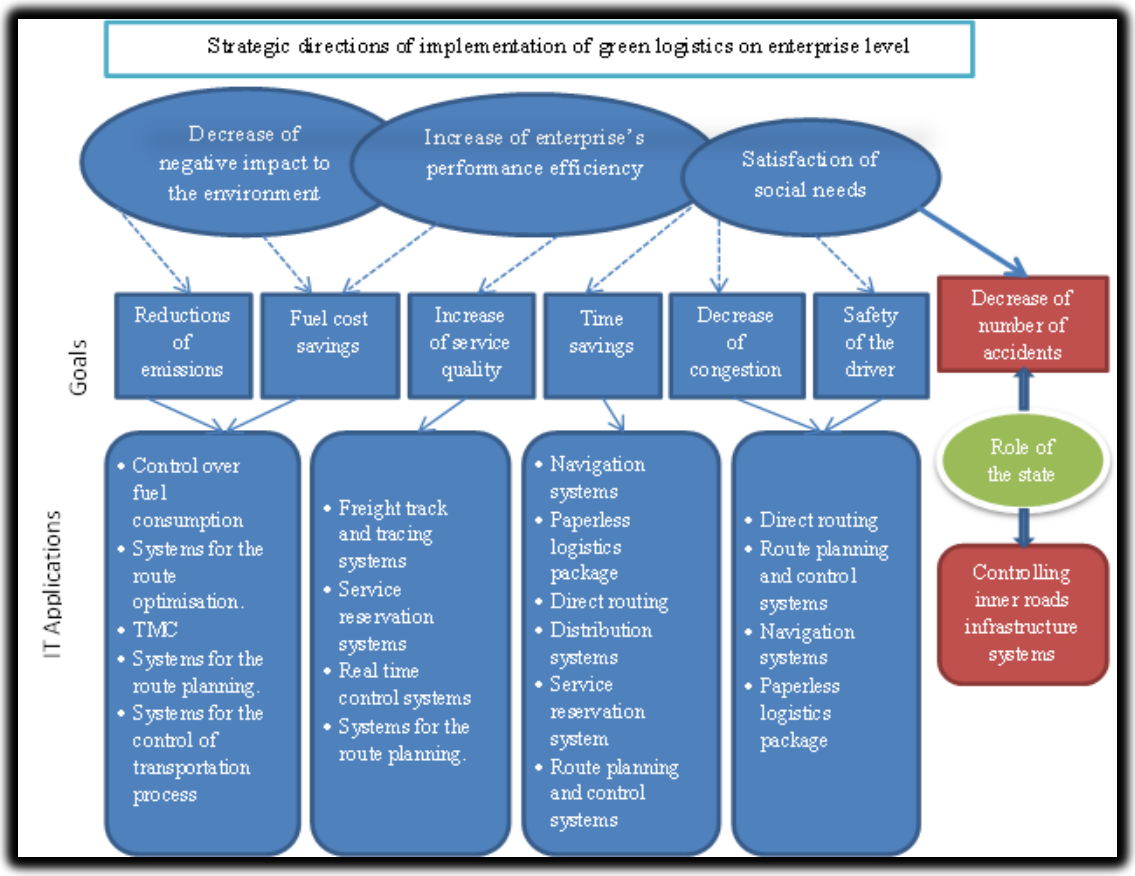

Figure 2. 12: STRATEGIC DIRECTIONS OF IMPLEMENTATION OF GREEN LOGISTICS ON ENTERPRISE LEVEL

The three strategic goals of sustainability should be followed in the implementation of the green logistics concept. There is also need for a clear strategy model such as the one in Fig 2.12 that provides an opportunity for decision makers at enterprise level (Vasiliauskas, et al, 2013). The model covers the factors affecting implementation, the implementation process and the prospects of adopting the concept of green logistics. These include reduced emissions, fuel cost savings, increased service quality, time savings, decreased congestion, driver safety and a decrease in the number of accidents.

The paradox theory approach is a source of motivation and provides opportunities for the implementation of green logistics concept in companies. Ozanne, et al, (2016) devised three themes which indicate that firms can manage tensions (Smith and Lewis, 2011) as they arise (Jay, 2013). Theme 1 outlines the four tensions propounded by Smith and Lewis (2011) viz.belonging, performing, organising and learning. Theme 2 suggests how these tensions can be made salient by public policy through creation of plurality, scarcity and change conditions; while theme 3 suggests that the companies' response to the tension can create conditions of certainty, abundance, and stability. These three themes together create a balance in the demands of the triple bottom line. (Ozanne, et al, 2016). All the above suggest that it is possible to adopt the green logistics. One of the key barriers to achieving a more sustainable logistics is the belief that it will always be costly. However, in many cases costs can actually be cut by increasing resource efficiency, reducing waste, and promoting innovative new products.

From the above discussion it can be concluded that there are a number of prospects that companies can pursue by adopting green logistics practices. Some companies have begun to implement proactive environmental protection measures such as reporting environmental information that go beyond the basic commitments (Liu and Anbumozhi, 2009) in order to achieve higher environmental goals. As a starting point, large companies can determine the sustainability phase in which the company currently is. The first phase is rejection, the second phase is non-responsiveness, the third phase is compliance, the fourth phase is efficiency, the fifth phase is strategic pro-activity and the sixth phase is the sustainable corporation (Rensburg, 2015). It is recommended that unlike large companies, SMEs should aim to implement practices that are rated as very important but easy to implement (Rensburg, 2015).

2.10 CHAPTER SUMMARY

The literature reported in this chapter has revealed that environmental protection is becoming crucial for enterprises because of stronger public awareness, competitors and communities, and government regulations. The role of logistics in environmental protection is particularly important because it is an art of conflict management. However, to achieve entrepreneurial goals does not require for example the reduction in road

transport, or increased environmental taxes. It also requires a decision and definition of the parameters of logistics activity based on the general indicators of sustainable development. The way companies respond to the turbulent environment is influenced greatly by the attitudes of customers and equity holders (Ambec and Lanoie, 2008) because their expectations, preferences and requirements determine the company's competitiveness (Gadenne, et al, 2009; Siegel, 2009). Equity holders mostly request sustainable performance and risk reduction (Ambec and Lanoie, 2008) and such requests prompt companies to adopt environmental practices (Sarkis, et al, 2004). The literature gives a clear idea of how complicated the implementation of green logistics practices can be and without collaboration between business, the society and the government, the complication can only be magnified.

CHAPTER 3

3 RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter describes and justifies the design, paradigm, sampling, and data collection methods used to conduct this study. According to Kothari (2004), the methodology of a research involves a plan for the achievement of identified goals, and outlines a methodical process for the effective use of the necessary tools. This chapter also discusses the role of the researcher in qualitative research in relation to reflexivity.

The interpretative research paradigm (Cohen and Manion 1994) was adopted in this study to examine the nature and extent of green logistics practices implemented by large construction companies in Botswana, as well as, to investigate the opportunities and challenges experienced by these companies. A qualitative research approach using in-depth interviews with project managers of the identified large construction companies in Botswana was used in this study. Furthermore, the explanatory research allowed the researcher to provide deep insight into a specific subject, which resulted in more issues being unearthed and in more opportunities becoming available for the researcher to study and anaylse emerging themes (Hair, Bush and Ortinau, 2006).

Project managers from the selected 15 large construction companies in Botswana were interviewed to examine the nature and extent of green logistics practices in large construction companies in Botswana. Thematic analysis was used to interpret the results derived from the interview schedules under the guidance of Maguire and Delahunt's guideline (2017). Thereafter, a comparative analysis was done between the results obtained from the interview schedules and the literature review on green logistics. The findings are presented in frequencies derived from sub-themes or categories created from the results.

3.2 RESEARCH PARADIGMS

A paradigm is an entire collection of principles, values and common techniques used by a controlled communal (Kuhn, 1962), and in research such principles and values inform the way the study is conducted. Lincoln and Guba (1994) extend this definition by adding that

a paradigm guides the scholar during research on the selection of research techniques and on the ontology and epistemologically essential methods that the researcher can use in the study. In brief, a paradigm is a philosophical stance consisting of ontological, epistemological and methodological assumptions which guide a research perspective and the fundamental role the researcher plays in any scientific inquiry or investigation (Lincoln and Guba, 1994). Furthermore, Lincoln and Guba (1994) claim that paradigm issues are critical and no researcher should conduct an inquiry lacking a vivid understanding of what model enlightens and directs his or her approach. Numerous paradigms that guide research according to Lincoln and Guba (1994),include interpretative, positivism, constructivism, critical theory, and realism. For this study, the interpretative research paradigm was adopted by the researcher as indicated in the next section.

3.2.1 Justification of the Interpretative Research Paradigm

This study employed an interpretative research paradigm which enabled the researcher to view the interviewee's narrative against the context in which they existed. Cohen and Manion (1994) infer that interpretivist research paradigms help researchers to understand the world of human experience by analysing their opinions and views. According to Willis (2007), interpretivism usually seeks to subjectively understand a particular context, and believes that reality is socially constructed by those experiencing it. In this study the researcher examined the nature and extent of green logistics practices in large construction companies in Botswana, and the challenges and opportunities they experienced in adopting green logistics practices in the country.

3.3 RESEARCH DESIGN

A research design is defined as a plan and structure of a study that indicates how answers to the research questions are going to be obtained (Cooper and Schindler, 2006). A majority of research aims are attained simply through applying any of the exploratory, causal or descriptive research designs (McDaniel and Gates, 2014). This study methodically employed an explanatory research design which was complimented by a qualitative research approach to examine the nature and extent of green logistics practices in large construction companies in Botswana.

Prior to selecting a research design for this study, the researcher explored all designs and their applicability to this study. Furthermore, the researcher selected from amongst various methods such as, a case study, a survey, secondary data model or an experiment research (Hair, Bush and Ortinau (2006). This study adopted a survey method where participants from 15 large construction companies in Botswana were subjectively selected to participate in in-depth interview schedules. The utilisation of explanatory research methodology helped the researcher to gain an indepth understanding of the problem under study more effectively. It allowed the researcher to reconnoiter the research with varying levels of depths and to determine how and why things happen from the participants' perspectives. Furthermore, it allowed the researcher to provide deep insight into a specific subject, to discover more subject issues and to do more research.

3.4 QUALITATIVE RESEARCH APPROACH

Denzin and Lincoln (2005) indicate that a research methodology or strategy is determined by the nature of the research questions and the subject being investigated. There are two types of research approaches viz. quantitative and qualitative research approaches. This study sought to explore and understand the meanings constructed by the participants in relation to the problem under study. To that end, a qualitative research approach was employed to reinforce an understanding and interpretation (Schwandt, 1997) of how construction companies in Botswana interact with the environment. The data for this study was collected using in-depth interviews. Denzin and Lincoln (2005) describe qualitative research as a multifaceted research method involving an interpretative, naturalistic approach to subject matter which explores respondents' opinions. Meyer (2001) posits that qualitative research allows the researcher to provide a description of the experiences of the participants, which either sustains or confronts the theoretical assumptions on which the study is based.

The current research employed an inductive qualitative approach, and the rationale for its selection was based on the fact that the purpose of this study was to explore the views and opinions of the project managers on the nature and extent of green logistics practices in the large construction companies in Botswana. According to Readings (2006), qualitative methods are typically more flexible and allow greater spontaneity and adaptation of the

interaction between the researcher and the study participants. Qualitative research methods are also helpful as they give more opportunities to the respondents to respond more elaborately and in greater detail than is typically the case with quantitative methods that require closed questions (Mohajan, 2018). As echoed by Readings (2006), open-ended questions in the qualitative research give the participants the opportunity to respond in their own words, elaborately, rather than force them to choose from fixed responses as quantitative methods usually do (Readings, 2006).

3.5 POPULATION OF THE STUDY

Ary, et al, (2010) define population as the larger group of all members of any well-defined class of people or objects about which the generalization is made. According to PPADB, 2015 database, there are more than one thousand construction companies registered on the database in Botswana. These are categorised in Table 3.1 according to the tender threshold, that is, Grade OC, A, B, C, D and E with the last two being the ones comprising of the 32 largest construction companies who embark on projects of BWP85 million+.

Best and Khan (2003) refer to a target population as any group of individuals that shares one or more characteristics that are of interest to the researcher. For this study, the target population consisted of 32 companies in Grade D and E and these are indicated in Table 3.1. These companies were selected as the population because green initiatives are recognised more by large corporates who are able to at least allocate a separate budget for such, compared to small companies which occupy Grade OC, A, B and C.

Table 3. 1 CONSTRUCTION WORKS FOR LARGE CONSTRUCTION COMPANIES IN BOTSWANA

Roads and bridges	Infrastructure macro and building construction	Airfields and aerodromes	Water supplies and storage tanks	High-rise buildings and Pre-fabricated buildings	Dams and irrigation
Kalcon	Murray and Roberts Botswana	Asphalt Botswana	Excavator Hire	Stefanutti stock	Bash Carriers
Landmark Projects	Cul de Sac	Kopano Building Construction	Lempehu Investments	MIDO Construction	Magara Building Construction
Group Five Botswana	M.P.P. Construction	ZAC Construction	Phangastin Projects	UNIK Construction	ZhengTai Group
China Civil Engineers	Katz Holdings	WBHO	Mason Group	COMPLANT Botswana	China Jiangsu International
China Railway Services	Rockefeller	Josnadliz.	Thiite Rubble	Colic Construction	Evolution Engineers
		Hitecon			Concor

Source: Author, 2019
(data drawn from PPADB: 2015)

3.6 SAMPLING TECHNIQUE AND SAMPLE SIZE DETERMINATION

Kumar (2005) defines a sample as an idealistic sub-group of the population that represents the entire population. Zikmund (1991) argues that researchers usually fail to make direct observations of every individual in the population under their study due to larger population or limited time and insufficient funds. Thus, this prompts them to collect data only from a representative sample and make inferences from those observations about the entire population. Non-probability sampling was subjectively employed in this research. In this type of sampling, "every unit of population does not get an equal chance of participation in the investigation since the selection of the sample is made on the basis of subjective judgment of the investigator" (Alvi, 2016). In addition, the researcher used the snowballing technique sampling to select respondents who possessed knowledge and expertise in line with the subject of this study. This sampling method creates "biased samples because respondents who have great number of social connections are able to provide investigators with a higher proportion of other respondents who have characteristics similar to that initial respondent" (Etikan, Alkassim and Abubakar, 2015). This was done to improve accuracy and reliability of the findings of this study. Furthermore, the respondents were purposively selected in this study, as guided by Etikan,

et al, (2015), because of their expertise as compared to other construction employees who are not aware of the subject area of the study or green logistics.

The interview sample size was determined through the method of saturation which is the point at which accumulated data stops providing any new information (Glaser and Strauss, 1967; Grady, 1998; Urquhart, 2013; Given, 2016). The researcher probed the interviewees' in-order to fully understand their perspective with regard to green logistics. The moment the researcher felt that the comments were becoming repetitive she stopped collecting data as that was an indication of data saturation (Cleary, 2014; Saunders, et al, 2017). The interview respondents were also purposively selected in order to facilitate the generation of noteworthy comprehensions necessary to increase a deeper understanding of the research phenomena. Therefore, the sample was subjectively restricted to project managers who had knowledge of green logistics.

3.7 DATA COLLECTION INSTRUMENTS

Guided by Mathers, et al, (2002), the data for this study was collected using semi-structured in-depth interview schedules which allowed the interviewees to further explain their opinions through open ended questions. Furthermore, within the tradition of qualitative research perspective, there are three broad categories of data collection viz. participant observation; interview; and documents review (Mouton and Marais, 1991).

The interview method was used in this study because, as Braun and Clark (2006) highlights, interviews have become a commonly used qualitative methodology for collecting data. In-depth interviews were conducted using a guide in Appendix B to establish sentiments and attitudes towards green logistics. The participants were individually interviewed by the researcher in a private and quiet room at their work place premises within a period of three weeks. The fact that the researcher was the data collector ensured efficiency since she is familiar with the subject matter. The result was that the interview process saved time and ensured full responses on all the interview questions.

The efficiency of the interview method is noted by Potter (1996) who argues that interviews are valuable and advantageous tools for collecting data in qualitative

research. A one-on-one face to face interview method allows the researcher to easily strike rapport and to interact with the participants. It also allows the researcher to observe non-verbal cues during the interview process (Oltmann (2016). Furthermore, Denzin and Lincoln (2005) argue that an in-depth interview allows the researcher to understand the complexity of the situation without imposing any prior categorisation.

The interviews conducted in this study therefore allowed the researcher to gain a deeper understanding of the participants' ideas and perceptions through interchange and the language they used in constructing their discourse. The interview method further allowed the researcher to seek clarity and probe for deeper understanding in cases where the respondent could not give detailed responses. Before the interview an explanation of the area of the study and the nature of the interviews was provided. Thereafter, a comparison was done between the results obtained from the interview schedules and the literature review. Appendix E shows the structure of the interview guide with the themes used to gather data from the respondents.

3.8 DATA PRESENTATION AND ANALYSIS PROCEDURE

Thematic content analysis was used to analyse the interview data; to establish key themes; and to interpret them. This method of analysis consists of five steps, namely: transcription, checking and editing, analysis and interpretation, generalisation and verification (Sarantakos, 2005). In this study the recorded interviews were transcribed by the researcher. During data transcription sub-theme(s) were identified and recorded and tabulated. White, et al, (2012) describes thematic analysis as a method for identifying, analysing and reporting on patterns within the data. Saunders, et al, (2017) further notes that qualitative analysis involves discovering themes from the interview transcripts. Furthermore, Braun and Clark (2006) indicates that once the themes have been selected, a valid argument for choosing the themes is built.

Overall, in this study, the data was processed and categorised using the thematic content analysis. The data was grouped first by domain; second by identifying core ideas or themes from each domain; and third, by sub-themes or categories. The last column on Appendix F

shows the participants' responses according to themes. Themes or categories for one participant are labeled *Rare*; for two to six participants are labeled *Variant; for* seven to eleven participants *Typical*; and for twelve or more participants *General*. The frequencies of the responses in each category or sub-themes were then used to analyse the qualitative data of the study.

3.9 RESEARCH MANAGEMENT AND ETHICAL CONSIDERATIONS

3.9.1 Ethical Considerations

Kasambira (2014) indicates that ethical considerations are set standards, values and principles of good within the society. The respondents were made aware of the aim of the study and the possible risks and benefits associated with the project so that they could make informed consent. To ensure that their rights were not trampled upon, the participants were informed that their participation and involvement was voluntary; hence, each participant was given a chance to decline or to participate in the study. In line with Lincoln and Guba, 1985 and Yin, 1994, the participants were informed that they had the right to withdraw from the study without any fear of prejudice. The potential respondents were therefore requested to sign the consent form to indicate that their participation was voluntary. This study was therefore ethically approved by the UNISA Ethics Review Committee as shown by Appendix C to ensure that it met all ethical considerations to be done on human subjects.

3.10 STRATEGIES FOR ENSURING TRUSTWORTHINESS IN QUALITATIVE RESEARCH PROJECTS

This study utilised four main strategies employed in qualitative research to ensure the trust worthiness of the research and to set guidance for quality assurance as indicated in subsequent sub-sections.

3.10.1 Credibility

Credibility refers to developing internal consistency and showing the readers the way of maintaining thoroughness or rigour (Lincoln and Guba, 2000). To ensure credibility in this

study, the procedures for administering the research instrument and for analysing the data analysis were derived from those that had been successfully utilised in previous logistics studies. As guided by Merriam (1998), before data collection was done the understanding of the culture of the organisations in this study was sought through consultation of appropriate documents and reconnaissance visits to the organisations.

3.10.2 Dependability

A research study should be consistent across time, researchers and analysis techniques (Lincoln and Guba, 2000) as the consitency enables a future researcher to repeat the work and to the same outcomes. In-depth reporting allows the reader to assess the extent to which appropriate research practices have been followed. The research report includes sections which are dedicated to the research design and its implementation; the operational detail of data gathering and reflective appraisal of the research project (Fidel, 1993; Marshall and Rossman, 1999; Flori-Ruane, 1991).

3.10.3 Conformability

Conformability addresses the notion that the researcher should focus on the situation and opinions of those that are being researched rather than on her pre-supposition and beliefs (Lincoln and Guba, 2000). Therefore, this study focused on the research questions, the research discoveries, and the experiences and ideas of respondents as opposed to the researcher's inclinations. The beliefs supporting the research paradigm and methods of data collection for this study were acknowledged (Patton, 2002; Lincoln and Guba, 1985). Furthermore, a detailed explanation of the methodology of this study enabled the readers to conclude how far the data and constructs emerging from the study may be accepted.

3.10.4 Transferability

Transferability refers to the generalisability of current findings and to the comparable context and backgrounds of the study (Lincoln and Guba, 2000). Research highlights that enough information about the study should be collected to enable transfer of information by the reader. Therefore, a sufficient description of the data collection methods allows readers to understand the methods; thereby enabling them to infer the findings to similar

situations or to use same methods under different locations and to acquire similar findings that would allow generalisation of the same. This allows researchers to match instances of the phenomenon described in the research project with those that they have seen in their situations. For example, in relation to this study, further information was given before transference to guide the reader about the number of organisations taking part and their locations; restrictions in the type of participants; sample size; data collection methods; duration of data collection sessions (Stake, 1994; Denscombe, 1998; Gomm, Hammersely and Foster, 2000). This was intended to provide the reader with the boundaries of the study.

3.10.5 Authenticity

McLaughlin, (2001) indicates that evidence is regarded as being authentic if it is real, genuine and there are elements of truth in it. According to Schwandt (1997), five categories of authenticity include fairness, ontological, educative, catalytic and tactical authenticity. To allow for authenticity in this study, the researcher solicited the participants' different ideas and core values and presented them in a balanced and unbiased way. She also ensured that the participants' own constructions were enriched and made more informed through their involvement in the research. The research process was designed in such a way that it encouraged and facilitated the participant's behaviour.

3.11 LIMITATION AND DELIMITATIONS OF THE STUDY

The limitations of this study included limited time, fear of participation, confidentiality, lack of anonymity, and discomfort since the interviews were conducted face to face. The construction industry is a very busy industry, something which the researcher observed and noted during the data collection process. The participants hardly had time for interviews and to address this, the researcher secured official appointments with the targeted participants at their most convenient time to avoid compromising the interviews. To ensure confidentiality, the participants were coded in such a way that their responses could not be tallied to their responses by any individual other than the researcher. Furthermore, the participants were not obliged to participate in this study as indicated in the Participant Information Sheet and Consent To Participate Form in Appendix A. On anonymity, the interview questions were designed in such a way that personal information from the

respondents could not be easily identified. On the question of discomfort, the researcher established rapport with the participants, a process which started during the seeking of permission from the gatekeeper to gain access to the participants.

3.12 CHAPTER SUMMARY

This chapter explained the research methodology of this study in terms of how the data was collected and analysed. The methodology covered the research paradigm, research design and approach, target population, sampling techniques and sample size, data collection instrument, data processing, and analytical tools. An inductive qualitative methodological approach was implemented to conduct the study. The use of open-ended and probing questions gave the participants an opportunity to give their opinions and perceptions.

CHAPTER 4

4 DATA ANALYSIS, AND DISCUSSION OF THE FINDINGS

Thematic analysis was used to interpret the results derived from the interview schedules. Thereafter, a comparative analysis was done between the results obtained from the interviews and the literature review on green logistics. This chapter presents the major findings according to the objectives of this study which primarily sought to examine the nature and extent of green logistics practices in large construction companies in Botswana. The objectives of this study were; to ascertain the challenges experienced in adopting green logistics practices in large construction companies in Botswana; to investigate the causes of the challenges experienced by large construction companies in adopting green logistics practices in Botswana; and to establish the opportunities available for future operations of the large construction companies in Botswana as shown in the summative matrix in Appendix F.

4.1 GENERAL CHARACTERISTICS OF CONSTRUCTION COMPANIES

The findings of this study indicate that relatively large construction companies operating as holding entities, branches and subsidiaries in Botswana have logistical functions represented at middle management level. Therefore, it can be inferred that there is recognition of logistics activities by larger companies. The respondents highlighted that companies used construction vehicles such as dumpers, tankers and tippers. Furthermore, these companies had open yard site storage facilities where materials, equipment and construction vehicles were housed. The availability of these storages facilities indicates that there is bulk movement of materials and use of fuels and lubricants, which has a potential of harming the environment. It is against this background that this research sought to establish the existence of green logistics practices with a view to lessening the impact of construction logistics activities on the environment, identifying challenges faced in the adoption of the practices, and exploring the causes of the challenges and the prospects thereof.

4.2 GREEN LOGISTICS PRACTICES BY THE CONSTRUCTION COMPANIES

Green logistics are indispensable for every organisation whose drive is towards environmental sustainability and/or green environment. This section aims at establishing if the sampled companies in the Botswana construction industry employed any green logistics practices during their day to day activities or incorporated them in their operational plans. The main focus of this study was on the green transportation, green warehousing, green packaging, green procurement, green data collection and management and waste management. These are key six themes which the research identified and sought to establish if they were implemented in large construction companies under study.

4.2.1 Green Transportation

The study utilised several variables to establish implementation of green transportation by the companies. In addition to establishing if the companies were practising green transportation, the study found it imperative to identify the challenges the companies were facing when implementing the green logistics practices especially during the planning stages. Several thematic ideas were qualitatively deduced from the respondents on their capacity to employ green transportation as follows:

4.2.1.1 Modes of transport in use

The findings of this study show that rail transport is used sparingly by the construction industry in Botswana. The majority (60%) (9 out of 15) of the respondents indicated that their companies did not utilise rail services due to limited rail network in the country which does not extend to relatively smaller settlements. One of the respondents indicated thus:

> *"…Botswana Railways which is our major rail-service provider in the nation does not have specialized trains to cater for the transportation of construction materials … oversized materials such as steel beams cannot share space with other cargo which leaves us with an option of using trucks." [CC3]*

Given the fact that rail transport is perceived as a relatively green inland mode, its non-accessibility to other areas limits a company's efforts of green logistics practices. Therefore, it can be implied that green logistics is compromised given the limitations of

the rail transport in Botswana. Aditjandra, et al, (2016) emphasizes that among all the other modes of transport, the rail mode is a "green inland mode" whose consumption of energy per unit load per kilometre is lower than the road modes. Despite the efficiency of the rail transport mode, the development of the Trans-Kalahari Corridor (TKC) which is intended to link Namibia, Botswana and South Africa has not improved. This infrastructural development would also provide linkages between Southern African hinterland, the Americas and the East European markets (YourBotswana, 2018). The anticipated improvement of the transportation service due to improved rail network was indicated in one of the respondent commentaries which were highlighted as:

> *"… if completed, the infrastructure will provide us with a wider market to source materials from and have them delivered cheaply either through South African or Namibian ports" [CC7]*

The rail transport mode is also eco-friendly because of its ability to transport goods in bulk with less frequent deliveries and reduction of carbon emissions. Unfortunately the development of the Trans-Kalahari Corridor (TKC) is still at the planning stage and the nation of Botswana is eagerly waiting for its implementation, which is likely to take time. The respondent also acknowledged the anticipated contribution by the dry port in Namibia which is a Botswana Railways owned subsidiary leased from Namport trending as Sea Rail Botswana. One of the respondents aptly said:

> "*Once the Trans Kalahari railway project is complete, we will not only have a rail link between Botswana's north-south main line and the Namibian rail network to give Botswana access to the coastal ports but also allow us to fully use our dry port" [CC2]*

The above sentiment corroborate the literature findings that the establishment of a dry port is necessary for green logistics because of its low carbon dioxide emissions. For example, one train can substitute around thirty trucks especially at the seaport gates and along the main routes (Roso, 2007).

Furthermore, the respondents indicated that despite its economic advantage, the green logistics has not yet gained ground in the construction industry because the industries still used the road as the main source of transportation. One of the respondents appositely indicated his concern about the impact of the road mode of transportation on the environment that:

> *"Most construction material is bulk and heavy with sand and quarry being dusty…..usually the weight destroy roads" [CC14]*

The above sentiment is supported by Roso (2007) who indicated that an increased number of trucks results in road congestion, increased local pollution, increased road maintenance costs and accidents; therefore, use of rail transport would effectively reduce congestions.

With regard to sea transportation, all the respondents appreciated its efficiency because it opened up more opportunities and enabled bulk importation of locally unavailable materials into Botswana. One of the respondents appreciatively opined:

> *"There is no close alternative to this mode especially for international purchases of bulk materials needed for our construction works and sea will still be of use for a very long time." [CC6]*

Despite the advantages mentioned above, the sea transport mode has been found to pollute air more than the road transport mode (Cullinane and Cullinane, 2013; Eyring, et al, 2010) and to emit more greenhouse gasses (Crist, 2009). According to Bailey, et al, (2015) and DiBacco, et al, (2012), sea transport releases ballast water containing aquatic invasive species. It also releases cargo residues (Grote et al, 2016) and oil spills to the bodies of water (Kim, 2002). Furthermore, it has poor waste disposal and garbage management (Pettipas, et al, 2016). According to MacAskill, et al, (2016) the environmental impact brought by the sea transport also include sediment contamination in ports and harbours during ship breaking activities. It could therefore be concluded that construction companies use Import Sea mainly for its economic benefits without paying much attention to its environmental impact. There is however no other alternative for the import of international bulk construction materials and sea-ports will always remain a stakeholder in this supply chain and it is the responsibility of the ports and country in which it is located to ensure that they take all the necessary measures and mitigations to ensure that they comply with the countries' green policies and strategies.

Comparatively, air transportation was mainly used for transportation. All the respondents except one indicated that they usually used it only for transporting emergency materials. For example one of the respondents highlighted that:

> *"We receive materials such as parts and spares for construction equipment, finishing materials, lighting equipment, furniture, and various decorative*

accessories by air transportation in cases where there is need for urgency to complete a particular segment of a project." [CC1]

The above sentiment suggests that comparatively there is minimal use of air transport for movement of construction materials and therefore positive for green logistics. Limited air and noise pollution caused by air transport mostly takes place at the airports (Jakubiak, 2015).

4.2.1.2 Reasons for selection of modes

In terms of selection of transportation modes, the findings of this study showed that there was diversity for the reasons listed in Figure 4.1. The respondents indicated that the selection reasons were environmental, but were based on low freight or transportation rates and reliability. One of the interviewees said that:

"Transportation to and from the suppliers to the sites is too frequent and very costly so we need modes which are reliable at cheaper rates to have our materials."[CC8]

The above argument suggests that the rail transport mode is more popular not because of its environmental responsiveness, but because of its lower freight rates and reliability. However, it should be noted that only 40% of the respondents utilised rail for their transportation services.

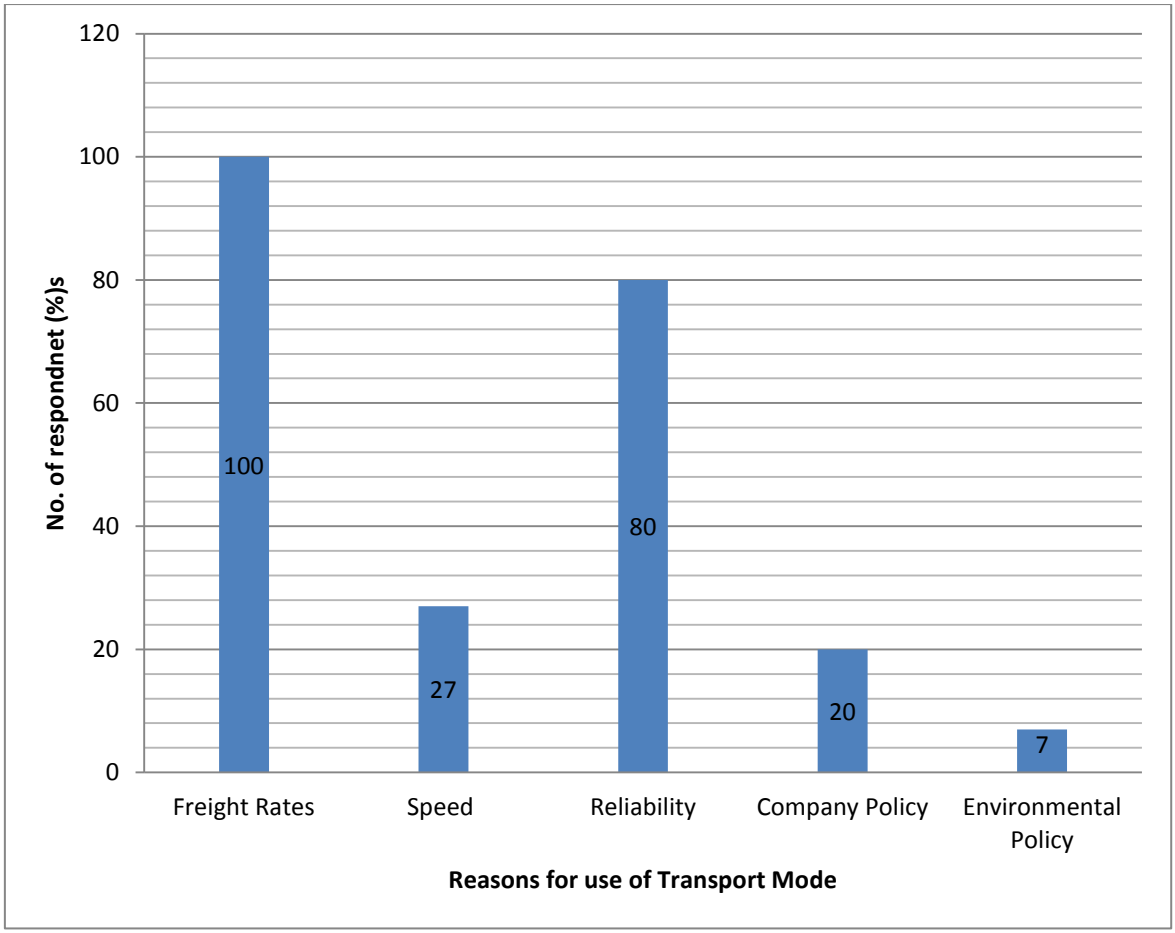

Figure 4. 1: THE REASONS FOR CHOICE OF MODE OF TRANSPORT

Source: Author, 2019
NB: Each organisation had an opportunity to mention multiple reasons

4.2.1.3 Use of fuels and lubricants

Lubricants minimise direct metal-to-metal contact at the same time protecting parts and engines against corrosion and wear and tear. They also prolong the technical lifespan of the engine and minimise waste accumulation. On the other hand, fuels include liquefied natural gas, natural gas liquids, ultra-low sulphur diesel, and petroleum coke. The findings of this study show that there was a relatively high need for fuels and lubricants for the equipment due to strong reliance on heavy machinery on construction sites. This was ascertained by one of the comments from the respondents who highlighted that:

> *"Construction works use heavy equipment and off-the-road vehicles so we require lubricants to make certain that our equipment offers the highest levels of performance" [CC12]*

It has been found that diesel and petrol are used more than other fuels. Given the environmental impacts associated with these fuels, it could be inferred that the green logistics is compromised. It should however be noted that construction companies are forced by non-availability of high-sulfur fuels to resort to low-sulfur fuels which are more environmentally friendly. One of the respondents highlighted that:

"…older off-the-road vehicles are being phased out so the higher sulfur fuels are more difficult to source which leaves us with no choice but to use the low sulfur diesel fuel" [CC2].

The environmental benefits of using fuel containing sulphur is arguably supported by Hileman *etal*, (2008) who highlights that low sulfur content conventional fuels or low sulfur content synthetic fuels are usually characterised by reduced emissions that contribute to airborne particulate matter.

4.2.1.4 Company strategy for upgrading vehicles

When asked about strategies of upgrading their vehicles some respondents focused on the economic justification of incorporating strategies to upgrading the vehicles than on the environmental care. The emphasis was to address the company's economic concerns with little to no regard to the environment.

> *"We still want to see the benefits of electric driven engines over diesel-driven engines which are well suited to the heavy-duty construction vehicles… I saw the technology working in one country where we had a joint-project but doubts if it can be incorporated in Botswana soon." [CC5]*
>
> *"… taking the electric-driven engines route will require an electricity storage solution yet electricity on its own is a bit of a challenge as evidenced by load-shedding and black-outs which are sometimes experienced in the country."[CC4]*

The respondents' perception towards fuel efficiency engines and incorporation of hybrid and electric engines into vehicles, demonstrates more interest in saving fuel than on saving the environment.

Though in support of the incorporation of the electric engine, one participant made a very outstanding economic point;

> *"it makes no sense to come up with an electric 20 tonne excavator which will operate an eight-hour shift requiring lots of the scarce electric power especially given that most construction activities such as road, dam and bridge construction are usually in remote sites where there is less to no access to electricity supply… it would be economic to have medium-sized equipment which has a number of functions powered by electric batteries but driven by the diesel engine." [CC9]*

The idea of migrating to electric vehicles suggests that green logistics is second to economic justification or strategy formulation by companies. Electric vehicles require more electric power and are an inconvenience in situations where there are power cuts.

4.2.1.5 Software in use

Insofar as software use is concerned, the findings of this study showed that several companies utilised a wide range of software for their day to day activities in the management of their logistical works as indicated in Figure 4.2. It was reported in the literature that good construction logistics management through the use of technology improves order processing, reduces lead times, promotes proper scheduling for the availability of cranes and skips, improves coordination, and improves driver safety (Almohsen, and Ruwanpura, 2013). The findings of this study show that software not only improved productivity, but also positively affected the environment. For example one of the participants indicated that:

> *"Teletrac Navman Director is quiet useful for us as it gives information which can be used to maximise the use of equipment and vehicles, monitor fuel usage and improves the performance of the drivers and the safety of operators on site." [CC15]*

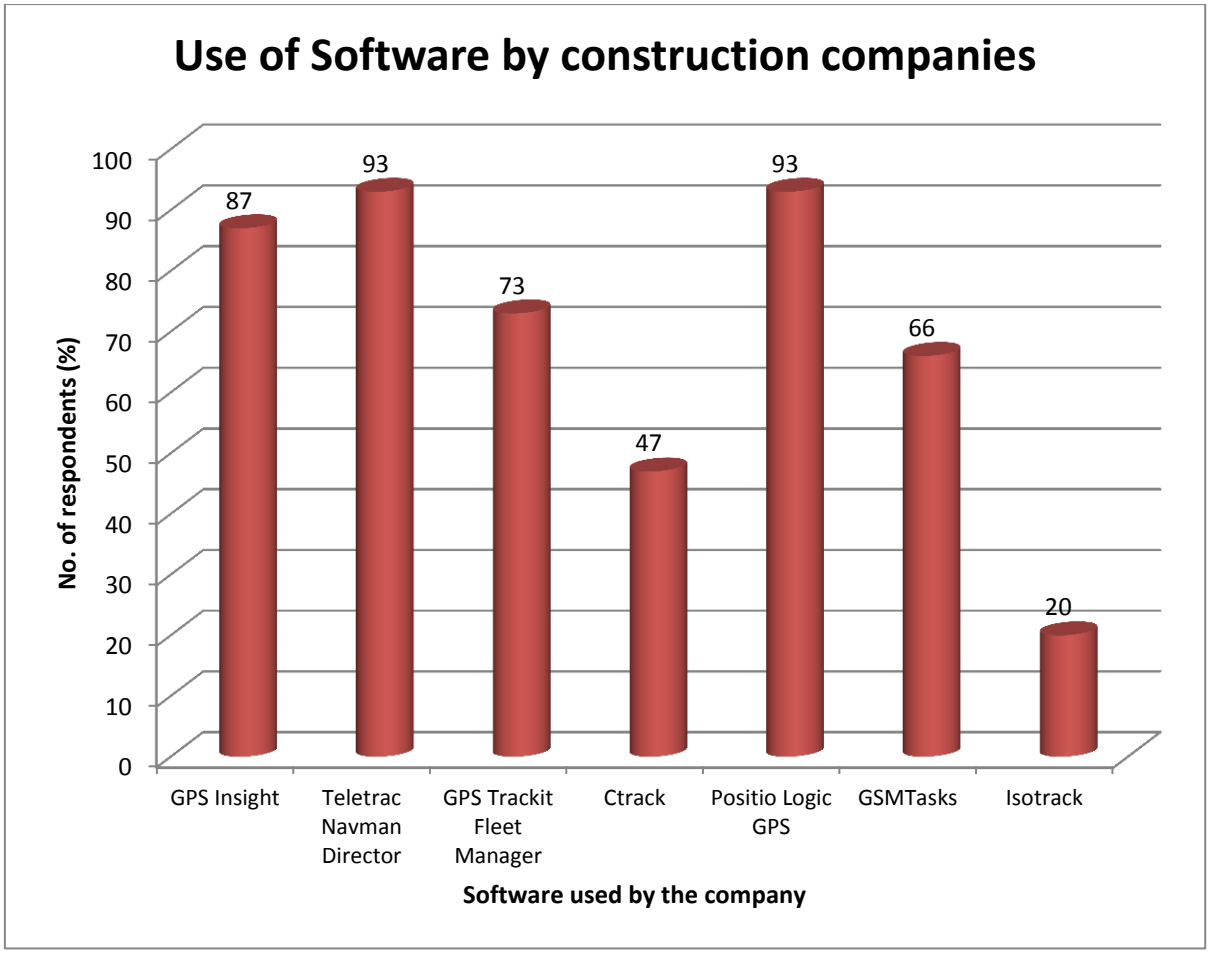

Figure 4. 2: SOFTWARE USED BY DIFFERENT CONSTRUCTION COMPANIES

Source: Author, 2019
NB: Each organisation had an opportunity to mention multiple-software used

It can therefore be concluded that good order processing through the use of software systems contributes positively to green procurement, whilst reduced lead times and proper scheduling of equipment equally promotes green transportation. Driver and staff safety answers to one pillar of the triple-bottom line which is the society.

4.2.1.6 Strategy on encouraging backhauls

Joint venture strategy is reported to result in low carbon transportation and less waste. The findings of this study showed that several companies in Botswana formed joint ventures to execute their projects. In a joint venture, the main contractor engages other companies as specialists, generalists, labour-only, domestic, selected and or nominated subcontractors. This allows them to share risk, reduce costs, control expenditure, improve productivity, quality, and reduce responsibility on labour retention. Furthermore, joint venture reduces

duplication of trips and the amount of inventory needed for the same project. One of the respondents appreciatively commented that:

> *"Our company has a strategy on encouraging backhauls through collaborative transportation and inventory management … especially where we are operating as a joint venture for a particular project."[CC7]*

It could be concluded that joint ventures do not only reduce costs, but also contribute immensely in keeping the environment cleaner. For example, one of the company representatives highlighted the importance of joint ventures by indicating in a comment that:

> *"the strategy of Construction Consolidation Centres (CCC) was implemented in one of our international projects outside Botswana ... its success is inevitable given that most construction companies work together in various projects and coming up with a good recommendation to the government of Botswana may receive a buy-in [CC10]"*

Literature also shows that construction consolidation contributes in reducing noise especially in cities, and reduces fumes from many large trucks. It also guarantees full-truckloads-delivery from larger trucks compared to more frequent yet small truck deliveries which make the sites unnecessarily much busier (Lundesjo, 2011). This will therefore mean an attainment of the green logistics initiatives.

4.2.1.7 Accident reduction strategy for road

It has been found that road risk policy promotes green logistics and efficiently reduces accidents. It also saves drivers who are at the most risk because of the nature of their occupations. As far as accident reduction strategy is concerned, the findings of this study revealed that implantation of the road risk policy was utilised according to eight out of fifteen respondents who stated that they had a written policy on road risk. Two of the participants highlighted that their road risk policy was different from the construction site risk policy which addresses and takes into account all the workers and visitors and their general behaviour. One of the respondents indicated that:

> *"Our road risk policy concentrates on the generally accepted areas such as the journey, that is its necessity and any special hazards like the terrain and weather; the vehicle, that is, its roadworthy status and whether it is fit for purpose; the driver that is his license and experience together with overall health and behaviour record … and the system which includes training of drivers, making them aware of the policy and regular checks." [CC2]*

4.2.1.8 Servicing and maintenance of vehicles

As far as servicing and maintenance of vehicles is concerned, the findings of this study indicate that 80% (12 out of 15) of construction companies were using preventive maintenance, whose guiding principle is "the regular and systematic application of engineering knowledge and maintenance attention to equipment and facilities to ensure their proper functionality and to reduce their rate of deterioration" (Preventive and Predictive Maintenance, online). This is corroborated by one of the respondents'comment that:

> *"In order for us to eliminate downtime and realise high productivity, we hire experts from the dealers of the vehicles or use the tendering system to have a company come and do the servicing on a regular interval at the sites and deal with breakdowns as well." [CC9]*

Proactively reducing the rate and extent of deterioration means that equipment and vehicles disposal is prolonged and, therefore, less environmental pollution. Unfortunately, 20% of the respondents only serviced their vehicles when the need arose. This is not withstanding the fact that unserviced vehicles pose danger to employee's health and safety as they emit more dangerous exhaust fumes. The vehicular exhaust is the worst type of polluting agent because it emits gas fumes near the ground level which is the breathing level or at the atmospheric level, and it gives maximum human exposure. Traffic exhaust emissions contain different noxious oxides of sulphur, nitrogen, carbon, volatile organic compounds and suspended particulates (Ahmad, et al, 2016). These pollutants are toxic and have health effects on people.

4.2.1.9 Strategy on management and disposal of pallets

Management and disposal of pallets used by construction companies was controlled as far as the findings of this study are concerned. All the construction companies indicated that they preferred returning the pallets to the supplier and 20% gave out the pallets to small entrepreneurs. One of the respondents indicated that:

> *"Loads which we receive are straight from suppliers and these take back their pallets after a given time of delivery or immediately after placing the materials in storage places… there is also CHEP Botswana a company which collects the pallets." [CC13]*

The above report suggests that collection of used pallets by CHEP and the residents implies that the pallets will be re-used and recycled instead of being discarded; a process which saves the environment of timber clearance. Therefore, the pallets often represent a significant investment in terms of reuse, recycling, down cycling, and incineration (Bilbao et al, 2011) because they reuse, reduce waste and saves the environment.

4.2.2 Green Warehousing

The purpose of this study was to establish whether large construction companies are incorporating green initiatives as a way of cutting out waste and reducing the amount of energy used. The study therefore sought to establish practices that remove the negative impact of warehouses such as clean material handling, process optimisation, automatic warehousing systems, inventory minimisation programs and Just-in-Time system together with product disposition and on-site recycling.

4.2.2.1 Materials handling equipment in use

The findings of this study show that a wide range materials handling equipment was reportedly used by construction companies under study. For example, 93% of the respondents utilised LPG (pneumatic) driven and mechanically driven equipment. Furthermore, all companies under study used hydraulic driven handing equipment while 60% used electric driven equipment. The diversity of equipment used was made significant by one of the respondents who reflected in the comment that:

> *"We use cranes, conveyors, hoists, excavators, telescopic handlers and forklifts for handling materials at the construction site which are operated by hand, pneumatics and electricity." [CC1]*

This study appreciates the use of pneumatic driven conveyors because they are clean, cost-effective and efficient. Literature supportively highlights that the operation of pneumatic systems does not or limitedly produce pollutants and the air released is also processed in special ways to reduce pollution; therefore, pneumatic systems can work in environments that demand high levels of cleanliness (Woodruff, 2019). Furthermore, Koskinen, (2008) indicates that use of different waters instead of oils in hydraulic systems promotes environmental safety, fire safety, explosion safety, low cost fluid, good availability of the fluid and easy storage of the fluid. Furthermore, the findings by Nordelof, et al, (2014) demonstrate a reduction in greenhouse gases emissions with an increasing degree

of electrification, although different vehicle categories overlap with regard to minimum and maximum values. Therefore, it can be concluded that construction companies are contributing to greening of the environment through the use of pneumatic, hydraulic and electric driven equipment which are reportedly environmental friendly methods of material handling.

4.2.2.2 Strategy on minimizing visual intrusion

Offsite construction activities and temporary works have effects on the society which consists of the people who are the visually sensitive receivers. These receivers can be categorised into four groups, which include:

- views from residences;
- views from workplaces;
- views from recreational landscapes
- views from riverside access, public roads and railways including vehicle travellers with transitory views (Mott-MacDonald, 2010).

The findings of this study show that few companies had plans to minimise the visual intrusion in areas they operated from. For example, only 13% of the interviewed companies recommended advertising or artwork on hoardings while the same percentage suggested tree and shrub planting adjacent to all sites boundaries. One of the respondents summed up as follows:

> *"There is no strategy in place at the moment and what is usually seen around construction sites are signs informing the public about road closure, or temporary routes to link to the main highways … otherwise all the activity will be in the eyes of the passer-by since what we normally use is a barrier fence for safety to demarcate or mark the construction zone." [CC3]*

It was also reported that the sight of construction works underway is destruction and a disturbance which can even result in accidents especially for the drivers and pedestrians. Therefore, it was concluded that lack of the strategies for visual intrusion compromises green logistics initiatives and environmental sustainability.

4.2.2.3 Strategy on noise pollution

All construction companies under study claimed to have noise reduction strategies. For example, all the respondents claimed that they regularly maintained the old equipment to reduce noise levels from such equipment. Furthermore, the results show that all the companies appreciated a need for noise reduction in their places of operation in order to promote health and safety of employees and the communities nearby. For example one of the respondents said:

> *"With noise we can't compromise much because it is a health requirement for our workers so we are trying to make use of modern, quiet power tools, equipment and generators for the purposes of both efficiency and noise reduction." [CC10]*

Moreover, protective clothing and communication devices were used to ensure employee safety and health (for example ear muffs or ear plugs). However, as long as strategies are not in place to prevent spill over effects, the communities around the construction site remain at risk. It is also evident that noise affects people and animals surrounding the site which are part of the environment. Noise leads to loss of concentration, sleep disturbances, hypertension, increased stress levels and hearing loss.

4.2.2.4 Accident reduction strategy in warehouses

It is imperative for every workplace to be accident free. Therefore each organisation or company needs to have strategies and/or plans towards elimination or minimisation of accidents or incidents. Evidence indicates that site storage or warehouses are susceptible to accidents due to a number of hazards which require attention. For example, it has been found that energised or motorised equipment if not shut off can be a danger to employees and visitors as they can be electrocuted or suffer some injuries. Therefore, a lockout/tagout (LOTO) programme could be implemented to prevent such accidents. However, unfortunately none of the respondents mentioned the implementation of the accident reduction strategy in their warehouses.

Another accident reduction strategy can be in the form of a communication programme for the storage, handling and disposal of hazardous chemicals. Interestingly, all the respondents reported use of communication signage and warning devices to alert employees or anyone involved of the possible dangers and accidents in the area.

Furthermore, 93% of the companies reported to have safety procedures for handling hazardous materials. Optimum procedures to manage physical layout of the site storage was highlighted by 40% of the respondents as a measure implemented to reduce accidents within warehouses. This therefore, is an indication that these companies take into consideration their employees' health and safety. One of the respondents indicated that:

> *"To us a construction site is more like an airport in terms of safety so the use of signage and warning devices is a must, especially in site storage. We have SHEQ (Safety, Health and Environmental Quality) Officers to offer continuous guidance on accident reduction as there is regulation in the construction industry." [CC7]*

The researcher expected that the participants would mention strategies such as keeping passageways and aisles in good condition with loads properly stacked and positioned in storage places. Warehouse management involves a situation where operators of forklifts become very alert in moving loads and use warning signs and sounds to prevent people from getting in the way of forklifts. Surprisingly, the avoidance of manual lifting and handling was not mentioned as an accident prevention strategy yet improper lifting of objects is one of the most hazardous acts causing musculoskeletal disorders. Therefore, use of communication posters on lifting was expected within the site vicinity. Charging stations and conveyors also required special mention as most recorded accidents are associated with these.

Figure 4. 3: Poster showing proper ways of lifting load

Source: Author, 2019 – Picture taken from Safety Laboratory

4.2.2.5 Accident reduction strategy in the construction sites

As far as accident reduction strategy is concerned, the findings of this study show that all companies under study had strategies in place for reducing accidents at the construction sites. For example all the companies reported to utilise signage and reflective clothing and to practice defensive driving and parking. Furthermore, 93% of the respondents indicated that they reduced working at nights and applied interventions for 'black-spots' as a way of minimising sites accidents. One of the respondents indicated that:

> *"We try by all means even when we are behind schedule to reduce the amount of night work and avoid any extended hours if it's road upgrading … We also have it as a rule that workers and visitors must wear reflective clothing on site." [CC2]*

The above report suggests that companies positively contribute to green logistics which does not just end with the delivery of materials but also continues with the flow of those materials and equipment in the production process. Materials handling takes place both in the warehouses and on site and therefore, safety should be promoted because it assures sustainability. It is important to note that drivers and operators together with other staff members were trained on defensive driving and reverse parking, which the respondents reported to be a norm on their operational sites.

4.2.2.6 Energy efficient strategy

The respondents reported several energy reduction strategies and therefore there was less concern regarding the use of energy. Throughout the interviews, there was emphasis on most of the projects having the government as the sponsor and the client; hence, energy efficiency was not a challenge. One of the respondents said:

> "*The cost of electricity in Botswana is low and subsidized just as its fuel so we are not pressured to be using solar energy … most of the construction works are government projects which are done through the tendering system meaning the cost of electricity is quoted in the price."[CC5]*

This therefore suggests that as long as the government does not enforce measures to reduce energy use or provide alternatives, the construction companies will not be obliged to save energy or utilising cheaper alternative methods.

In terms of green logistics it was encouraging to note that companies were using LPG counterbalance forklifts as indicated in Fig 4. 4 and high frequency (HF) charging which consumed less energy. Solar energy was also found to lessen energy use when used for lighting purposes and not for production. One of the respondents commented on the efficient utilisation of solar energy that:

> *"…solar energy is highly variable yet we require a constant base load production of electricity."[CC11]*

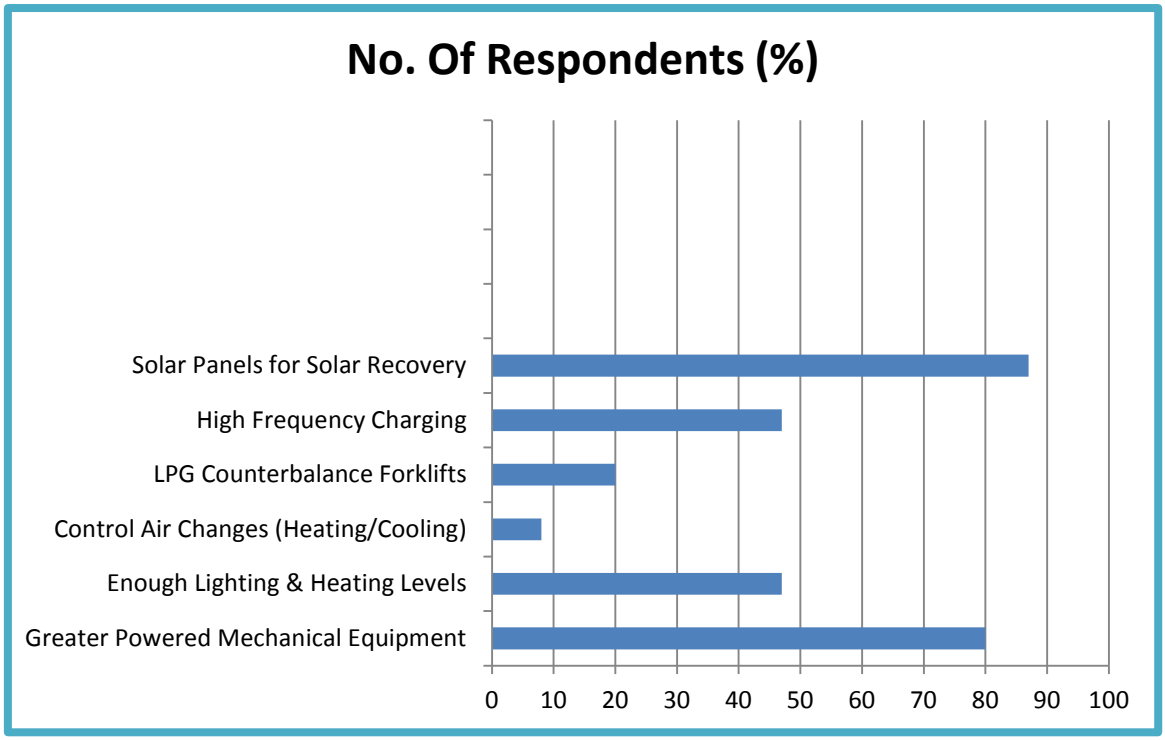

Figure 4. 4: ENERGY EFFICIENT STRATEGIES EMPLOYED BY COMPANIES

Source: Author, 2019

The respondents perceived that the prioritisation of solar energy would compel the government to install the initial solar energy infrastructure. This implies that environmental initiatives such as green logistics could be possible when implemented at national level and not at company level.

4.2.3 Green Packaging

The purpose of this section was to establish the extent to which large construction companies were maximising the following: transport and storage fill rate, optimisation of

unitisation and material use, avoidance of hazardous substances, and use of packaging which allows for efficient reuse, recovery and recycling of materials. These approaches were reported to minimise the impact of packaging on the environment. Their absence reflects that green packaging strategies are not being incorporated during packaging.

4.2.3.1 Packaging reduction and efficient strategies for materials

The findings of this study revealed that all companies were implementing packaging reduction strategies. For example, all of the companies that took part in this study reported to be using protective and informative packaging. They further reported large scale and unitised packaging approach. 67% of them maximised the weight and volume of packed materials, while 100% maximised fill rate under transport and storage. One of the respondents indicated a need of considering green packaging and commented that:

> *"... since we are not manufacturers, our packaging has more to do with materials being moved from site to site and we have a few strategies for this ... we are using large scale packaging especially with our bricks, cement, admixtures; protective packaging and we maximize loads during transportation and storage." [CC12]*

Despite reported progress in efforts towards green packaging, some companies highlighted challenges when it comes to maximising loads in storage because most storage facilities have maximum carrying capacity. It has been found that transporting materials in bulk cuts on fuel costs and reduces emissions because it reduces the number of trips but it has ripple effects on the amount of inventory both in storage and in-transit. This was made apparent by the commentary from one of the respondent who indicated that:

> *"...we try by all means to increase the weight and the volume of materials to be packaged in order to try and save on packaging material." [CC4]*

The above findings suggest that there should be a trade-off between weight and volumes transported so that the amount of inventory is reduced. This is because excess inventory implies more energy required for heating, cooling and lighting which are needed in the prolonged stay together with obsolescence and expiry of materials which may result in the disposal of materials as waste due to elapsed shelve life.

4.2.3.2 Materials in use for packaging

The results show that all the respondents used shrink bags, poly sheeting, metal scrap, metal bands, ratchet nap, nets and chain lashing for packaging. All, save one, reported the use of plastic film sheeting. One of the respondents argued that they would not do away with packaging due to the status of the products transported. He highlighted that:

> *"Our work involves bulk and liquid products and without packaging it is obviously impossible to transport them… it works well in stabilising the loads so that they do not fall or move sideways or gets damaged where the trucks go through rough terrains." [CC11]*

Overall, the construction companies indicated that they were using a variety of packaging materials. In construction logistics, packaging has a distribution function that if not well managed will further cause pollution. The respondent said:

> *"… we use plastic films and sheeting, shrink bags, poly sheeting, metal strap, metal bands, ratchet strap, nets and chain lashings in transportation of materials from site to site and from site to disposal areas and these are a challenge to environmental waste management." [CC7]*

Surprisingly, the findings of this study do not indicate what companies do with the packaging materials after use. Pongracz, (2007) argues that there are numerous environmental concerns regarding residue from packaging after transportation and construction activities have been completed. For example, packaging materials such as glass, plastic bottles, cans, paper and plastic wrappings are the main constituents of waste on the environment that usually end at the dumping site. Pongracz, (2007) further argue that direct packaging-related emissions arise from landfill sites, as a consequence of decomposition of wood and paper, releasing CO_2, and methane.

4.2.3.3 Environmental certifications

It is causing concern that a slight percentage of the interviewed companies were registered under environmental certified bodies. Therefore, without environmental certifications environmental audit of these construction companies was not being properly conducted. However, some of the companies were registered in the following three certifications: Leadership Energy and Environment (8%), Comprehensive Assessment System for Building Environmental Efficiency (8%) and Green Star with 8% as well. 13% indicated that they were observing ISO14001. One of the respondents indicated that due to limited or

lack of stringent rules forcing companies to be certified, few did find a need to register with such bodies. One of the responded pertinently said:

> *"…there are no hard and fuss rules in Botswana when it comes to these certifications but there is criteria used by Botswana's Public Procurement and Asset Disposal Board (PPADB) and other clients to measure compliance for works such as construction of a road, parking area, a bridge, a dam or a building … these include evaluation by quality based selection, by fixed budget selection, by least cost selection and by qualification selection." [CC8]*

The fact that most construction companies are not registered in any environmental bodies suggests that they do not even undertake green logistics initiatives although they enjoy the business proceeds.

Eves (2016) indicates that the real benefit of a programme does not come from the certificate on the wall, but from the positive implementation behaviours that the process reinforces and validates. Similarly, the organisations that have efficaciously accomplished the programme, its benefits, efficiency and positive effects do not only address efficiency in production processes, but also save in physical and financial resources through energy conservation and reuse of raw materials (Eves, 2016). Moreover, the prominence of sustainability, the attitude of efficiency, and the culture of continuous improvement, experienced by internal and external stakeholders alike, all have a powerful effect on the long-term success of these organizations (Eves, 2016). This shows that there is commitment towards environmental protection and environmental sustainability measures which comes with a certification. In conclusion, being on the check reminds a certified company of regularly giving attention to the conditions laid down for sustainability.

4.2.4 Green Procurement

4.2.4.1 Inspections upon receipt of materials

It is important to note that all of the interviewed construction companies performed inspections from receipt of materials to their use and the final product. Such steps were highlighted by a comment from one of the key respondents who indicated that:

> *"…we do inspection in three occasions which are upon receipt of materials, during the construction process and after the project has been completed…" [CC3]*

Such stages of inspection are essential for the organisation as they eliminate some of the materials which were incorrectly delivered or that have faults. Eliminating materials which are not suitable for the process helps in minimising accumulation of waste which if identified at a much later stage will end up at the dumping sites quickly.

> *"The problems which we usually experience are that the delivery of incorrect type of materials, incorrect sizes, incorrect quantities and damaged materials, therefore we use this opportunity to return such materials back to the supplier." [CC14]*

However, the findings of this study revealed that there is a possibility of faulty materials such as cement passing through the receiving stage without being noticed. However, this problem can still be picked up after the completion of the construction process through methods such as rebound hammer or the pull-out test.

4.2.4.2 Quality check monitoring tools

The findings of this study showed that all the interviewed construction companies employed quality check monitoring tools. Quality check measures include spot checks, visual inspection, and technical inspections. Some companies used different methods to test concrete (test cubes, slump test), and others sand (silt test and bulking test), timber (use of moisture meter and oven dry testing), and bricks (water absorption test, soundness test, hardness test, size, shape). One of the respondents confirmed that:

> *"Indeed we inspect the quality of the materials, equipment and vehicles…materials which come in bulk are sampled and checked."[CC6]*

The importance of checking materials before use was echoed by DST Consulting Engineers, (2019) who indicated that engineers and scientists using materials such as for construction and geo-materials must understand their characteristics and their performance upon completion of construction. It is also important so that the materials should perform as expected and achieve maximum strength, durability and compressibility. Therefore, to achieve these, several laboratory tests on the material should be performed under controlled environments so that good results are accomplished (DST Consulting Engineers, 2019). For instance, one of the requirements of the Construction Products Directive key concern and objective is to address 'Hygiene, Health and the Environment' and to address issues concerning emissions from hazardous substances and their

monitoring in places where construction products are used (European Concrete Platform, 2007). This therefore, demonstrates the extent to which quality checks are important to the care of the environment; thus addressing and incorporating green logistics.

4.2.4.3 Partnerships in procurement and delivery

The findings of this study show that large construction companies work together with suppliers especially those dealing with critical materials and those which require installation and interior works. Such collaboration, joint efforts and one-stop-shop was shown in one of the comments from the respondent who stated that:

> *"In such cases we give suppliers a supply and fix contract for the finishing stages of the project where they will be doing fittings, plumbing, tiling, tubing or glazing." [CC6]*

The findings indicate that procurement collaboration and delivery of materials have their own economic and environmental benefits. This corroborates the literature that indicates that joint procurement ensures that parties enjoy quantity discounts and that economies of density are gained in the transportation of the materials (Bowersox, et al, 2010). Joint delivery also means that trucks operating at full capacity reduce the number of trips they make and this results in reduced emissions; which is a positive drive towards environmental sustainability.

4.2.4.4 Strategies for waste efficient procurement

The Just-In-Time method of delivery was reported to be the best strategy for waste efficient procurement by the construction companies that used it. It was indicated that although companies delivered materials as required, they, some of them needed extended times of delivery because their operations were based in remote areas where the project were taking place. One of the participants indicated that:

> *"…some materials are sourced from far away and will therefore require supplies to be stored well in advance to avoid disruptions." [CC5]*

This strategy is an effort to reduce unnecessary waste, because if waste is not managed, then the essence of green logistics cannot be successfully attained.

4.2.5 Green Data Collection and Management

4.2.5.1 Data collection and management systems

Majority of the participants (87%) specified that a great deal of decision making needed to be done for the entire running of a construction project and as such decision-making support systems helps companies in dealing with complex processes. In capturing materials for storage, at least 30% of the participants pointed out that barcoding and scanning assists even in the positioning of the materials and in locating them easily. Furthermore, 40% of the respondents indicated that they had inventory optimisation software that assisted them to monitor stock levels, and to monitor the stocks that are due for replenishment. Moreover, 67% of the respondents stated that they utilised Transport Management Systems for the management of their fleet of vehicles (Figure 4.5). The findings also showed that 27% of the construction companies have also invested in Enterprise Resource Planning (ERP) Systems which has all the modules to help them achieve efficiency through improved planning and implementation processes.

According to Mohemad, et al, (2010) the Software Application Processing ERP modules are convenient for the swift running of the operations in a construction set up and can be of great value to environmental conservation and sustainability. According to Mohemad, et al, (2010, modules such as Human Resource Management (SAP HRM), Production Planning (SAP PP), Materials Management (SAP MM) and Quality Management (SAP QM) address a number of green logistics initiatives discussed in this research. The incorporation of decision support systems is effective right from the tendering process (Mohemad, et al, 2010) to the engineering works (Zavadskas and Kaklauskas, 2004). Therefore, having such systems in place is a good platform for adopting green logistics initiatives.

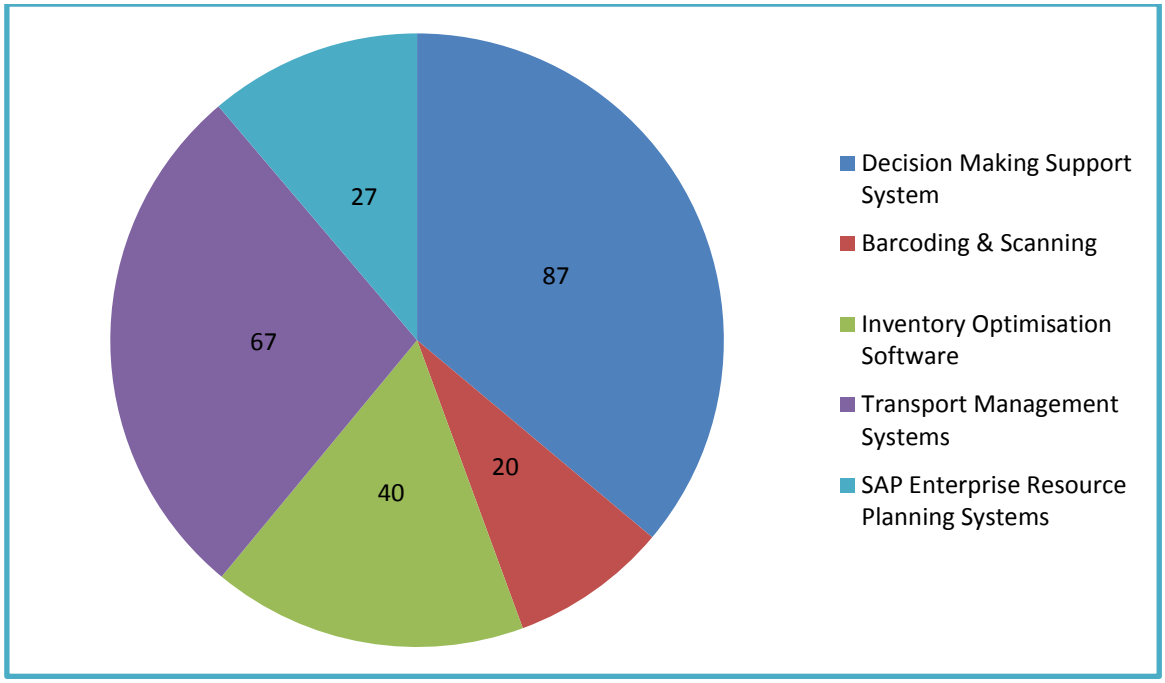

Figure 4. 5: DATA COLLECTION AND MANAGEMENT SYSTEMS USED BY COMPANIES

Source: Author, 2019

4.2.5.2 Materials and equipment used in collecting and managing data

The results in Table 4.1 indicates that all participants equally used paper, electronic material, tablets, laptops and biometric gadgets to collect and manage data. However, it is important to note that the use of paper for collecting and managing data is contrary with greening the environment where the emphasis now is on paperless operations. This is because paper production entails cutting of trees that are key carbon sink materials. Moreover, the use of paper has been seen in green packaging to contribute to the overall litter in the environment, especially where recycling is limited.

Table 4. 1: MATERIALS AND EQUIPMENT USED TO COLLECT AND MANAGE DATA

Material Used	Frequency	Percentage (%)
Paper	15	100
Electronic material	15	100
Electricity driven tablets	15	100
Electricity driven laptops	15	100
Electronic boards	1	7
Infra-radio	15	100
Closed Circuit Televisions (CCTV)	4	27
Biometric gadgets	15	100

Source: Author, 2019

Overall, the participants in this study reported a greater use of electricity driven tablets and laptops together with the use of infra radio in the collection and management of data. Literature indicates that some gadgets in the market use solar which can be adopted by construction companies to try to reduce the use of energy. For instance, American Cancer Society (2019) highlight that the Radiofrequency (RF) radiation, which includes radio waves and microwaves, is at the low-energy end of the electromagnetic spectrum. Therefore, it is a type of *non-ionizing radiation* which has enough energy to move atoms in a molecule around or cause them to vibrate, but not enough to ionize (remove charged particles such as electrons). (American Cancer Society, 2019). This means that the use of infra radio has limited harm as long as energy levels are kept at their lowest.

4.2.5.3 Disposal of materials used in collecting and managing data

Majority of the participants (87%) (13 out of 15) indicated that they shreded the paper or left it to the waste contractor to find ways of disposing it. On the other hand, (47%) of the total respondents indicated that they gave electronic gadgets to recycling companies or back to the manufacture. Otherwise all companies reported that some of their waste or non-functioning gadgets found their way to the dumping sites with only one respondent specifying that they burnt some of the materials.

Green data collection and management is a critical green logistics initiative because it deals with resources that directly affect the environment. The participants specified that there are electronic gadgets used in these processes and there is need to pay attention to them at both point of use and point of disposal. Research showes that the electronic waste or E-waste which includes cast-off electrical and electronic equipment is quite a fresh addition to the ever-growing hazardous waste stream (Bortharkur and Singh, 2012). The developing countries are faced with challenges related to E-waste generation and management which are either internally generated or imported illegally causing serious threat to human health or the environment (Bortharkur and Singh, 2012). The major disadvantage of using this equipment is during the waste management phase and the burning process brought up by one participant cause air pollution since they contain hazardous components. All this is against the principles of green logistics.

4.2.6 Waste Management

4.2.6.1 Company's waste management strategy

Figure 4.6 shows that 40% of the participants used a waste contractor to manage their waste. On the other hand 73% highlighted that they managed waste by ordering volumes they require when they ordered materials. With reference to storage conditions, the respondents in this study highlighted that they kept their goods and equipment in such a way that materials did not become damaged. Furthermore, only 20% (3 out of 15) indicated that they sorted their waste into recyclable, reusable and disposable, something which they said is the responsibility of the waste contractor. Positive to green logistics, 40% of the contractors indicated that they have platforms where they discuss with suppliers on the possibilities of returning certain components.

It can therefore be argued that engaging a waste contractor is a good move in managing waste because it is done by those who specialise in waste management and can easily apply the 3Rs strategy. It is a form of outsourcing which leaves the contractors with time to concentrate on their core business whilst the waste contractor is taking care of their environmental obligation. Waste contractors are able to supervise the collection, transportation and disposal and recycling of waste in a safe and efficient way.

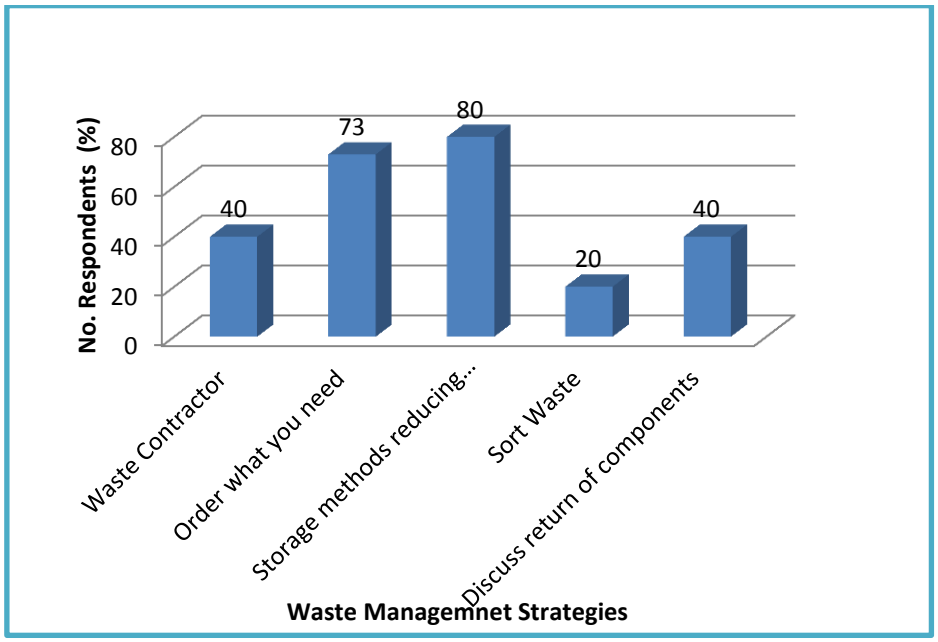

Figure 4. 6: WASTE MANAGEMENT STRATEGIES EMPLOYED BY COMPANIES

Source: Author, 2019

4.2.6.2 Company's reduce, re-use and recycle (3R) strategy

Although only 20% of the respondents practiced the 3R strategy, they acknowledged that it was an effective way of managing waste and reducing bulk waste deposited at the dumping site. For example, some reduced costs by buying in bulk and they indicated that they benefited because they enjoyed bulk discounts and ascertained supplies. The respondents indicated that they had quantity surveyors who helped them with the estimations and quantification of goods to avoid overbuying. Similarly, as indicated in Fig 4.7, 73% of the respondents had their materials also pre-cut at lumber yards, pre-assembled and off-site fabrication to avoid a situation where they would have to deal with excess unwanted material at the construction sites. The participants also believed that this strategy helped the suppliers to resell the offcuts and shavings to clients who may need them; thus reducing waste to the dumping sites while gaining more income. On the other hand, 33% of the participants pointed out they were using re-tread tyres which were purportedly relatively cost effective and reliable.

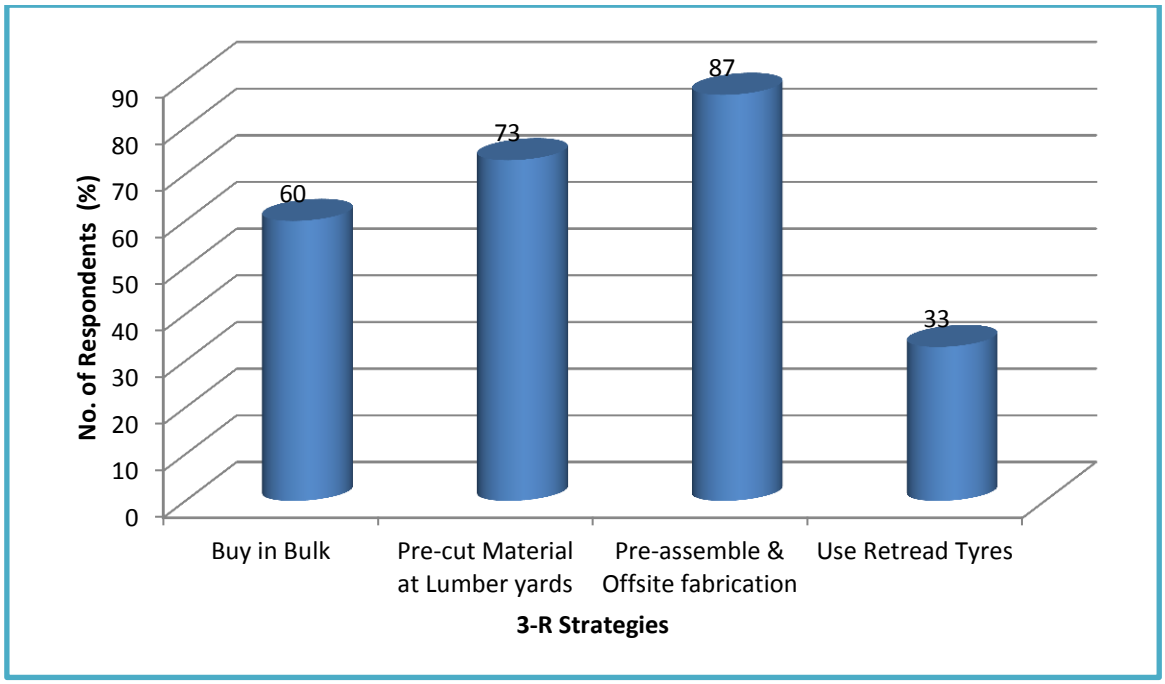

Figure 4. 7: REDUCE, RE-USE AND RECYCLE STRATEGIES

Source: Author, 2019

The participants of this study indicated that the 3Rs strategy was relatively effective though it was not being used optimally with the consciousness of green logistics. Overall, it can be affirmed that indeed having materials cut at lumber yards or having the roofing frames structured at the timber yards totally deals with excess materials on site which would end up at the dumping sites. Similarly, the use of re-tread tyres, however, with due care and caution has become very common as indicated in Fig 4.7 and is a good way of managing waste.

4.2.6.3 Strategy to reduce carbon footprint

The findings of this study showed that 47% of the respondents always tried to source the materials from the local market as this would help them to cut on transportation costs; thus, indirectly saving the environment from carbon emissions from cars and trucks during transportation stage. On the other hand, very few (13%) indicated that they incorporated planning for energy requirements before the commencement of the project. They also stated that they sent back unused, faulty and recyclable materials to the manufacturers.

The word 'try' indicates that there are some limitations placed on the construction markets to source materials domestically. These may include materials not being readily available or if they are there, they might not be meeting volume and quality specifications of the contractors. Therefore planning energy requirements is easier if there is guaranteed supply of the energy. Therefore, Sanchez, et al, (2018) argued that it made sense to send unused, faulty and recyclable materials back upstream of the supply chain to the manufactures a process called reverse logistics. This allows for remanufacturing or giving the products another life cycle instead of letting them become waste.

4.3 CHALLENGES OF ADOPTING GREEN LOGISTICS

This section addresses the second objective of this study which examines the challenges of adopting green logistics practices by large construction companies in Botswana. The interviews focused on construction, organisational and technical issues as the predefined themes for this section and several challenges were identified.

4.3.1 Challenges in Implementing Green Logistics Practices

4.3.1.1 Construction issues

All respondents in this study identified a wide range of challenges in an effort to adopt green logistics in their day to day activities. Some of the challenges mentioned by more than 85% of the constructors are:

- Congested construction sites
- Limited on-site storage
- More frequent and peak hour deliveries
- Lack of procurement policies
- Lack of ownership of waste

Some respondents also indicated that they had challenges with bundled tenders while other companies were going through business rescue. One of the respondents appositely argued that working in an already built-up area was a challenge and stated that:

> *"Our main challenge is congestion at construction sites especially when the construction is taking place in already built up areas such as cities … if you recall the construction of a number of structures in the Central Business District of Gaborone, parking lot upgrading at the Airport Junction and the Thapama interchange, which is popularly known as the 'Spaghetti' road which had to be erected in the middle of Francistown." [CC1]*

It was also highlighted that working in congested construction sites is against the conservancy of the environment and the issue of pollution is rampant under such conditions. Therefore, one respondent lamented that:

> *"Areas that are earmarked for construction have limited on-site storage for all the equipment, machinery and materials awaiting use and collection by waste contractors ... we experience more frequent and peak hour deliveries which worsens the problem of limited space" [CC6]*

The study also gathered that without enough storage, spillages of oils and lubricants are likely to occur. Frequent and peak hour deliveries worsen the congestion and proper storage cannot be guaranteed. One respondent said:

> *"… procurement policies I would say are not in place and the issue of bundled tenders leaves a lot to be desired and that is beyond our control." [CC13]*

Furthermore, procurement policies usually guard against over-purchasing and under-purchasing and if they are not in place there is likelihood of excess materials on site or re-ordering which duplicates the emissions from the transportation of those materials. The issue of bundled tenders limits the contractors or the subcontractors' decision making towards green logistics.

4.3.1.2 Organisational Issues

Shortage of adequate environmental experts impedes full implementation of the green initiatives agenda among the construction companies. Environmental experts are responsible for raising general awareness and disseminating information concerning sustainability. They are the ones who should articulate information on green logistics so that it is well grasped and contextualized for the success of its adoption; hence, they need to be part of decision making or human capital of the organisation. However, one respondent indicated challenges of employing such specialists as:

> *"One of our problems is the availability of environmental experts and when one finds them, employing or outsourcing their services is quiet costly…" [CC5]*

Furthermore, the issue of tripartite collaboration helps with engineering such initiatives because involvement of the government, workers and the industry will ensure incorporation of diverse experience and inclusion of observation from all these sectors. Therefore, conclusively there should be a buy in from the government, the construction industry and the workers. Because employees are usually the ones on the ground, they are responsible for implementing and ensuring that strategies are put in place. One of the three stakeholders indicated that:

> *"… there is no adequate cooperation between the government, workers and us as the industry and this makes it difficult for us to fully engage in environmental issues." [CC15]*

To ensure that all stakeholders in the construction industry achieve the same mandate of conserving the environment the government as the primary regulator and a sponsor for such decision making initiatives put in place strategies that cut across industries which act as enablers of the construction industry such as the transport and logistics sector, the mining sector, the manufacturing sector and the retail industry. If all these concerns by the industry are not addressed, coupled with pressure from competitors to finish up a running

project and move to the next upcoming project, then implementation of green logistics may not be achieved.

Due to financial constraints the contractors end up engaging in collusive behaviour such as the one that was observed during the construction of stadiums for the Fifa World Cup and The Competition Commission settled with 15 firms in 2013" (M&A Community, 2019). One of the participants lamented about financial constraints in the following excerpt:

> *"What happens here is that we are not excused from our contractual commitments because we are in a business rescue ... it's business as usual for the client but to us budgets have to be squeezed and paying attention to environmental concerns is a bit of a problem under such situations." [CC11]*

The findings of this study also showed that lack of support on green technology from the suppliers and the public makes it difficult to go green. 73% of the respondents highlighted that green logistics is not so popular in Botswana's construction industry with the general perspective being that it is only applicable to the transport and logistics industry. Furthermore, all the respondents indicated that information on green logistics was not publicly articulated and not readily available. Moreover, they were concerned that pressure from competitors and partners in the region to complete projects made it difficult for them to prioritise green logistics initiatives. One of the respondents indicated that:

> *"The situation is tough for us and the competition is so rife so we have to finish projects quickly and try to get the next tender either as the main contractor or as a subcontractor. [CC7]"*

All the respondents were also concerned about the restricted of modes of transport. They lamented that the companies had to resort to road than any other modes of transport because of lack of availability or high cost of mechanical parts in the country. All the above reports suggest that the adoption of green logistics strategies in Botswana is beset with many challenges.

4.3.1.3 Technical Issues

The findings of this study show that two thirds of the construction companies faced a challenge of limited or non-availability of Information and Communications Technology (ICT) skilled personnel who could assist with establishing systems which can help with enabling waste management, green procurement, green packaging, green

transportation and green warehousing (Kumar, 2015). This makes it difficult for the construction industry to adopt green logistics strategies without ICT personnel to help set up and implement those strategies that involve use of technology. Limited ICT personnel was observed by one of the respondents who reflected that:

> *"Ours is a specialised industry which requires internal and external ICT skills contextualised to our works and these are in short supply here in Botswana leaving us to depend on South African based experts." [CC12]*

Moreover, with reported poor logistics infrastructure such as highways, railways, airways and storage facilities such as cross docks and distribution centres, it is a challenge to embrace green initiatives. For example, all the respondents in this study indicated that poor logistics infrastructure was one of the challenges towards implementing green logistics initiatives.

4.4 CAUSES OF CHALLENGES FOR ADOPTING GREEN LOGISTICS

4.4.1 Cost

The findings of this study show that cost has a bearing on the challenges faced by construction companies in adopting green logistics practices. Some companies have limited funds to employ environmental experts. One respondent even asked to say;

> *"... where will we indicate green logistics in our books of finance?" [CC5]*

This concern suggests that green logistics did not bring direct return on investment, hence, it was not worth taking as long as the rules are not so stringent. They stated that adopting green logistics would be costly because it requires construction employees to attend sensitisation seminars. It can therefore be argued that as long as green initiatives do not accrue individual gains, none or a few contractors will be ready to consider adoption of some components of green logistics as a strategy to save the environment. Therefore, if they cannot bear the compliance costs together with the regulation that comes with it, they are therefore not ready to adopt the initiative.

4.4.2 Time

The findings of this study also show that another challenge impeding the adoption of green logistics by construction companies was over-reliance on international suppliers for some of the materials and equipment required and to use the JIT system. As a result, when under pressure companies are mostly forced to extend their production times. Extended time of production means that the contractors cannot adopt JIT but will require storage of materials well before the task is performed. Their argument on international purchase also means that to avoid disruptions they need to keep materials in stock which is against JIT principles and which also results in congested on-site storage. The challenge of using JIT strategy was indicated in an excerpt that:

> *"... Just-in-Time method of delivery is desirable but is possible if the transport networks and distribution centres are well established ... storage houses and depots are not well spread around the country and many are concentrated around cities yet our works are nationwide." [CC10]*

It is important to note that the extension of production time increases more energy and more emissions of carbon dioxide, oxides of nitrogen and other gases into the atmosphere.

4.4.3 Reliability

Road transport and air transportation are the least environmentally efficient modes of transport but the participants preferred them. This is probably because road and air transport still remains the most common mode of transport because Botswana is a landlocked country. The overuse of road transport in Botswana certainly significantly contributes to the emission of greenhouse gases. Dependence on the road transport was shown in a comment from one respondent that:

> *"Road is the best option for us… it's much dependable and accessible than the other modes here in Botswana. We resort to air transport especially for delicate materials which cannot be transported by the longest and safer modes of transport." [CC9]*

4.4.4 Warehousing

Although green logistics discourages the keeping of too much inventory;acccording to the respondents there are still limited options of storing goods, suggesting that the issue of congestion and space consumption is still not being addressed. One respondent highlighted thus:

"Inventories have to be kept and whatever is kept has to be enough for as long as possible and space is so much needed for such inventories." [CC7]

This also suggests that as long as the distribution network is not well structured, the geographical positioning of construction supplies, vehicles and equipment is a challenge for the adoption of green logistics initiatives. The above findings suggest that a number of grey areas still exist in construction as far as green logistics is concerned.

4.5 PROSPECTS FOR ADOPTING GREEN LOGISTICS PRACTICES

This section discusses the opportunities of using green logistics as identified by the respondents in Figure 4.9. During the interviews the Project Managers claimed to have an idea about green logistics. They claimed to be aware of the prospects of green logistics initiatives in terms of sustainability.

The findings of this study suggest that construction companies are aware of the significant contribution of their industry to the destruction of the environment through the use of construction vehicles and equipment and sourcing of materials together with the storage thereof. One respondent highlighted thus:

"…construction works taking place for example at the Kazungula bridge affects even the animals through the noise coming from the drilling, frequent deliveries and running equipment." [CC2]

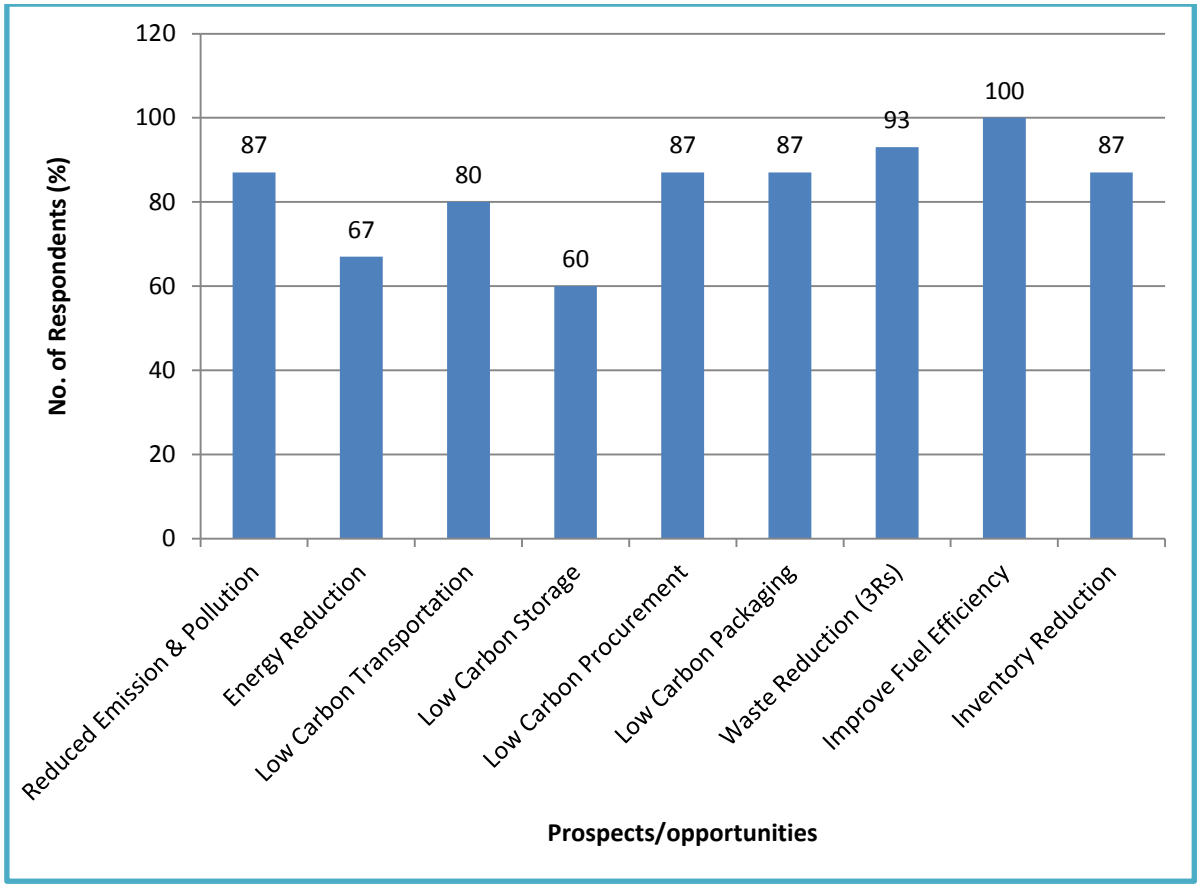

Figure 4. 8: Prospects and opportunities for adopting green logistics

Source: Author, 2019

4.5.1 Reduced emissions and pollution

Responses in Figure 4.8 indicate consensus on the point that construction works make too much noise and pollute the water bodies during construction of dams, bridges and roads. It also pollutes the air with the dust which rises when materials are being transported from the supplier to site and from site to site. That the workers were concerned about pollution and the realise the opportunities brought by adopting green logistics strategies is highlighted in the following report by one of the respondents:

> *"... from my understanding of green logistics and from the articles promoting green environment, there obviously will be reduced emissions and pollution." [CC13]*

4.5.2 Energy reduction

Participants were also of the interpretation that if green logistics strategies are adopted through the adoption and use of solar energy and green energy recovery for example,

energy use can be reduced. They highlighted that the construction industry uses a lot of energy such as electricity, diesel, petrol and gas with a lot of it tied to large construction vehicles so the green initiatives can help in modal selection and in choosing vehicles and equipment which has efficient engines.

4.5.3 Low carbon transportation

Participants indicated that the adoption of green logistics initiatives through using electric driven vehicles and equipment may result in low carbon transport. Therefore, the benefits will be clean air and fewer accidents from well-maintained vehicles. Furthermore, the participants indicated that if they choose building materials that are manufactured, pre-assembled and pre-cut locally, they could reduce carbon since the materials will be transported for a lesser distance.

4.5.4 Low carbon storage

Participants indicated that green logistics initiatives can assist in achieving low carbon storage. This is because, for example,

> *"… if there is use of battery powered forklifts, fuel use will be reduced and that benefits the environment… Similarly, recycled wood and steel for building our site storage could add to the reduction of carbon." [CC8]*

4.5.5 Low carbon packaging

The participants pointed to the use of second-hand pallets, intermediate bulk containers, big bags, steel drums and ropes as initiatives to promote low carbon packaging. The research also found that the silica gel bags can be reused for most of the electronics in storage to absorb moisture. One respondent encourages that his staff puts them aside to be used when they move items and gadgets susceptible to moisture from site to site. Moreover, after the completion of the project the silica gel bags would save a lot of gadgets that may end up in the dumping sites prematurely.

4.5.6 Low carbon procurement

The findings highlighted that there are instances where companies received materials which did not meet their specification and they are compelled by limited time, high costs and distance to consider using them. Such practice was highlighted in the interview excerpt below:

> *"… the situation is that at times, we get excess materials which will create much residue for dumping or less materials which will mean re-ordering and re-transportation… either way, it is a problem…" [CC15]*

Nevertheless, participants perceive and believe that green logistics initiatives will and usually result in low carbon procurement.

4.5.7 Waste reduction (turning waste into valuable resources)

The findings indicated that green logistics strategies, if implemented, will possibly reduce waste and what they are requesting is that waste in the construction industry be turned into valuable resources which can be reused and recycled. One respondent did put appositely that:

> *"… from the way I see it, most of the waste comes from the materials we use, be it the products themselves or the packaging materials, so reducing, recycling and re-using can cut the amount of waste generated." [CC4]*

4.5.8 Improving fuel efficiency

Overall, the participants reported that if new generation engines are incorporated and preventive servicing and maintenance performed, there will be an improvement in fuel efficiency; hence, an opportunity for green logistics which eventually yield a green and sustainable construction industry.

4.5.9 Inventory reduction

The participants pointed out that from their understanding of Just-in-Time principles, if adopted, will reduce inventory both in-transit and in site storage, thus an opportunity for a green environment through reduced carbon emission.

4.6 CHAPTER SUMMARY

Green transportation is mostly associated with the transport and logistics sector and contractors expect green logistics initiatives to be incorporated by the respective sector. Most justifications for adoption of strategies are aligned to economic reasons than the environment. Open yards type of storage sites are the most common and these are meant for temporary storage at construction sites. This being the case, the contractors see no reason of investing so much on the layout and sustainable storage systems. Strategies are however in place for storage and handling of hazardous substances.

Packaging is linked to the manufacturing and distribution industry. The contractors mention the use of packaging only when transporting materials from site to site where more of the responsibility is given to the transporter for example. Strategies on green procurement are visible though they have an economic justification on the part of the contractors. Collection and management of data is done with less attention being placed on the effects which the use of resources and equipment have on the environment. Responsibility for waste is delegated to waste contractors and there is less to no follow-up to what happens after the contractors collects the waste.

The general feeling of the participants was that most of the strategies mentioned can only be a success if the infrastructure allows such. Until and unless the construction issues, technical and administration issues are addressed, the adoption of green logistics can really be a challenge for the construction industry of Botswana. They also argued that there was need for them to work closely together with transporters, suppliers and the government if this should be a success otherwise each party will be chasing its own goals. It is desirable to recognise green procurement in the sourcing of materials, green transportation in the delivery of materials and green warehousing in the storage of materials; thus, ensuring and implementation of green logistics right up to the end of the production process.

CHAPTER 5

5 SUMMARY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This study set out to investigate the nature and extent of green logistics practices implemented by large construction companies in Botswana and challenges experienced by the same in their efforts to implement green practices. The objectives and subsequent research questions were as follows:

The specifically addressed objectives of this study were to:

- Identify the green logistics practices in large construction companies in Botswana.
- Ascertain the challenges in adopting green logistics practices in large construction companies in Botswana.
- Investigate causes of the challenges experienced by large construction companies in adopting green logistics practices in Botswana.
- Establish the opportunities available for future operations of the large construction companies in Botswana.

This study endeavoured to achieve the above set objectives through answering the following questions:

- What are the green logistics practices adopted in the large construction companies in Botswana?
- What are the challenges faced by the large construction companies in adopting green logistics practices in Botswana?
- What causes the challenges faced by the large construction companies in adopting green logistics practices in Botswana?
- Which opportunities or options are available for future operations of the large construction companies in Botswana?

The study also aimed at collecting qualitative data from the large companies in the construction industry in Botswana through implementation of inductive and interpretative approach. This chapter consolidates the key findings of this study and details inferred conclusions that influence the recommendations for further studies or policy implications.

Fig 5.1 provides the framework which guided the whole research process and facilitated the achievement of the research objectives. The practices which were investigated included green transport, green warehousing, green packaging, green procurement, green data collection and management together with waste management. Research questions were designed to try to identify the presence of green logistics practices within the large construction companies in Botswana. The answers to interview questions provided the extent to which the practices are being implemented. The research however did not cover cross elasticities of demand to measure travel behaviour such as changes brought about by changes in transport fares, changes in vehicles operating costs or price changes in other modes of transport.

The framework assisted in ascertaining the challenges experienced by large construction companies in adopting green logistics practices. Literature had indicated that the main sources of the challenges lie in construction, organisational and technical issues. The study then sought to establish these issues from the companies representing the industry. A further investigation was done to come up with the possible causes for the challenges because the challenges suggested that there are some other underlying factors behind their existence. Interviews were therefore used to test whether cost, time, reliability and warehousing paradoxes had a bearing on the challenges. Out of the nine anticipated prospects on the framework, the interviews confirmed all of them, though at different ratings.

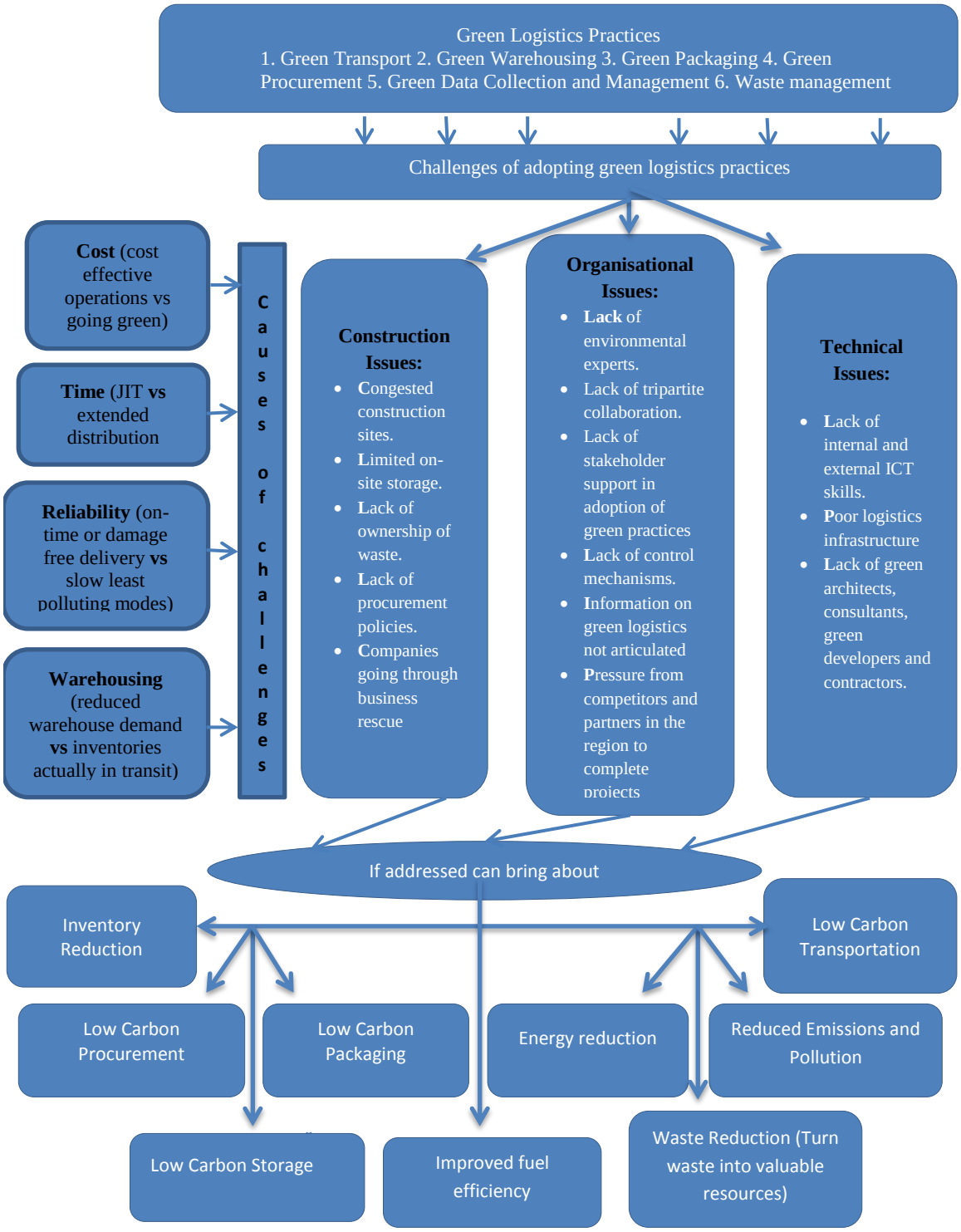

Figure 5.1: FRAMEWORK FOR DATA ANALYSIS

Source: Author, 2019

The framework worked well to keep the study in context and within the defined parameters.

5.2 MAJOR FINDINGS OF THE STUDY

5.2.1 Awareness on Green Logistics

Green logistics is gaining popularity because of its association with the trending word "green" and the qualitative results revealed that 75% of Botswana's construction industry companies were aware of the phenomenon, and this magnitude warranties the study of green logistics in the construction industry very significant. However, it is important to note that, their level of awareness did not directly imply implementation of the known green logistics approaches. It can be inferred from the findings that implementation of green logistics practices is still limited in the construction industry of Botswana.

5.2.1.1 Green transportation

Evidence suggests that most of the companies are influenced by cost savings rather than environmental consciousness and recognition of environmental consequences brought by implemented projects. This is likely because environmental management has both direct and indirect costs which are experienced by companies; hence, their limited involvement to such practices. Nevertheless, this study revealed that green logistics strategies are not really a burden in trying to sustain and stimulate the building construction sector in terms of growth, but rather have indirect or direct incentives to both the environment, communities and the company, since costs are saved in the long run.

5.2.1.2 Green warehousing

Based on the findings of this study it can be deduced that green warehousing is considerably implemented in the construction industry in Botswana as evidenced by a relatively high rate of materials handling equipment ranging from pneumatic, hydraulic to mechanical driven which positively contribute to the greening of the environment.

5.2.1.3 Green packaging

The findings of this study show that construction companies are maximising unitisation, avoiding hazardous substances, and utilising reusable, recoverable and recyclable

packaging. Thus, such practices reported by companies reflected that they were considerate to the environment. Despite indications towards environmental friendliness, few of the interviewed companies were environmentally certified, suggesting that there is minimal green logistics initiatives incorporation by companies.

5.2.1.4 Green procurement

The findings of this study show that there is relatively high levels of green procurement compared to other forms of green practices, and that all of the interviewed construction companies performed inspections from receipt of materials to its use and up to the final product. Thus, the inspections are performed upon receipt of materials, during the construction process and after the project is completed.

5.2.1.5 Green data collection and management

The key findings of this study suggest that large companies within the construction industry limitedly incoporate green data collection and management and all companies largely used paper, electronic material, tablets, laptops and biometric gadgets to collect and manage data, of which all have impact to the environment during their use or at disposal stage.

5.2.1.6 Challenges of implementing green logistics practices

Much is expected from the large construction companies who are likely to have a greater impact on the environment through their large scale projects. The findings of this study revealed that several companies faced various challenges hampering the implementation of green logistics initiatives. Business crisis due to non compliance limited devotion of their resources in promoting green logistics or green construction because such practices become not a business priority when in such situations. Based on the findings of this study, green transportation is limitedly practiced since the reportedly dominant mode of transport was road. Road transport has relatively higher impact on the environment as compaired to rail which is a green-inland mode and was reported to be used by a minority due to its time inefficiency in Botswana. It can therefore be inferred that there is limited commitment towards the greening of the environment by construction companies and this

is noted through practices where costs saving usualy preceed the environment consideration as reported by this. Furthermore, congested construction sites (especially those in the built-up areas) and limited on-site storage presented storage and operation challenges for construction companies. Other noted challenges include:

- Limited procurement policies and ownership of waste, thus, presenting difficulties in implementation, enforcement and monitoring of green logistics practices in the construction industry.
- Limited environmental experts on the ground to raise awareness and disseminating information concerning sustainability in the construction industry.
- Absence of tripartite collaboration which would assist as consolidated efforts are needed in the implementation process.
- Limited funding and incentives towards implantation of green logistics for the construction companies to commit.
- Limited ICT personnel in the nation hinders implantation of technology incorporated in green logistics.

5.2.2 Causes of the challenges for implementing green logistics practices

The findings of this study show that more of the underlying factors to the challenges experienced by large construction companies in adopting green logistics practices rest in cost, time, reliability and warehousing. Cost effectiveness in operations is against going green. Every process is monitored and every operation should endeavour to minimise costs; and the rule for productivity to them means less inputs for more outputs. In such a situation, it is clear that green initiatives become an option. This also means there is less room in accommodating environmental experts, and hiring internal and external ICT skills. Stakeholders mostly where funds are required, they take a back stage if they do not see the return on investment. To them, going green is not a priority as long as it does not add to the profit margin..

The issue of time came up as a factor underlying the challenges and this was pronounced in terms of large construction companies having to rely on extended production and the traditional methods of distribution where inventory is kept in large quantities in anticipation of shortages and to cut on transportation cost through consolidation. Just-in-Time which supports green logistics is not given a priority and an argument placed is

that, the logistics infrastructure in Botswana does not allow for JIT principles to be adopted. This is what has led to congested sites and limited on-site storage resulting in more frequent and peak hour deliveries.

Green logistics promotes slow and least polluting modes of transport such as rail but in construction business, the Project Managers work with time lines looking at the number of projects and tasks to be completed and running along the critical path is what they consider the most important. They would therefore prefer freight being delivered undamaged and timely by the fastest modes of transport which makes the use of road most popular and also import sea.

Over-reliance on international suppliers for most of the construction materials coupled with extended production results in the accumulation of materials. Instead of warehouses being reduced, there is a need to increase them which results in more inventory being kept in storage. This accumulation may also mean accumulation of waste from expired materials and residue from packaging materials making it difficult for the sorting of waste into recyclable, reusable and disposable.

5.2.3 Prospects for adopting green logistics practices

There is high anticipation that if implemented, green logistics practices can go an extra mile in reducing pollution, reducing emissions, reducing energy, reducing inventory and reducing waste. The other prospects expected by the construction experts include lowered carbon transportation, lowered carbon storage, lowered carbon packaging and lowered carbon procurement. Fuel efficiency is also expected to improve. This is an indication that green logistics practices' advantages and opportunities are known within the construction industry and if challenges to implementation are dealt with, then there can be a new experience.

5.3 LIMITATIONS OF THE STUDY

Limited time on the part of the participants was one of the limitations faced by the researcher. The researcher was compelled to exercise maximum tolerance because the interviewees being people of responsibility, had deadlines to meet therefore needed a great deal of patience. However, the good thing was that once an appointment was

scheduled, the interviews were carried out accordingly. The issue of confidentiality required a great deal of assurance because most managers were worried about where the collected data was going to be used. This was countered by explaining how the responses were going to be coded. This resulted in a buy in and the interviews continued as planned. The sample from which data was drawn did not cover the entire construction industry and this survey was specifically for the large construction companies operating in Botswana. The implication therefore is that a study on smaller construction companies in Botswana might produce totally different results. Most of the participants had to be interviewed at the construction sites which meant movements to respective sites. Rescheduled appointments meant that the researcher had to do return trips as per the convenience of the participant.

5.4 CONCLUSIONS

The following conclusions can be drawn from this study:

Given the study findings it can be deduced that there is limited efforts towards adoption and implementation of green logistics in the construction industry in Botswana. However, given high levels of awareness on green logistic practices, its implementation and incorporation in the future is anticipated. Furthermore, there are limited large companies maximising the implantation of green logistics practices in Botswana. There are several challenges that contribute to limited uptake of green logistics practices by large construction companies in Botswana. These challenges revolve around construction, organisational and technical issues. High levels of awareness on green logistics present opportunities and probability of implementation in future. Implementation is likely to result in reduced emissions and pollution; energy reduction; low carbon transportation; low carbon storage; low carbon packaging; low carbon procurement; waste reduction (turning waste into valuable resources); improved fuel efficiency and inventory reduction.

The research therefore satisfied the four objectives which it intended to and answered the subsequent research questions questions. There was an identification of the green logistics practices in large construction companies in Botswana and the challenges faced in adopting the practices were ascertained. An investigation into the causes of the challenges experienced by large construction companies pointed mainly to the paradoxes of adopting green logistics practices. The opportunities available for future operations of

the large construction companies in Botswana were also drawn.

5.5 RECOMMENDATIONS

5.5.1 Recommendations and Contribution to Policy and Future research

The challenges of implementing and incoporating green logistics by several construction companies requires enforcement of policies, regulations and ethical responsibilities by all concerned parties; which includes law enforcement agents, policy makers and implementers as well as the contractors engaged in the construction industry. These findings directly inform construction company policies and strategies that would reduce the challenges associated with the adoption of green transportation, green warehouse gases, promote green packaging, green procurement and waste management.

Due to limited studies on intensified incorporation of green logistics and sustainance of construction industry in Botswana, this study can be utilised to benchmark on the subject by organisations and construction companies intending to implement green logistics practices in the construction industry. Furthermore, tertiary institutions such as University of Botswana, Botswana International University of Science and Technology, Botswana Open University, BA ISAGO University, Botho University, New Era and others with specialities on the built environment should intensify research on green logistics in the construction industry in Botswana in order to provide guidance to the large construction companies.

5.5.2 Recommendations for the large construction companies and other stakeholders entailed in Green Logistics

The following recommendations are made after careful analysis of the findings of this study:

- The large construction companies should work with environment experts to gainfully understand good practices and significant benefits of green logistics practices in construction logistics.
- There should be facilitation of coordination between contractors; project owners; project managers; the government; consultants; suppliers, manufacturers, society,

NGOs and tertiary institutions in relation to green logistics and green environments.

- The stakeholders should play a role in ensuring green practices, that is:
    - Owners of projects should consider environmental aspects in awarding contracts and in assessing the quality and costs incurred towards the environment;
    - Manufacturers should consider innovative technologies to design and manufacture green materials;
    - Consultants should assist by selecting green materials in the project specifications;
    - Contractors should incorporate green logistics practices into their strategic plans and have a stand alone specific team for environmental issues that would provide training sessions for employees on green logistics;
    - All companies must get environmentally certified (ISO 14001) and select suppliers according to environmental performance;
    - Civil society and non-governmental organisations should be on the ground to report any violations and non-compliance and to enforce the adoption and implementation of green logistics practices;
    - Project managers should train and educate team members on the prospects of implementing green logistics practices.

Based on the findings of this study, there is a need for inclusive decision making and raised awareness and implementation of green construction logistics. This therefore, stimulates future research in the field of green logistics, particularly on the establishment of the circular economy in Botswana because the circular systems employ, reuse, share, repair, refurbish, remanufacture and recycle to create a close-loop system, minimising the use of resource inputs and reducing the creation of waste, pollution and carbon emission. It will be a delight to have Botswana be among the African nations who are forming the Africa Circular Economy Network as indicated in Fig 2.11 after adopting a number of green initiatives. Botswana can learn from for example, Rwanda's e-waste recycling facility, Mauritius's closed loop waste management system, Kenya's biomass and recycled plastic, Angola's recycled tyres together with South Africa and Zimbabwe's biomimicry principles.

REFERENCES

African Circular Economy Network, 2019. *Welcome to The African Circular Economy Network.*
Available from:<https://www.acen.africa/>
[Accessed 07 January 2010]

Ahmad, I., Rehan, M., Balkhyour, M. A., Abbas, M., Basahi, J. M., Almeebi, T. & Ismail, I. M. I. 2016. Review of Environmental Pollution and Health Risks at Motor Vehicle Repair Workshops: *Challenges and Perspectives for Saudi Arabia. International Journal of Agricultural and Environmental Research,* 2(1):1-23

Albekov, A. U., Parkhomenko, T. V., & Polubotko, A. A. 2017. Green Logistics in Russia: The Phenomenon of Progress, Economic and Environmental Security. *European Research Studies* 20(1);13 – 21

Almohsen, A. & Ruwanpura, J., 2013. Logistics Management In Construction Industry. Proceeding of the International Council for research and Innovation in Building and construction (CIB), W78-W102, 2011, *International Conference, France*, 26- 28 October.

Alvi, M.H. 2016. A Manual for Selecting Sampling Techniques in Research.
Available from:https://mpra.ub.uni-muenchen.de/70218/
[Accessed 17 March 2020]

Ambec, S., & Lanoie. P. 2008. Does it pay to be green? A systematic overview. *Academy of Management Perspectives,* 22(4);45–62.

American Cancer Society, 2019. *Microwaves, Radio Waves, and Other Types of Radiofrequency Radiation.*
Available from:< https://www.cancer.org/cancer/cancer-causes/radiation-exposure/radiofrequency-radiation.html>
[Accessed 06 January 2020]

Anyango, A. 2019. *Top construction companies in Botswana.* [online]
Available from:< https://constructionreviewonline.com/2019/01/top-construction- companies-in-botswana/>
[Accessed 13 December 2019]

Arden, J. 2012. Five Easy Ways to Green Your Warehouse [online].
Available from:< http://www.bizenergy.ca/how-tos/five-easy-ways-to-

green-your- warehouse/>
[Accessed 26 May 2017].

Arif, D. B., Tahsin, T. S. & Monty, S. 2012. *"Construction waste management in India: an exploratory study"*, Construction Innovation, 12(2):133-155.

Ary, D., Jacobs, L. C. & Sorensen, C. 2010. *Introduction to Research in Education.* 8th ed. Wadsworth: Cengage Learning.

Asmi, A., Azis, A., Memon, A, H. and Latif, Q. B. A. I. 2012. *Challenges Faced by Construction Industry in Accomplishing Sustainable Goals. Conference: 2012 IEEE Symposium on Business, Engineering and Industrial Applications (ISBEIA),* At Hyatt Regency Bandung, Indonesia.

Atkinson, W. 2017. *Getting Lean and Going Green: Innovations in Warehouse Operations* [online].
Available from:< http://www.inboundlogistics.com/cms/article/getting-lean-and-going-green-innovations-in-warehouse-operations/>
[Accessed 26 May 2017]

Ayman O. A., Shaaban, E. A. H. 2012. Public-private partnership for lean sustainable development in construction. *Journal of Construction Project Management and Innovation,* 2(2): 377-402

Azis, A. ,A. A., Memon, A. H., Rahman, I. A., Nagapan, S. & Latif, Q. B. A. I. 2012. Challenges faced By Construction Industry in Accomplishing Sustainablity Goals. *2012 IEEE Symposium on Business, Engineering and Industrial Applications.*

Bagdoniené, D., Galbuogiené, A. & Paulaviíiené, E. 2009. Darnios organizacijos koncepcijos formavimas visuotinés kokybés vadybos pagrindu [Formation of the Conception of Sustainable Organization on the Basis of Total Quality Management], *Ekonomika ir vadyba [Economic and Management]* 14:1044-1052.

Bailey, S.A., Chan, F.T., MacIsaac, H.J., 2015. Relative importance of vessel hull fouling and ballast water as transport vectors of nonindigenous species to the Canadian arctic. *Canadian Journal of Fisheries and Aquatic Sciences* 72 (8), 1230–1242.
Available from:<https://www.nrcresearchpress.com/doi/full/10.1139/cjfas-2014- 0473#.XgygPpMzbIU and Aquatic Sciences

Bakker, C., M. Den Hollander, E. Van Hinte, and Y. Zljlstra. 2014. *Products that last: Product design for circular business models*: TU Delft Library.

Balkyte, A. & Tvaronavicienė, M. 2010. Perception of competitiveness in the context of sustainable development: facets of "sustainable competitiveness". *Journal of Business Economics and Management* 11(2): 341-365.

Bartholdi, J.J. III & Hackman, S.T. (2016), *Warehouse and Distribution Science*, Georgia Institute of Technology, Atlanta, GA.

Berns, M., Townend, A., Khayat, Z., Balagopal, B., Reeves, M., Hopkins, M.S and Kruschwitz, N. 2009. "The Business of Sustainability: What It Means To Managers Now". *MITS Loan Management Review*, 51(1): 20-26.

Besch, K.M., & Pålsson, H. 2016. A Supply Chain Perspective on Green Packaging Development-Theory Versus Practice. *International Journal on Packaging Technology and Science*. 29: 45–63

Best, J. W. & Kahn, J. V. 2003. Research in Education. Boston: Library of. Congress Cataloguing-in-Publication data.

Bilbao, A. M., Carrano, A. L., Hewitt, M. & Thorn, B. K. 2011. On the Environmental Imapcts of Pallet Management Operations. *Management Research Review*, 34(11):1222-1236

Boadu, P. 2014. Embracing Green Supply Chain Practices In The Construction Industry, The Case Of Construction Firms In The Kumasi Metropolis And Its Environs. *Researchjournali's ournal of Management* 2(6) ISSN 2347-8217
Available from:< https://www.academia.edu/8209151/Embracing_Green_Supply_Chain_Practices_In_The_Construction_Industry_The_Case_of_Construction_Firms_in_the_Kumasi_Metropolis_and_its_Environs
[Accessed 09 February 2020]

Borowy, I. 2013. *Defining Sustainable Development for Our Common Future: A History of the World Commission on Environment and Development (Brundtland Commission).* New York: Routledge.

Borthakur, A. & Singh, P. 2012. Electronic Waste in India: Problems and Policies. *International Journal of Environmental Science.* 3(1)
Available from:< https://doi:10.6088/ijes.2012030131033 >
[Accessed 15 May 2019]

Bowersox, D. J., Closs, D.J. and Cooper, M. B. 2010. *Supply Chain Logistics Management.* 3rd ed. New York: McGraw-Hill Inc.

Braun, V. and Clark, V. 2006. Using Thematic Analysis in Psychology. *Qualitative Research in Psychology, 3, NB 77-101.*

Central Statistics Office, 2019. *Transport & Infrastructure Stats Brief Q2 2019* [online]
Available from:< http://www.statsbots.org.bw/sites/default/files/publications/Transport%20%20%26%20Infrastructure%20Stats%20Brief%20Q2%202019.pdf>
[Accessed 14 December 2019]

Cherrett, T., McLeod, F., Maynard, S., Hickford, A., Allen, J. & Browne, M. 2009. Understanding retail supply chains to enable Greener logistics.*14th Annual Logistics Research Network Conference.* Cardiff, September 9-11.

Chopra, G. A. and Meindl, P. 2010. *Supply Chain Management; Strategy, Planning and Operation.* Boston: Pearson.

Clary, F. 2013. *10 Trends Driving Greener Supply Chains* [online].
Available from:
<http://www.inboundlogistics.com/cms/article/10-trends-driving-greener-supply-chains/>
[Accessed 03 November 2015]

Cleary, M. 2014. Data collection and sampling in qualitative research: does size matter? Leading Global Nursing Research.
Available from:<https://doi.org/10.1111/jan.12163>

Cohen, L. & Manion, L. 1994. *Research methods in education,* 4th ed, London: Longman.

Construction Excellence. 2008. *Key issues in Sustainable Construction* [online].
Available from:
< http://constructingexcellence.org.uk/resources/key-issues-in-sustainable-construction/ >
[Accessed 24 May 2017]

Cooper, D. R. and Gutowski. T. G. 2017. The Environmental Impacts of Reuse: A Review. *Journal of Industrial Ecology* 21(1): 38-56.

Cooper, D. R. & Schindler, P. S. 2006. *Business Research Methods.* Boston: McGraw-Hill Irwin

Council of Supply Chain Management Professionals (CSCMP). 2019. CSCMP Supply Chain Management Definitions and Glossary. Available from: <https://cscmp.org/CSCMP/Educate/SCMDefinitionsandGlossary_of_Terms.aspx> [Accessed 17 December 2019]

Crist, P., 2009. Greenhouse gas emissions reduction potential from international shipping (No. 2009-11). *OECD/ITF Joint Transport Research Centre Discussion Paper*. Retrieved from:. http://hdl.handle.net/10419/68758.

Cullinane, K. & Cullinane, S., 2013. Atmospheric emissions from shipping: The need for regulation and approaches to compliance. Transport Reviews 33 (4), 377–401.

Cullinane, S.L. 2014. *Greening Logistics: Sustainable Best Practices.* SEStran document prepared in partnership with TRI. June 2014.

Dadhich, P., Genovese, A., Kumar, N & Acquaye, A. 2015. Developing sustainable supply chains in the UK construction industry: A case study *Int. Production Economics.*164:271–284.

Daly, M., & Butler, T. 2009. Environmental responsibility and green IT: An institutional perspective. In Proceedings of the 17th European Conference on Information Systems. Verona, Italy: *Association for Information Systems*, 2009, paper 10.

Dedrick, J. 2010. Green IS: Concepts and issues for information systems research. *Communications of the Association for Information Systems*. 27(1); 173–184.

Delmas, M. & Blass, V. D. 2010. "Measuring Corporate Environmental Performance: The Trade-Offs of Sustainability Ratings," *Business Strategy and the Environment*. 19(4); 245–60.

Delmas, M., & Toffel, M.W. 2004. Stakeholders and environmental management practices: *An institutional framework. Business Strategy and the Environment*, 13(4), 209–222.

Denscombe, M. 1998. *The good research guide for small-scale social research projects*, Buckingham: Open University Press.

Denzin, N. K., & Lincoln, Y. S. 2005. *The SAGE Handbook of Qualitative Research* 3rd ed. Thousand Oaks: Sage Publications.

DEFRA, 2007. Annex C2: Commercial and Industrial Waste. *Waste Strategy for England 2007* Annexes.

Department of Statistics Botswana. (2012). *2011 Population and Housing census – Population of Towns and associated localities.* Gaborone: Department of Government Printing and Publishing Services.

DiBacco, C., Humphrey, D.B., Nasmith, L.E. & Levings, C.D., 2012. Ballast water transport of non-indigenous zooplankton to Canadian ports. *ICES Journal of Marine Science* 69 (3), 483–491.

Dowlatshahi, S., 2000. *Developing a theory of Reverse Logistics. Interfaces.* 30(3); 143- 155. http://dx.doi.Org/10.1287/inte.30.3.143.11670

DST Consulting Engineers, 2019. *Material Testing, Inspection & Quality Control Services.*
Available from:
<https://www.dstgroup.com/services/geotechnical-engineering/material-testing-inspection-quality-control-services/>
[Accessed 06 January 2020]

Elhedhli, S. & R. Merrick, 2012. Green supply chain network design to reduce carbon emissions. *Transport. Res. D-Tr. E.,* 17(5): 370-379.

EllenMacArthurFoundation. 2017. *Achieving ‚Growth Within': A €320-Billion Circular Economy Investment Opportunity Available to Europe to 2025*.

European Commission. 2015. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Closing the loop - An EU action plan for the Circular Economy. Brussels: European Commission.

Emmet, S. & Sood, V. 2010. *Green Supply Chains: an Action Manifesto.*294 p. ISBN 0470689412.

Etikan, I., Musa, S. A. & Alkassim, R. S. 2015. Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics.* 5(1):1-4.

Etikan, I., Alkassim, R. S. and Abubakar, S. 2015. Comparision of Snowball Sampling and Sequential Sampling Technique. *Biometrics & Biostatistics International Journal.*3(1): 00055

European Commission, 2004. *Protecting the environment and economic growth: trade-off or growth-enhancing structural adjustment*?
Available from:<

https://ec.europa.eu/economy_finance/publications/pages/publication7726_en.pdf [Accessed 09 February 2020]

European Concrete Platform, 2009. *Sustainable Benefits of Concrete Structures*. Available from: <https://www.theconcreteinitiative.eu/images/ECP_Documents/SustainableBenefitsConcreteStructures_EN.pdf> [Accessed 06 January 2019]

Fidel, R. 1993. *Qualitative methods in information retrieval research, Library and Information Science Research* 15 (1993), 219–247.

Florio-Ruane, S. 1991. *Conversation and narrative in collaborative research, in: Stories lives tell: Narrative and Dialogue in Education*, C. Witherell and N. Noddings, eds, New York: Teachers College Press. pp. 234–256.

Gadenne, D.L; Kennedy, J. & McKeiver, C. 2009. An empirical study of environmental awareness and practices in SMEs. *Journal of Business Ethics*. 84(1); 45–63.

Gechevski, D., Kochov, A., Popovska–Vasilevska, S., Polenakovik, R. & Donev, V. 2016. Reverse Logistics and Green Logistics way to Improving the Environmental Sustainability. *Acta Technica Corviniensis-Bulletin of Engineering*. 9(1):63

Ghisellini, P., C. Cialani, & S. Ulgiati. 2016. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal ofCleaner Production* 114: 11-32.

Given, L.M. 2016. *100 Questions (and Answers) About Qualitative Research*. Sage, Thousand Oaks.

Glaser, B., & Strauss, A. (1967). The Discovery of Grounded Theory: Strategies for Qualitative Research. Mill Valley, CA: Sociology Press.

Grote, M., Mazurek, N., Grabch, C., Zeilinger, J., Le Floch, S. & Wahrendorf, D., 2016. Dry bulk cargo shipping—An overlooked threat to the marine environment? *Marine Pollution Bulletin* 110 (1), 511–519.

Google Earth (2018). *Geographical location of Botswana*

Gomm, R., Hammersley, M. and Foster, P. 2000. Case study and generalization, in: *Case study method*, R. Gomm, M. Hammersley and P. Foster, eds, London: Sage. pp. 98–115.

Goransson, H. and Gustafsson, H. S. 2014. *Green Logistics in South Africa. A Study of the Management Perceptions in The Road Transportation Industry in South Africa.* Umea: UMEA University.

Grady, M.P. 1998. Qualitative and Action Research: *A Practitioner Handbook. PhiDelta Kappa Educational Foundation,* Bloomington (1998)

Guochuan, Y. 2010. Constraints and counter measures of China's Green Logistics Development. *Journal of Business Economics* 2:18-23.

Eves, J. 2016. *Benefits of Environmental Certification. 'Zero Waste to Landfill' helps organizations gain market share.* concur
Available from:
<https://www.qualitydigest.com/inside/management-article/benefits-environmental-certification-051016.html>
[Accessed 06 January 2019]

Eyring, V., Isaksen, I.S.A., Berntsen, T., Collins, W.J. Corbett, J.J., Endresen, O. & Stevenson, D.S. (2010). *Transport impact on atmosphere and climate: Shipping. Atmospheric Environment*, 44 (37), 4735–4771.

Hahn, T., Figge, F., Pinkse, J. & Preuss, L. 2010. Trade-offs in corporate sustainability: you can't have your cake and eat it. *Business Strategy and the Environment.* 19(4): 217–229.

Hair, J., Bush, R. & Ortinau, D. 2006. *Marketing Research: Within a changing environment.* 3rd ed. New York, USA:McGraw Hill.

Hamzeh, F.R., Tommelein, I. R., Ballard, G.& Kaminsky, P. M. 2007. *Logistics Centers To Support Project based Production In The Construction Industry.* Proceedings IGLC- 15, July 2007, Michigan, USA

Harker, A., Allcorn, W. & Taylor, D. 2007. *Waste minimisation in construction* [online]. Material logistics plan good practice guidance.
Available from:
<http://www.wrap.org.uk/sites/files/wrap/MLP%20Guidance%20Document.pdf>
[Accessed 05 November 2015]

Hileman, J., Ortiz, D., Waitz, I., Wong, H.M., Donohoo, P., Mahashadbe, A., Weiss, M., & Bartis., J., 2008. *"Alternative jet fuels," Santa Monica, California: RAND Corporation, forthcoming.*

Hitt, M. A., Keats, B. W., & Demarie, S. M. 1998. Navigating in the New Competitive Landscape: Building Strategic Flexibility and Competitive Advantage in the 21st Century. *The Academy of Management Executive.* 12(4); 22-42.

Holden, M.T., and Lynch, P. (2004). Choosing the appropriate methodology: Understanding Research Philosophy. *The Marketing Review*, 4(4), 347-409.

Hu, P.J., Hu, H., Wei, C. & Hsu, A. P. 2016. Examining Firms' Green Information Technology Practices: A Hierarchical View of Key Drivers and Their Effects. *Journal of Management Information Systems.*33(4); 1149–1179.

Isaksson, K. & Huge-Brodin, M. 2010. "Driving forces and barriers when pricing the environmental service offering, a cross case study of logistics companies, in Whiteing, T. (ed.) *Towards the Sustainable Supply Chain: Balancing the Needs of Business, Economy and the Environment, Proceedings of the 15th Annual LRN Conference*, Harrogate, UK, 303-311.

ITOPF, 2017. *Oil Tanker Spill Statistics 2016.*
Available from:
<http://www.itopf.com/fileadmin/data/photos_Publications/Oil_Spill_Stats_2016_l ow pdf.

Jakubiak, M. 2015. *Environmental impact of air transport - case study of Krakow Airport.*
Available from:
<https://www.researchgate.net/publication/280938169_Environmental_impact_of_air_transport_-_case_study_of_Krakow_Airport>
[Accessed 06 January 2020]

Jay, J. 2013. "Navigating Paradox as a Mechanism of Change and Innovation in Hybrid Organizations," *Academy of Management Journal*. 56(1); 137–59.

Jedlinski, M. 2014. The position of green logistics in sustainable development of a smart green city. *1st International Conference Green Cities 2014 – Green Logistics for Greener Cities. Procedia – Social and Behavioral Sciences* 151:102–111.

Kasambira, P. 2014. *Education, Administration and Management.* Gweru, Modern Press Pvt Ltd.

Kenne. J. P., Dejax, P. & Gharbi, A. 2012. Production planning of a hybrid manufacturing - remanufacturing system under uncertainty within a closed-loop supply chain. *International Journal of Production Economics,* 135, 81–93

Kilbert, C.J., Thille, L., Peterson, A., Monroe, M. 2010. *The ethic of sustainability.* Retrieved February 20, 2015, from http://www.cce.ufl.edu/ethics/text/

Kim, I. 2002. *Ten years after the enactment of the Oil Pollution Act of 1990: A success or a failure.*

Available from:
<https://www.researchgate.net/publication/222054097_Ten_years_after_the_enactment_of_the_Oil_Pollution_Act_of_1990_A_success_or_a_failure/citations>
[Accessed 06 January 2020]

Kiron, D., Nina K., Knut H., Martin, R., Sonja, F., & Georg, K. 2015. Joining Forces: Collaboration and Leadership for Sustainability, *Research Report,* Massachusetts Institute of Technology
Available at <http://sloanreview.mit.edu/projects/joining-forces/>

Klassen, R.D. 2001. "Plant-level environmental management orientation: the influence of management views and plant characteristics", *Production and Operations Management,* 10(3): 257-75.

Koskinen, K. T. & Leino, T. 2018. *Sustainable Development with Water Hydraulics – Possibilities and Challenges.*
Available from:< https://www.researchgate.net/publication/228677458 >
[Accessed 13 May 2019]

Koste, L. & Malhotra M. K. 1999. A Theoretical Framework for Analyzing the Dimensions of Manufacturing Flexibility. *Journal of Operations Management,* 18; 75-93.
http://dx.doi.org/10.1016/S0272-6963(99)00010-8

Kothari, C.R. 2004. *Research Methodology-Methods and Techniques,(Second Revised Edition)* New Delhi, New Age International (P) Limited, Publishers.
Available from:< https://www.modares.ac.ir/uploads/Agr.Oth.Lib.17.pdf

Kuhn, Thomas S. 1962. *The Structure of Scientific Revolutions: The Response to Crisis,* 1st ed, University of Chicago Press.

Kuo, H. C, Li, Y., Wang, L., & Ding, C. 2006. Flexibility and Performance of MNEs: Evidence From Taiwan. *International Journal of Business,* 11(4), 417-432.

Kumar, A. 2015. Green Logistics for sustainable development: an analytical review. *IOSRD International Journal of Business* 1(1): 07-13

Kumar, R. 2005. *Research Methodology-A Step-by-Step Guide forBeginners,* (2nd.ed). Singapore, Pearson Education.

Kumar, S., S. Teichman and T. Timpernagel, 2012. A green supply chain is a requirement for profitability. Int. J. Product. Res., 50(5): 1278-1296.
Available from:< https://doi.org/10.1080/00207543.2011.571924>

Kutkaitis, A. & Zuperkiené, E. 2011. Darnaus vystymosi koncepcijos raiáka uosto logistinése organizacijose [Expression of the Sustainable Development Concept in Seaport Logistics Organizations], *Management Theory and Studies for Rural Business and Infrastructure Development* 2(26): 130-136.

Lee, S.M; Park, S.-H; and Trimi, S. Greening with IT: *Practices of leading countries and strategies of followers. Management Decision*, 51(3); 629–642.

Lehtonen, M. 2004. "The environmental – social interface of sustainable development: capabilities, social capital, institutions", *Ecological Economics*. 49(2):199-214

Lewis, M. W. 2000. "Exploring Paradox: Toward a More Comprehensive Guide," *Academy of Management Review.* 25(4); 760–76.

Lincoln, Y. S. and Guba, E. G. 2000. Paradigmatic Controversies, Contradictions, and emerging confluences. In N. K. Denzin & Y. S. Lincoln (Eds.), *The handbook of qualitative research* 2nd ed. Beverly Hills, CA: Sage; 2000. P. 163- 88.

Lincoln, Y. S. & Guba, E. G. 1994. Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 105-117). London: Sage.

Lincoln, Y. S. and Guba, E. G. 1985. *Naturalistic inquiry*, Beverly Hills: Sage.

Liu, L. 2013. A New Advanced Logistics Supply Chain for Food Management Based on Green Logistics Theory. *Advance Journal of Food Science and Technology.* 5(10): 1337-1341.

Logistics and Materials Handling. 2019. Hydrogen fuel cell van for DHL. Available from:
< https://www.logistik-express.com/hydrogen-fuel-cell-van-for-dhl/> [Accessed June 2019]

Looney, J. H. 2012. *Environmental requirements for the constructon industry* [online]. Kier Supply Chain. South East Centre for the Built Environment. Available from:
<http://www.secbe.org.uk/documents/days_2_env_req_kier.pdf> [Accessed 03 November 2015]

Lundesjo, G. 2011. Using Construction Consolidation Centres to reduce construction waste and carbon emissions. *A guide demonstrating the*

*costs and benefits of using a Construction Consolidation Centre and how it can reduce waste and carbon.*Banbury, Oxon, Great Britain.

Luscher, L. S. & Marianne L. 2008. "Organizational Change and Managerial Sensemaking: Working Through Paradox," *Academy of Management Journal.* 51(2); 221–40.

Luscher, L. S., M4arianne L. & Ingram, A. 2006. "The Social Construction of Organizational Change Paradoxes," *Journal of Organizational Change Management.* 19(4); 491–502.

M&A Community, 2019. *South Africa's construction industry pleads for government help.*
Available from:
< https://manda.co.za/artikel/south-africas-construction-industry-pleads-for-government-help>
[Accessed 06 January 2020]

MacAskill, N.D., Walker, T.R., Oakes, K., Walsh, M., 2016. Forensic assessment of polycyclic aromatic hydrocarbons at the former Sydney Tar Ponds and surrounding environment using fingerprint techniques. *Environmental Pollution* 212; 166–177.

Maguire, M. & Delahunt, B. 2017. Doing a Thematic Analysis: *A Practical, Step-by-Step Guide for Learning and Teaching Scholars.*
Available from:
< https://ojs.aishe.org/index.php/aishe-j/article/viewFile/335/553>
[Accessed 07 January 2020]

Margolis, J. D. & James P. W. 2003. "Misery Loves Companies: Rethinking Social Initiatives by Business," *Administrative Science Quarterly*. 48(2); 268–305.

Markley, M. J. & Davis, L. 2007. Exploring Future Competitive Advantage Through Sustainable Supply Chains. *International Journal of Physical Distribution and Logistics Management*, 37(9).

Marshall, C & Rossman, G. B. 1999. *Designing Qualitative Research*, 3rd ed. Newbury Park: Sage.

Matambo, K. 2015. 2015 Budget Speech. [online]
Available from:
<http://www.dailynews.gov.bw/news-details.php?nid=17364>
[Accessed 03 July 2016]

Mathers, N., Fox, N. & Hunn, A. 2002. Trent Focus for Research and Development in Primary Health Care: *Using Interviews in a Research Project*. TRENT FOCUS GROUP

McDaniel, C. & Gates, R. 2014. *Marketing Research.* 10th ed. Wiley Global Education.

McKinnon, A. 2010. Environmental Sustainability. A New Priority for Logistics Managers. Green Logistics: *Improving the Environmental Sustainability of Logistics,* London, 3-30.

McKinnon, A.; Cullinane, S.; Browne, M. & Whiteing, A. 2012. *Green Logistics: Improving the Environmental Sustainability of Logistics. 372* p. ISBN 100749456787.

McLaughlin, J. M 2001. *Accommodating Perceptions, Searching for Authenticity and Decolonising Methodology: The Case of the Australia / Papua New Guinea Secondary School Students' Project.* Paper Presented at the 29th ANZCIES Conference Curtin University of Technology Perth.

Meiduté, L & Paliulis, N. K. 2011. Feasibility study of public-private partnership. *International Journal of Strategic Property Management* 15(3): 257-274.

Merriam, S. B. 1998. *Qualitative Research and Case Study Applications in Education*, San Francisco: Jossey-Bass.

Meyer, C. B. 2001. *A Case in Case Study Methodology.* Sage Journals 13(4)

Mintcheva, V. 2005. Indicators for Environmental Policy Integration in the Food Supply Chain. *Journal of Cleaner Production,* 13: 717-731.

Mish, J. & Scammon, D. L. 2010. "Principle-Based Stakeholder Marketing: Insights from Private Triple-Bottom-Line Firms," *Journal of Public Policy & Marketing,* 29(Spring); 12–26.

Mishra, N., Kumar, V. & Chan, F. T. S. 2012. A Multi-Agent Architecture for Reverse Logistics in Green Supply Chain. International Journal of Production Research 50(9):2396-2406
Available from:< http://dx.doi.org/10.1080/00207543.2011.581003>

MIST (Ministry of Infrastructure, Science and Technology). 2011.
Available from:
<http://www.gov.bw/en/Ministries-- Authorities/Ministries/MIST-Events/Departments/Department-of-Building-and-Engineering-Services-DBES1/
[Accessed May 2018]

Mohajan, H. 2018. Qualitative Research Methodology in Social Sciences and Related Subjects. Journal of Economic Development, Environment and People, 7(1): 23-48

Mohemad, R., Hamdan, A.R., Othman, Z. A. & Maizura, N. 2010. *Decision Support Systems (DSS) in Construction Tendering Processes.* Available from:< https://www.researchgate.net/publication/43225350 > [Accessed 14 May 2019]

Mokgoabone, K. 2006. *Budget to benefit construction industry.* [online] Available from: <https://www.mmegi.bw/2006/February/Wednesday8/80788477668.html> [Accessed 03 July 2016]

Molla, A. 2008. GITAM: A model for the adoption of green IT. In Proceedings of the 19th Australasian Conference on Information Systems, Christchurch, New Zealand: *Association for Information Systems, Christchurch*, 2008, paper 64.

Monczka, R. M., Handfield, R. B., Giunipero, L. C. & Patterson, J. L. 2009. *Sourcing and Supply Chain Management.* 5th ed. International Edition. South Western; Cengage Learning.

Monnet, M. 2008. The intermediary conditions of logistics service providers in the context of sustainable development. *Supply Chain Forum* 9(2): 78-87.

Mossman, A. 2008. *More than materials; Managing what's needed to create value in construction:Paper for the 2nd European Conference on Construction Logistics–ECCL, 2008 Dortmund* [online]. Available from: <www.thechangebusiness.co.uk/TCB/Construction_Logistics/files/> [Accessed 29 October 2015]

Mott-MacDonald, 2010. Landscape and Visual Impact. Consultancy Agreement No. NEX/2301. *South Island Line (East), Environmental Impact Assessment*

Mouton, J. & Marais, H. C. 1991. *Basic Concepts in Methodology of the Social Sciences.* Pretoria: HSRC Publishers.

Murphy, P. R. & Poist, R. F. 2003. Green perspectives and practices; A "comparative logistics" study. Supply Chain Management. *An International Journal,* 8(2): 122-131.

Ness, D. A. & K. Xing. 2017. Toward a Resource-Efficient Built Environment: A Literature Review and Conceptual Model. *Journal of Industrial Ecology*.

Nilsson, F., Fagerlund M, & Körner J. 2012. Globally standardised versus locally adapted packaging: a case study at Sony Ericsson Mobile Communications

AB. *International Journal of Retail & Distribution Management* 41(5): 396–414.

Nilsson F., Olsson A, & Wikström F. 2011. Toward sustainable goods flows – a framework from a packaging perspective. *Proceedings of the 23rd Nofoma Conference:* Harstad, Norway.

Nordelof, A., Messagie, M., Tillman, A. M., Soderman, M. L. & Mierlo, J. V. 2014. Environmental Impacts of Hybrid, Plug-in Hybrid and battery Electric Vehicles – What Can We Learn from Life Cycle Assessment? *International Journal Life Cycle Assess* (2014) 19:1866–1890 Available from:< https://core.ac.uk/download/pdf/81517338.pdf> [Accessed 06 January 2019]

Nowakowska-Grunt, J. 2008. Impact of Lean Management on Logistics Infrastructure in Enterprises. *Advanced Logistic Systems*,2(1), 71-74

O'Driscoll, A. 2008. "Exploring Paradox in Marketing: Managing Ambiguity Towards Synthesis," *Journal of Business and Industrial Marketing*. 23(2); 95–104.

Ojo, E. I., Mbohwa, C. & Akinlabi, E.T. 2014. *Green Supply Chain Management in Construction Industries in South Africa and Nigeria*. Available from: https://www.semanticscholar.org/paper/Green-supply-chain-management-in-construction-in-Ojo-Mbohwa/6db205384cde2857ba1a3fc4b7d1886501d82096#citing-papers> [Accessed 16 December 2019]

Oltmann, S. M. (2016). Qualitative Interviews: A Methodological Discussion of the Interviewer and Respondent Contexts [37 paragraphs]. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, *17*(2), Art. 15, Available from: <http://www.qualitative-research.net/index.php/fqs/article/view/2551/3998 > [Accessed 26 June 2019]

Ozanne, L. K., Phipps, M., Weaver, T., Carrington, M., Luchs, M., Catlin, J., Gupta, S., Santos, N., Scott, K. & Williams, J. 2016 Managing the Tensions at the Intersection of the Triple Bottom Line: A Paradox theory Approach to Sustainability Management. *Journal of Public Policy & Marketing.* 35(2); 249–261

Palalani, K. 2001. *Challenges Facing the Construction Industry: A Botswana Perspective*. [online]

Available from: <https://www.irbnet.de/daten/iconda/CIB8943.pdf>
[Accessed 24 October 2016]

Palanivelu, P. and Dhawan, M. 2010. *Green Logistics.* TATA Consultancy Services.

Palmer, A. & Piecyk, M. 2010. *Time, Cost and CO2 Effects of Rescheduling Freight Deliveries* [online].
Available from:<http://www.greenlogistics.org.>

Parkhomenko, T. 2015. Logistics as an incentive to increase export opportunities for the energy market in conditions of free competition. *Bulletin of the Rostov State University of Economics (RINE)* 2015 № 4 (52). p. 40-45

Patton, M. Q. 2002. *Qualitative research and evaluation methods.* 3rd ed. Thousand Oaks, CA: Sage;

Pettipas, S., Bernier, M. & Walker, T.R., 2016. A Canadian policy framework to mitigate plastic marine pollution. *Marine Policy* 68, 117–122.

Pfohl, H. C. 2004. *Logistik management* (2nd ed.). Berlin: Springer.

Phipps, M., Lucie K., Ozanne, M. L., Saroja, S., Sommer, K. & Jesse, C., 2013. "Understanding the Inherent Complexity of Sustainable Consumption: A Social Cognitive Framework," *Journal of Business Research.* 66 (8), 1227–34.

Pine, M.A., Jeffs, A.G., Wang, D., Radford, C.A., 2016. The potential for vessel noise to mask biologically important sounds within ecologically significant embayments. *Ocean and Coastal Management* 127, 63-73

Pointus, N. 2017. *The Warehouse of the Future*. 6 Ways Warehouses are Going Green to Reduce Costs [online].
Available from:
<https://www.business.com/articles/nicole-pontius-warehouses-going-green-cut-costs/>
[Accessed 26 May 2017]

Pongracz, E. 2007. *The Environmental Impacts of packaging.*
Available from:<https://www.researchgate.net/publication/229796182>
[Accessed 13 May 2019]

Popovski, P., Krigslund, R., Manev, B., & Pedersen, G. F. (2009). Green Communication: Where Can It Really Help and How It Is Related to RFID.

Wireless Personal Multimedia Communications. The 12th International Symposium on Wireless Personal Multimedia Communications WPMC'09) Available from:<
<https://vbn.aau.dk/ws/portalfiles/portal/19176661/GreenRFIDpublished.pdf>

Potter, J., 1996. Discourse analysis and constructionist approaches: theoretical background. IN: Richardson, J.T.E. (ed). *Handbook of Qualitative Research Methods for Psychology and the Social Sciences. Leicester: British Psychological Society*, pp. 125 - 140

PPADB. 2015. *Application for Inclusion /Additional Disciplines / Upgrading on PPADB List of Registered Contractors* [online].
Available from:
<http://www.ppadb.co.bw/PPADB_works_contractors_reg_form.pdf>
[Accessed 08 November 2015]

Preventive and Predictive Maintenance, [online]
Available from:<https://www.lce.com/pdfs/The-PMPdM-Program-124.pdf>

Readings, S. 2006. Qualitative Research Methods: *A Data Collector's Field Guide; Overview*.
Available from:
<https://course.ccs.neu.edu/is4800sp12/resources/qualmethods.pdf >
[Accessed 25 June 2019]

Rensburg, S. L. J. 2015. *A Framework in Green Logistics for Companies in South Africa* [online]. Master's Thesis. Pretoria: UNISA.
Available from:
<http://uir.unisa.ac.za/bitstream/handle/10500/18750/thesisjansen%20van%20rensburgsl.pdf?sequence=1>
[Accessed 08 November 2015]

Robust. 2012. *Ground Zero –A Baseline For Future Growth*. Murray & Roberts Group Magazine.
Availabla from:
<http://www.murrob.com/publications/robust_mar2011/cover_story.asp>
[Accessed 13 December 2019]

Rodrigue, J., Slack, B. and Comtois, C. 2012. Green Logistics (The Paradoxes of). *Handbook of Logistics and Supply Chain Management* [online]. Brewer, A. M., Button, K. J. and Henser, D. A. (eds), London.

Available from:
<https://people.hofstra.edu/geotrans/eng/ch8en/appl8en/ch8a4en.html>
[Accessed 27 October 2015]

Rogers, D. S. and Timben-Lembke, R.S. 1998. *Going Backward –Reverse Logistics Trends and Practices* [online].
Available from:
<http://www.abrelpe.org.br/imagens_intranet/files/logistica_reversa.pdf>
[Accessed 08 November 2015]

Roso, V. 2007. Evaluation of the Dry Port Concept from an Environmental Perspective: *A Note. Transportation Research Part D* 12(2007): 523-527.
Available from:< www.sciencedirect.com >
[Accessed 10 May 2019]

Sachs, J. D. 2012. *From Millennium Development Goals to Sustainable Development Goals*. Lancet 379: 2206–11

Salih, J. 2013. *Environmental Issues of the Construction Industry* [online].
Available from:
<http://www.bimhow.com/impact-of-the-construction-industry-on-the-environment/>
[Accessed 05 November 2015]

Salmane, L.A. 2015. Ethical aspects of sustainability. *Journal of Social Sciences* 1(7): 5-16

Sanchez, E. G., Villegas, J. G. & Caracuel, J. A. 2018. How do technological skills improve reverse logistics? The moderating role of top management support in information technology use and innovativeness. *Sustainability 2019*, 11(58);
Available from:< http:// doi:10.3390/su11010058>
[Accessed 14 May 2019]

Santos, J. R. A. 1999. Cronbach's alpha: A tool for assessing the reliability of scales. *Journal of Extension*, 37(2), 1-5.

Sarantakos, S. 2005. *Social research* (3rd ed.). New York: Palgrave Macmillan.

Sarkis, J.; Meade, L. M. & Talluri, S. 2004. E-logistics and the natural environment. *Supply Chain Management* 9(4)*:* 303-312. http://dx.doi.org/10.1108/13598540410550055

Saroha, R. 2014. Green Logistics & its Significance in Modern Day Systems. *International Review of Applied Engineering Research.* 4(1): 89-92.

Saunders, M., Lewis, P. & Thornhill, A. 2017. *Research Methods for Business Students.* Pearson Education, London.

Sbihi, A. & Eglese, R. W. 2010. Combinatorial optimization and green logistics. *Annals of Operations Research* 175:159-175. http://dx.doi.org/10.1007/sl0479-009-0651-z

Schwandt, T. 1997. *Qualitative inquiry: A dictionary of terms.* California: SAGE Publications.

Scriven, D.R., DiBacco, C., Locke, A. & Therriault, T.W., 2015. Ballast water management in Canada: *A historical perspective and implications for the future. Marine Policy*59, 121 – 133

Sekakela, K. 2018. Infrastructure Financing in Botswana; *Engagement with multilateral development banks and recommendations for improving lending processes.* GEG Africa-Global Economic Governance Available from: <https://media.africaportal.org/documents/GEG_africa_DP_sekakela_APRIL_2018_FINAL_WEB.pdf> [Accessed: 07 December 2020]

Sen, S. & Bhattacharya, C. B. 2001. "Does Doing Good Always Lead to Doing Better? Consumer Reactions to Corporate Social Responsibility," *Journal of Marketing Research.* 38(5); 225–43.

Siegel, D.S. 2009. Green management matters only if it yields more green: An economic/strategic perspective. *Academy of Management Perspective,* 23(3); 5–16.

Slawinski, N. & Bansal, P. 2015. "Short on Time: Intertemporal Tensions in Business. *Organisation Science,* 26(2)

Smith, W.K., Binns, A. and Tushman, M.L., 2010. Complex business models: Managingstrategic paradoxes simultaneously. Long range planning. 43(2). pp.448-461.

Smith, W. K. & Lewis, M. W. (2011), "Toward a Theory of Paradox: A Dynamic Equilibrium Model of Organizing," *Academy of Management Review*. 36(2); 381–403.

Srivastava, S. 2007. Green supply-chain management: a state-of-the-art literature review. *International Journal of Management.Reviews* 9(1): 53-80. http://dx.doi.Org/10.llll/j.1468-2370.2007.00202.x

Stake. R. E. 1994. Case studies, In *Handbook of qualitative research*, N.K. Denzin and Y.S. Lincoln, eds, Thousand Oaks: Sage. pp. 236–247.

Stangor, C. 2014. *Research methods for behavioural science*. 5th ed. United Kingdom: Cengage Learning [Online]
Available from:
<https://books.google.co.za/books?id=BssTCgAAQBAJ&source=gbs_navlinks>
[Accessed: 25 August 2015].

Stauffer, B. 2019. *Low-flush Toilets*.
Available from:
<https://sswm.info/water-nutrient-cycle/water-use/hardwares/toilet-systems/low-flush-toilets >
[Accessed:26 June 2019]

Stuckey H.L. 2014. The first step in Data Analysis: Transcribing and managing qualitative research data. *Journal of Social Health Diabetes* [serial online]
Available from: http://www.joshd.net/text.asp?2014/2/1/6/120254
[Accessed 31 October 2016]

Stock, J. R. & Lambert, D. M. 2001. *Strategic Logistics Management.* 4th Ed. International Edition. McGraw-Hill Higher Education.

Ssegawa, J. K. 1999. Construction Industry's Contribution Towards Botswana's Vision 2016. *Department of Civil Engineering, Faculty of Engineering, University of Botswana.* [online]
Available from:

<www.arcom.ac.uk/-docs/proceedings/ar1999-743-752Ssegawa.pdf>
[Accessed 11 June 2016]

Ssegawa, J. K. 1999. *The Construction Industry in Botswana* [online]. A Socio-Economic Development Perspective. *Botswana Journal of Technology* [online]. University of Botswana.
Available from:
<http://www.ubrisa.ub.bw/bitstream/handle/10311/706/Ssegawa_BJT_1999.pdf?sequence=1>
[Accessed 06 November 2015]

State of Hawaii Department of Business, Economic Development and Tourism (DBEDT). 2015. *Construction Indicators: Economic Drivers Relating to the Construction Industry* [online].
Available from:<http://www.uhero.hawaii.edu/104/construction-indicators>
[Accessed 28 October 2015]

Sunday Standard Commentary. 2010. *Now PPADB Means Business.* [online]
Available from:<www.sundaystandard.info/now-ppadb-means-business>
[Accessed 10 June 2016]

Supply & Demand-Chain Executive, 2014 . *What is a Supply Chain?* [online]
Available from:< http://2020vet.com/what-is-a-supply-chain/>
[Accessed 14 September 2019]

Swafford, P. 2003. *Theoretical Development and Empirical Investigation of Supply Chain Agility*. Georgia Institute of Technology.

Taherdoost, H. 2016. Sampling Methodsin Research Methodology; How to Choose a Sampling Technique for Research. *International Journal of Academic Research in Management (IJARM)*, 5(2):18-27.

The Climate Group, 2008. SMART 2020: *Enabling the low carbon economy in the information age*. Available from:
<https://www.theclimategroup.org/sites/default/files/archive/files/Smart2020Report.pdf >
[Accessed 13 December 2018]

Thiell, M. 2013. Is it Feasible to Implement Green Logistics in Emerging Markets? *International Journal of Applied Logistics (IJAL)* 4(1); 13
Available from:
<https://www.igi-global.com/article/feasible-implement-green-logistics-

emerging/76916>

[Accessed 15 March 2018]

Thiell. M., Zuluaga, J. P. S., Montanez, J. P. M. and Hoof, B. 2011. *Green Logistics: Global Practices and their Implementation in Emerging Markets* [online].
Available from:<http://www.irma-international.org/viewtitle/53258/>
[Accessed 27 October 2015]

Tibben-Lembke, R.S. & Rogers, D.S. (2002), "Differences between forward and reverse logistics in a retail environment", *Supply Chain Management: An International Journal*, 7(5); 271-282.

Tischer, A., Besiou, M. & Graubner, C. A. 2013. Efficient waste management in construction logistics; *A refurbishment case study. Logist. Res*, 6:159-171.

Tongco, M. D. C. 2007. Purposive Sampling as a tool for informant selection. *A Journal for Plant, People and Applied Research, 5*, 147-158.

Trading Economics. 2019. *Botswana GDP From Construction* 2003 – 2018
Available from:
<https://tradingeconomics.com/botswana/gdp-from- construction>

UKGBC. 2019. Circular economy guidance for construction clients: *How to practically apply circular economy principles at the project brief stage.*
Available from:
<https://www.ukgbc.org/ukgbc-work/circular-economy-guidance-for-construction-clients-how-to-practically-apply-circular-economy-principles-at-the-project-brief-stage/>
[Accessed 07 January 2019]

UNDP. (2000). *Millennium Development Goals*.
Available from:<http://www.undp.org/mdg/goal1.shtml>
[Accessed on 07 June 2018]

Urquhart C. 2013. *Grounded Theory for Qualitative Research*: A Practical Guide. Thousand Oaks: Sage

Vanderlaan, A.S.M., Taggart, C.T., 2009. Efficacy of a voluntary area to be avoided to reduce risk of lethal vessel strikes to endangered whales. *Conservation Biology* 23 (6), 1467–1474.

Walker, T.R., Grant, J. & Archambault, M.C., 2006. Accumulation of marine debris on an intertidal beach in an urban park (Halifax Harbour, Nova Scotia). *Water Quality Research Journal of Canada* 41 (3), 256–262

Walker, T.R., Reid, K., Arnould, J.P.Y. & Croxall, J.P., 1997. Marine debris surveys at Bird Island, South Georgia 1990–1995. *Marine Pollution Bulletin* 34 (1), 61–65.

Weber, P. 1990. Green sales of approval heading to market. *World Watch*,3:7-8.

White, D. E., Oelke, N. D., Friesen, S. 2012. Management of a large qualitative data set: Establishing trustworthiness of the data. *International Journal of Qualitative Methods*, 11, 244–258.

White, J. (2015). Green Logistics. *Business admin access*

Wilde, G. 2007. Green Procurement and Sustainable Procurement. Corporate Energy Management. Regional Municipality of Peel [online]. Available from: <https://www.peelregion.ca/finance/corp-energy/energy-matters07/pdfs/gary-wilde-session.pdf >
[Accessed 26 May 2017]

Wiles, R., Crow, G., & Pain, H. 2011. Innovation in qualitative research methods: A narrative review. *Qualitative Research*, 11(5), 587-604.

Willis, J. W. 2007. Foundations of Qualitative Research. *Interpretive and Critical Approaches.* Sage Publications

Woodruff, J. 2019 *Definition of Hydraulic & Pneumatic Systems*. [online] Available from: <https://sciencing.com/definition-of-hydraulic-pneumatic-systems- 13637116.html>
[Accessed 13 March 2019]

World Commission on Environment and Development (WCED). (1987). *Our Common Future: Brundtland Report.* Oxford University Press.

Wright, C., Nyberg, D & Grant, D. 2012. “Hippies on the third floor”: Climate Change, Narrative Identity and the Micro-Politics of Corporate Environmentalism. [online] *Organization Studies* 33(11): 1451-1475. Available from:
<https://www.researchgate.net/publication/233730299_Hippies_on_the_third floor Climate_Change_Narrative_Identity_and_the_Micro-

Politics_of_Corporate_Environmentalism>
[Accessed 17 December 2019]

Wu, H. & Dunn, S.C. 1995. Environmentally responsible logistics system. *International Journal of Physical Distribution and Logistics Management.* 25(2): 20-38.

Xia, Y. & Wang, B. 2013. *Green Logistics In Logistics Industry In Finland.* Case: Inex Partners Oy and Suomen Kaukokiito Oy. *Bachelor's Thesis in International Business.* Spring 2013.

Xiu, G. & Chen, X. 2012. Research on green logistics development at home and abroad. *Journal of Computers*. 7(11):2765–2772.

Van der Byl, C. A. & Slawinski, N. 2015. "Embracing Tensions in Corporate Sustainability. *A Review of Research from Win-Wins and Trade-Offs to Paradoxes and Beyond,"* Organization & Environment. 28(1); 54–79.

Vasiliauskas', A. V., Zmkeviciüté, V. & Simonyte, E. 2013. *Implementation of the concept of green logistics referring to IT Applications for road freight transport enterprises.*

Verghese K, & Lewis H. 2007. Environmental innovation in industrial packaging: A SC approach. *International Journal of Production Research*. 45(18–19): 4381–4401.

Welman, C., Kruger, F. & Mitchell, B. 2007. *Research Methodology*. 3rd ed. Cape Town, South Africa: Oxford Southern Africa.

Wiles, R., Crow, G., & Pain, H. 2011. Innovation in qualitative research methods: A narrative review. *Qualitative Research,* 11(5), 587-604.

Yin, R. K. 1994. Case study research: design and methods, 2nd ed., Thousand Oaks: Sage. *Applied Social Research Methods Series,* Vol. 5.

Zavadskas, E. K. and Kaklauskas, A. 2004. *Civil Engineering Decision Support Systems in Lithuania.*
Available from:<https://www.researchgate.net/publication/240633650>
[Accessed 14 May 2019]

Zhang, Z. & Wang, Y. 2015. Exploration of China's green logistics development. *Management Science and Engineering,* 9(1):50-54.

Zhang, Y. Z., Thompson, R. G., Baoa, X., Jianga, Y. 2014. *Analyzing the Promoting Factors for Adopting Green Logistics Practices:* A Case Study

of Road Freight Industry in Nanjing, China. *8th International Conference on City Logistics.Procedia - Social and Behavioral Sciences* 125:432 – 444.

Zhu, Q., Sarkis, J. & Lai, K.H. 2007.Confirmation of a measurement model for green supply chain management practices implementation. *International Journal of Production and Economics*. 111(2):261–27

Zikmund, W. G. 1991. *Business Research Methods.* Thomson Learning South–Western 3rd ed.

http://mhdsupplychain.com.au/2019/05/29/dhl-and-ford-to-develop-new-electric-drive-vehicle-with-hydrogen-technology/

6 APPENDIX A: PARTICIPANT INFORMATION SHEET

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PARTICIPANT INFORMATION SHEET

Ethics clearance reference number: ***2018_CEMS_ESTTL_008***

30 JULY 2018

GREEN LOGISTICS PRACTICES IN BOTSWANA: CHALLENGES AND PROSPECTS FOR THE LARGE CONSTRUCTION COMPANIES.

Dear Prospective Participant

My name is **PRISCILLA FUNGAI MPONDORI** and I am doing research with **PROFESSOR JOHAN DU PLESSIS**, at the University of South Africa. We are inviting you to participate in a study entitled **GREEN LOGISTICS PRACTICES IN BOTSWANA: CHALLENGES AND PROSPECTS FOR THE LARGE CONSTRUCTION COMPANIES.**

This study is expected to collect important information that could inform policies and strategies that would reduce the challenges associated with green transportation, green warehouses, green packaging, green procurement and waste management. To the industry under study, it is hoped that the study findings will form the basis for decision making in the area of construction logistics and stimulate more research in the field of green logistics. The results will outline the problems in the building construction sector and opportunities that can be explored by the large construction companies. The study findings will give the industry opportunities to protect the environment in the long run as well as to increase environmental, economic and social value.

Being a Project Manager for a large construction company, you have been invited to participate since you have acceptable level of education, experience in the construction industry, acceptable level of management, acceptable communication skills, and influence in decision-

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

making together with acceptable possession of specialty knowledge. Your contacts were obtained from the contractor register on http://ipms.ppadb.co.bw/registerdcodes which is the Public Procurement and Asset Disposal Board (PPADB) website. You are one of the thirty-two Project Managers representing the thirty-four large construction companies in Botswana and falling under Grade D and E according to PPADB and handling projects of P85 million+. The study involves an in-depth interview which seeks to gather data on green logistics practices, the challenges companies might be facing in adopting the practices, the possible causes of those challenges and the probable opportunities for future operations. The interview session would take you approximately 40 minutes.

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason. However it will not be possible to withdraw once you have submitted the questionnaire. The audio recording does not require you to identify yourself so your identity remains anonymous. Your name will not be recorded anywhere and no one, apart from the researcher will know about your involvement in this research and no one will be able to connect you to the answers you give. Your answers may be reviewed by people responsible for making sure that research is done properly, including the members of the Research Ethics Review Committee.

The audio recording will be stored by the researcher in a memory stick for a period of five years in a locked cupboard/filing cabinet in my work office for future research or academic purposes; electronic information will be stored on a password-protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. As for the disposal of information, hard copies will be shredded and electronic copies will be formatted and permanently deleted from the memory stick and hard drive of the computer through the use of a relevant software programme.

This study has received written approval from the Research Ethics Review Committee of the College of Economic and Management Sciences at UNISA. A copy of the approval letter can be obtained from Priscilla Fungai Mpondori on +267 75120410 and 42818222@mylife.unisa.ac.za

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

if you so wish. This same contact applies might you require any further information or aspect of this study. Should you have concerns about the way in which the research has been conducted, you may contact Professor Johan du Plessis on +27 11 465 5506 or +27 11 465 9908 and logintsa@iafrica.com. Contact the research ethics chairperson of the CAES General Ethics Review Committee, Prof EL Kempen on 011-471-2241 or kempeel@unisa.ac.za if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.

Priscilla Fungai Mpondori

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

CONSENT TO PARTICIPATE IN THIS STUDY

I confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty.

I am aware that the findings of this study will be processed into a research dissertation, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the interview.

I have received a signed copy of the informed consent agreement.

	Yes	No
I understand and accept the above	☐	☐

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Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
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7 APPENDIX B: INTERVIEW GUIDE

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INTERVIEW GUIDE FOR PROJECT MANAGERS OF LARGE CONSTRUCTION COMPANIES OPERATING IN BOTSWANA

Section A: General Information

1. What is your gender?

   .....

   .....

2. What is your level of education?

   .....

   .....

3. How long have you been with the construction industry?

   .....

   .....

4. Which grade do you place your company?

   .....

   .....

5. What level of management do you occupy?

   .....

   .....

6. How many employees are working in your company?

   .....

   .....

7. Do you have any representation of logistics functions in your company's management?

   Yes ..... **No** .....

   If yes, at what level are the following activities represented:

Transport Management: .....
Warehousing Management: .....
Packaging Management: .....
Procurement Management: .....
Waste Management: .....
Data Management: .....

8. **How many vehicles do you own in your company in terms of**

Dumpers: .....
Tankers: .....
Tippers: .....

Any other?

.....

.....

9. **What size of vehicles do you have in your company in terms of**

Dumpers: .....
Tankers: .....

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Tipper: .....
Any other?
.....
.....

10. Which type of warehouse space do you have?
.....
.....

11. How big are your warehouses in m^2?
.....
.....

12. Which option describes the status of the company you work for best? A head office, holding company, branch, subsidiary or independent unit?
.....
.....

Section B: Green Logistics Practices

1. The following questions seek to identify the green logistics practices adopted in the large construction companies in Botswana?

a. Green transportation

i. What transportation mode is mostly used in the transportation of construction materials?
.....
.....

ii. Justify the reason for the selection of the mode of transportation.
.....
.....

iii. Which fuels and lubricants are used by your transport vehicles?
.....
.....

iv. What is your company strategy for upgrading vehicles to the latest environmental and safety standards?
.....
.....

v. What type of softwares are you using for transport routing, scheduling and maintenance of vehicles?
.....
.....

vi. What is your strategy on encouraging backhaul?
.....
.....

vii. Do you have accident reduction strategy in your company?
Yes..... **No** .....

If Yes, what is your strategy?

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.....

.....

viii. Under what circumstances do you perform servicing and maintenance of vehicles?

.....

.....

ix. What are your strategies on the management and disposal of pallets?

.....

.....

b. Green warehousing

i. Which equipment do you use in material handling in your warehouse?

.....

.....

ii. What source of powers is used to each of the material handling equipment you have mentioned?

.....

.....

iii. What strategies are in place to minimise visual intrusion in your warehouse?

.....

.....

iv. What strategies are in place to reduce noise pollution in your warehouse?

.....

.....

v. What strategies are in place to reduce accidents in your warehouse?

.....

.....

vi. Do you have energy efficient strategies in place?
Yes..... **No** .....

If Yes, which are the strategies?

.....

.....

c. Green packaging

i. What are your packaging reduction strategies for materials?

.....

.....

ii. Which materials are being used for packaging supplies to the sites and waste from sites?

.....

.....

iii. Are you environmentally certified?
Yes..... **No**.....
If Yes, which environmental certifications do you have?

.....

.....

d. Green Procurement

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
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i. Which inspections do you undertake upon receipt of materials?

.....

.....

What monitoring tools are you using for Quality checks?

.....

.....

ii. Are you in any partnerships for your procurement and delivery of materials?
Yes ..... No .....
If Yes, which type of partnerships are you in?

.....

.....

iii. What are your strategies for waste efficient procurement?

.....

.....

e. Green data collection and management

i. Which systems are you using in data collection and management?

.....

.....

ii. Do you have analytic technologies in use?
Yes ..... **No** .....
If Yes, elaborate on the analytical technologies in use.

.....

.....

iii. What are the materials used in collecting and managing data?

.....

.....

iv. Which equipment are you using in collecting and managing data?

.....

.....

v. How do you dispose the materials used in collecting data?

.....

.....

f. Waste management

i. What are your company's waste management strategies? (waste related to transportation, warehousing, packaging, procurement and data management)

.....

.....

ii. Do you have a company reduce, re-use and recycle strategy?
Yes ..... **No** .....
If Yes, elaborate

.....

.....

iii. What strategies do you have to reduce carbon footprint?

.....

.....

Section C: Challenges of adopting green logistics practices

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PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
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1. **The following questions seek to find out the challenges faced by large construction companies in adopting green logistics practices.**
   a. What are the construction issues/challenges faced by your construction company in adopting green logistics practices in Botswana?
   .....
   .....
   b. What are the organizational issues/challenges faced by your company in adopting green logistics practices in Botswana?
   .....
   .....
   c. What are the technical issues/challenges faced by your company in adopting green logistics practices in Botswana?
   .....
   .....

Section C: Causes of challenges of adopting green logistics practices

1. **The following questions seek to find out the causes of challenges faced by large construction companies in adopting green logistics practices.**

   What do you think are the causes of the challenges faced by your company in adopting green logistics practices in Botswana?
   .....
   .....

Section D: Opportunities for adopting green logistics practices

1. **The following questions seek to find out the opportunities for large construction companies in adopting green logistics practices.**

   a. Which opportunities or options are available for future operations of your company in Botswana?
   .....
   .....
   b. In your opinion, what strategies would you recommend in order to improve green logistics in your company?
   .....
   .....

Thank You!!!

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
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8 APPENDIX C: ETHICS CLEARANCE CERTIFICATE

UNISA university of south africa

UNISA DESTTL ETHICS REVIEW COMMITTEE

Date: 26 September 2018

ERC Reference #: 2018_CEMS_ESTTL_008

Name: Ms Priscilla Fungai Mpondori

Student #: 42818222

Dear Priscilla Fungai Mpondori

Decision: Ethics Approval from 09/2018 to 09/2021

Researcher(s): Ms Priscilla Fungai Mpondori
42818222@mylife.unisa.ac.za
00267 75120410

Supervisor (s): Prof J.H du Plessis
logintsa@iafrica.com
+27 83 325 0290

Working title of research:

Green Logistics Practices in Botswana: Challenges and Prospects for the Large Construction Companies.

Qualification: MCom Logistics

Thank you for the application for research ethics clearance by the Unisa DESTTL Ethics Review Committee for the above mentioned research. Ethics approval is granted for three years

*The **low risk application** was **reviewed** by the DESTTL Ethics Review Committee in September 2018 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision was approved on the 26th of September 2018.*

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
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2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the XXX Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
7. No field work activities may continue after the expiry date **(09/21).** Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Add any other conditions if relevant.

Note:

*The reference number **2018_CEMS_ESTTL_008** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Yours sincerely,

Signature
Acting Chair of DESTTL ERC
E-mail: mmakonm@unisa.ac.za
Tel: (012) 429-4298

Signature
Executive Dean: CEMS
E-mail: mogalmt@unisa.ac.za
Tel: (012) 429-4419

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

9 APPENDIX D: LANGUAGE EDITING CERTIFICATE

UNIVERSITY of BOTSWANA

Centre for Academic Development
Communication & Study Skills Unit

Corner of Notwane and Mobuto Road, Gaborone, Botswana

Private Bag 0022 **Gaborone**, Botswana

Tel: [267] 355 2419/20
Fax:[267] 390 2884
E-mail: cad@mopipi.ub.bw

19 March, 2020

To whom it may concern,

Dear Sir/Madam,

Re: Letter of confirmation of language editing

I hereby confirm that I have proof read and edited Priscilla Fungai's (ID – EN 956258) thesis entitled:

Green Logistics Practices in Botswana: Challenges and Prospects for the Large Construction Companies.

A Thesis Submitted in Fulfillment of the Requirements for the Degree of Master of Commerce (Logistics).

Although the greatest care was taken in the editing of this document, the final responsibility for the product rests with the author.

Yours faithfully,

Dr Joel M. Magogwe
Associate Professor, Communication & Study Skills Unit
Tel: 3552421(W)
Email: magogwej@mopipi.ub.bw

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10 APPENDIX E: STRUCTURE OF THE INTERVIEW GUIDE OF THE STUDY

	DOMAIN	CORE IDEA	CATERGORY	N	RESPONSE
1.	**GREEN LOGISTICS PRACTICES** **RQ1:** What are the green logistics practices adopted in the large construction companies in Botswana?	**A. GREEN TRANSPORTATION**			
		i. Modes of Transport in use			
		ii. Reasons for Selection of modes			
		iii. Fuels and lubricants in use			
		iv. Company strategy for upgrading vehicles			
		v. Software in use			
		vi. Strategy on encouraging backhauls			
		vii. Accident reduction strategy for road			
		viii. Servicing and maintenance of vehicles			
		ix. Strategy on management and disposal of pallets			
		B. GREEN WAREHOUSING			
		i. Materials handling equipment in use			
		ii. Strategy on minimizing visual intrusion			
		iii. Strategy on noise pollution			

		iv. Accident reduction strategy for warehouses			
		v. Accident reduction strategy for sites			
		vi. Energy efficient strategy			
		C. GREEN PACKAGING			
		i. Packaging Reduction and efficient strategies for materials			
		ii. Materials in use for packaging			
		iii. Environmental certifications			
		D. **GREEN PROCUREMENT**			
		i. Inspections upon receipt of materials			
		ii. Quality check monitoring tools			
		iii. Partnerships in procurement and delivery			
		iv. Strategies for waste efficient procurement			
		E. GREEN DATA COLLECTION AND MANAGEMENT			
		i. Systems in use			
		ii. Analytic technologies in use			
		iii. Materials used in collecting and			

		managing data			
		iv. Equipment used in collecting and managing data			
		v. Disposal of materials used in collecting and managing data			
		F. WASTE MANAGEMENT			
		i. Company's waste management strategy			
		ii. Company's reduce, re-use and recycle strategy			
		iii. Strategy to reduce carbon footprint			
2.	**CHALLENGES OF ADOPTING GREEN LOGISTICS** **RQ2:** What are the challenges faced by the large construction companies in adopting green logistics practices in Botswana?	A. CONSTRUCTION ISSUES			
		B. ORGANISATIONAL ISSUES			
		C. TECHNICAL ISSUES			
3.	**CAUSES OF CHALLENGES FOR ADOPTING GREEN LOGISTICS PRACTICES** **RQ3:** What are the causes of the	COST			
		TIME / AVAILABILITY			
		NETWORK			
		RELIABILITY			

	challenges faced by the large construction companies in adopting green logistics practices in Botswana?	WAREHOUSING E-COMMERCE			
4.	**PROSPECTS FOR ADOPTING GREEN LOGISTICS PRACTICES** **RQ4:** Which opportunities or options are available for future operations of the large construction companies in Botswana?	**PROSPECTS**			

11 APPENDIX F: THE SUMMATIVE MATRIX THEMATIC ANALYSIS FINDINGS TABLE

Domain	Core idea	Category	Frequency	Percentage (%)	Level of response
GREEN LOGISTICS PRACTICES **RQ1:** What are the green logistics practices adopted in the large construction companies in Botswana?	**A. GREEN TRANSPORTATION**	Rail	6	40	Variant
	Modes of Transport in use	Road	15	100	General
		Import Sea	15	100	General
		Import Air	1	7	Rare
	Reasons for Selection of modes	Freight rates	15	100	General
		Speed	4	27	Variant
		Reliability	12	80	General
		Company policy	3	20	Variant
		Environmental policy	1	7	Rare
	Fuels and lubricants in use	Liquefied Petroleum Gas	1	7	Rare
		Liquefied Natural Gas	15	100	General
		Natural Gas Liquids	15	100	General
		Industrial Lubricants	15	100	General
		Fuels & Lubricants	15	100	General
		Base & Fuel Oils	15	100	General
		Ultra-Low Sulphur Diesel	15	100	General
		Petrochemicals	15	100	General
		Petroleum Coke	15	100	General
		Equipment oil	15	100	General
	Company strategy for upgrading vehicles	Incorporation of new generation engine with increased fuel efficiency	4	27	Variant
		Incorporation of hybrid and electric engines into vehicles	1	7	Rare
	Software in use	GPS Insight	13	87	General
		Teletrac Navman Director	14	93	General
		GPS Trackit Fleet Manager	11	73	Typical

		Ctrack	7	47	Typical
		Position Logic GPS	14	93	General
		GSMTasks	10	67	Typical
		Isotrak	3	20	Variant
	Strategy on encouraging backhauls	Collaborative transportation/inventory management	2	13	Variant
		Construction Consolidation Centres	1	7	Rare
	Accident reduction strategy for road	Write a road risk policy	8	53	Typical
		Continuously assess driver skills	13	87	General
	Servicing and maintenance of vehicles	Plan for preventive maintenance	12	80	General
		As need arises	3	20	Variant
		After breakdown	15	100	General
	Strategy on management and disposal of pallets	Have suppliers take back	15	100	General
		Give to small scale entrepreneurs	3	20	Variant
		Use a third party	13	87	General
	B. GREEN WAREHOUSING				
	Materials handling equipment in use	LPG (pneumatic) driven	14	93	General
		Hydraulic driven	15	100	General
		Electric driven	9	60	Typical
		Mechanical driven	14	93	General
	Strategy on minimizing visual intrusion	Use of advertising or artwork on hoardings	2	13	Variant
		Inclusion of tree and shrub planting adjacent to all site boundaries	2	13	Variant
	Strategy on noise pollution	Use of modern, quiet power tools, equipment and generators	7	47	Typical
		Make old equipment quieter by good maintenance and lubrication.	15	100	General
		Erect noise barriers before commencement of works	1	7	Rare
	Accident reduction strategy for	Use safety guidelines to handling	14	93	General

	warehouses	hazardous materials			
		Optimise procedures to manage the physical layout of site storage	6	40	Variant
		Use of signage and warning devices	15	100	General
	Accident reduction strategy for sites	Reduce the amount of night work	14	93	General
		Clear signage to warn of danger and reflective clothing	15	100	General
		Practice defensive driving/parking	15	100	General
		Have applied interventions for “black-spots”	11	73	Typical
	Energy efficient strategy	Greater use of powered mechanical equipment	12	80	General
		Enough lighting and heating levels	7	47	Typical
		Control of air changes (cooling and humidity)	1	7	Rare
		Use of LPG counterbalance forklifts	3	20	Variant
		Use of High Frequency (HF) charging	7	47	Typical
		Solar panels for solar recovery	13	87	General
	C. GREEN PACKAGING				
	Packaging Reduction and efficient strategies for materials	Use of large scale and unitised packaging	15	100	General
		Use of protective packaging	15	100	General
		Use of informative packaging	15	100	General
		Maximizing fill rate under transport and storage	15	100	General
		Increase the weight and volume of materials to be packaged	10	67	Typical
	Materials in use for packaging	Plastic films and sheeting	14	93	General
		Shrink bags	15	100	General
		Poly sheeting	15	100	General
		Metal strap	15	100	General

		Metal bands	15	100	General
		Ratchet strap	15	100	General
		Nets	15	100	General
		Chain lashings	15	100	General
	Environmental certifications	Leadership in Energy and Environmental Design (LEED)	1	7	Rare
		ISO 14001	2	13	Variant
		CASBEE (Comprehensive Assessment System for Building Environmental Efficiency)	1	7	Rare
		GREENSTAR	1	7	Rare
	D. **GREEN PROCUREMENT**				
	Inspections upon receipt of materials	Receiving inspection	15	100	General
		In-process inspection	15	100	General
		Final inspection	15	100	General
	Quality check monitoring tools	Spot checks/sampling	15	100	General
		Visual inspection	15	100	General
		Technical inspection	15	100	General
	Partnerships in procurement and delivery	Buyer-supplier collaboration	15	100	General
		Require Just In Time (JIT) delivery.	13	87	General
		Use ‘consolidation center’ to facilitate JIT delivery.	1	7	Rare
	E. GREEN DATA COLLECTION AND MANAGEMENT				
	Systems in use	Decision-making support system	13	87	General
		Barcoding and Scanning	3	20	Variant
		Inventory Optimisation Software	6	40	Variant
		Transport Management Systems	10	67	Typical
		SAP Enterprise Resource Planning Systems	4	27	Variant

	Materials used in collecting and managing data	Paper	15	100	General
		Electronic material	15	100	General
		Electricity driven tablets	15	100	General
		Electricity driven laptops	15	100	General
		Electronic boards	1	7	Rare
		Infra-radio	15	100	General
		Closed Circuit Televisions (CCTV)	4	27	Variant
		Biometric gadgets	15	100	General
	Disposal of materials used in collecting and managing data	Shredding	13	87	General
		Surrender to recycling companies (breakers)	7	47	Typical
		Dumpsites	15	100	General
		Burning	1		Rare
	F. WASTE MANAGEMENT				
	Company's waste management strategy	Use of waste contractor	6	40	Variant
		Order materials to optimally meet your needs (support Just In Time system)	11	73	Typical
		Develop methods of storing materials that will reduce their susceptibility to damage	12	80	General
		Sort waste into recyclable, reusable and disposable	3	20	Variant
		Discuss with suppliers if components can be returned.	6	40	Variant
	Company's reduce, re-use and recycle strategy	Bulk buy when possible, but don't buy more than can be used	9	60	Typical
		Consider having materials pre-cut at lumber yards	11	73	Typical
		Pre-assembled and offsite fabrication	13	87	General
		Use retread tyres if they are appropriate.	5	33	Variant

	Strategy to reduce carbon footprint	Source materials locally to reduce on transportation	7	47	Typical
		Plan the energy requirements of a project	2	13	Variant
		Send back unused, default and recyclable materials to the manufactures	3	20	Variant
CHALLENGES OF ADOPTING GREEN LOGISTICS **RQ2:** What are the challenges faced by the large construction companies in adopting green logistics practices in Botswana?	Construction Issues	Congested construction sites	15	100	General
		Limited on-site storage	15	100	General
		More frequent and peak hour deliveries	15	100	General
		Lack of ownership of waste	13	87	General
		Lack of procurement policies	15	100	General
		Bundled tender system	11	73	Typical
		Companies going through business rescue	5	33	Variant
	Organisational Issues	Lack of environmental experts	15	100	General
		Lack of tripartite collaboration	13	87	General
		Lack of stakeholder support in adoption of green practices	11	73	Typical
		Information on green logistics not articulated	15	100	General
		Pressure from competitors and partners in the region to complete projects	15	100	General
		Imposed modes of transport	15	100	General
	Technical Issues	Lack of internal and external ICT skills	10	67	Typical
		Poor logistics infrastructure	15	100	General
		Lack of green architects, consultants, green developers and contractors	15	100	General
CAUSES OF	Cost	- cost effectiveness in operations	15	100	General

CHALLENGES FOR ADOPTING GREEN LOGISTICS PRACTICES RQ3: What are the causes of the challenges faced by the large construction companies in adopting green logistics practices in Botswana?		is against going green			
	Time / Availability	- Just In Time is against extended production and distribution models	15	100	General
	Reliability	- delivering freight undamaged on time is against slow and least polluting modes	15	100	General
	Warehousing	- a reduction in warehousing demands is against inventories actually in transit	15	100	General
PROSPECTS FOR ADOPTING GREEN LOGISTICS PRACTICES **RQ4:** Which opportunities or options are available for future operations of the large construction companies in	Prospects	Reduced emissions and pollution	13	87	General
		Energy reduction	10	67	Typical
		Low carbon transportation	12	80	General
		Low carbon storage	9	60	Typical
		Low carbon packaging	13	87	General
		Low carbon procurement	13	87	General
		Waste reduction (turning waste into valuable resources)	14	93	General
		Improving fuel efficiency	15	100	General
		Inventory reduction	13	87	General

Botswana?					

12 Appendix G: Turnitin Digital Receipt

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