REVERSE LOGISTICS PRACTICES IN MANUFACTURING FIRMS IN THE VAAL TRIANGLE AREA

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DECLARATION

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree

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ABSTRACT

The primary objective of this study was to investigate the influence of reverse logistics practices on environmental sustainability and business performance in manufacturing firms in the Vaal Triangle Region. The study employed a quantitative research method that used a survey questionnaire to gather data from supply chain professionals operating in the manufacturing small and medium-sized enterprise (SME) sector. The survey was self-administered to 350 randomly selected respondents who were mainly supply chain professionals drawn from various manufacturing firms in the Vaal Triangle region. Despite the large number of respondents, only 201 questionnaires were usable, which represented a response rate of 57 per cent. Data obtained were analysed using SPSS 25.0 in which descriptive statistics were analysed to assess the demographic characteristics of the respondents. An analysis of mean scores was performed to establish the perceptions of supply chain professionals toward the levels of the constructs in manufacturing firms. Besides, the study made use of correlation and regression analyses to examine the causal relationships between reverse logistics practices on environmental sustainability and business performance.

The results of the study show that the identified reserve logistics practices (repairs, remanufacturing, recycle, recondition and disposal) were insignificantly correlated to environmental sustainability. However, environmental sustainability was significantly correlated to the two sub-dimensions of business performance, namely, sales and profit. Likewise, in the regression analysis, all reverse logistics components were statistically insignificant, whereas environmental sustainability significantly influenced both profits and sales. The study thus offered a contrasting perspective from the general findings that have found reverse logistics to be a significant contributor to sustainability initiatives. However, the study confirms the importance of environmental sustainability as a predictor of business performance in manufacturing firms.

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION AND OVERVIEW OF THE STUDY

1.1 INTRODUCTION

The concept of reverse logistics has gained increasing importance as a profitable and sustainable business strategy (Azadi & Saen 2011:143). Its strategic factors consist of vital costs, overall quality, customer service, environmental concerns, and legislative concerns. The operational factors include cost-benefit analysis, transportation, warehousing, supply management, remanufacturing, recycling, and packaging (Azadi & Saen 2011:143). This highlights the value and importance that reverse logistics has as a critical element of any organisation supply chain network. However, there is a lack of understanding of the business process of reverse logistics (Hsu, Alexander & Zhu, 2009:515). This was cautioned by Bai and Sarkies (2011:56), who advanced that firms should recognise the importance of having an effective reverse logistics strategy to reduce risks of damaging customer relations and jeopardising brand image and reputation.

Reverse logistics includes all the activities on reducing the generation of waste, and the recycling of it, reusable packaging, and disposal of waste; as well as the returns of unsold and wrongly delivered goods, the active dealing with demand information by cooperating with manufacturing, marketing, procurement and packaging departments (Hans, Hribernik & Thoben 2010:276). According to More and Badu (2009:31), reverse logistics refers to the logistic management skills and activities involved in reducing, managing and disposing of hazardous waste from packaging and products. It includes backward distributions, which cause goods and information to flow in the opposite direction from normal logistics activities. Considering the advanced literature, it could be posited that reverse logistics encompasses a number of factors such as repairs, recondition, remanufacture, recycle, and disposal (Shaik & Kader 2012:70). As such, it could, therefore, be conceived that these practices, if implemented effectively, could have a direct correlation on environmental sustainability and business performance.

Environmental sustainability has emerged as an essential strategic aspect that requires significant attention from business owners and practitioners alike (Caniato, Caridi, Crippa, & Moretto 2012:661). This view is due to its core value and relevance to the overall adherence to sound production and business practice. Complying to environmental regulation has become a norm that all supply chain networks must conform to, to ensure the productive success of their operation activities (Sarkis, Gonzalez-Torre & Adenso-Diaz 2010:163). Given the stated narrative, it could be deduced that sustained environmental practices have a critical influence on business success.

1.2 PROBLEM STATEMENT

Producers and suppliers are assuming more and more responsibility to placing their products in the market due to the increased pressure to meet and exceed their customers' expectations (Choudhary, Sarkar, Settur & Tiwari 2015:96). For a variety of economic, environmental, or legislative reasons, product disposal may no longer be the consumer's responsibility because products come to be recycled or remanufactured by the original manufacturers (Azadi & Saen 2011:144). Zhou and Zhou (2015:58) state that firms are beginning to recognise the importance of effective reverse logistics systems. According to Choudhary et al. (2015:97), the reasons for promoting reverse logistics practices are both economical as well as environmental ones, which emphasise the significance that reverse logistics has and the role it plays in today's value chain.

As mentioned previously, reverse logistics has gained significant momentum and attention from both local and international perspectives. From a global standpoint, a recent study conducted by Bottani, Vignali, Mosna and Montanari (2019:289) focused on the economic and environmental assessments of reverse logistics. Chan, Man, Fang, and Campbell (2019:1165), examined the coordination between supply chain and reverse logistics. While, Chileshe, Jayasinghe and Rameezdeen (2019:64) analysed the information flow-centric approach for reverse logistics. From a South African context, Shakantu and Emuze (2012:18) assessed reverse logistics in the construction sector, while Khan, Dong, Zhang, and Khan (2017:263) researched on the decision-making of green reverse logistics in enterprises. Besides, Ojo, Mbohwa, and Akinlabi (2014:146) conducted a comparative study on green supply chain management in construction industries in both South Africa and Nigeria. Mutingi (2014:189) investigated the impact of reverse logistics in green supply chain management.

Despite the vast body of current literature on the concept of reverse logistics, it appears that there is a limitation of investigations that focused on the adoption of reverse logistics practices and their role in environmental sustainability and business performance. A review of online literature within the South African environment does not identify any previous similar studies on this subject. This is in spite of the significance and role of reverse logistics in contributing to the overall success of firms' value chains. The present study, therefore, intends to occupy this gap of knowledge by addressing the importance of the identified practices (repairs, recondition, remanufacture, recycle, and disposal). And their strategic influence on both environmental sustainability and business performance.

1.3 PURPOSE OF THE STUDY

The purpose of this study is to investigate the influence of reverse logistics practices on environmental sustainability and business performance in manufacturing firms in the Vaal Triangle region.

1.4 RESEARCH OBJECTIVES

1.4.1 Theoretical objectives

To achieve the purpose set for this study, the following theoretical objectives were formulated:

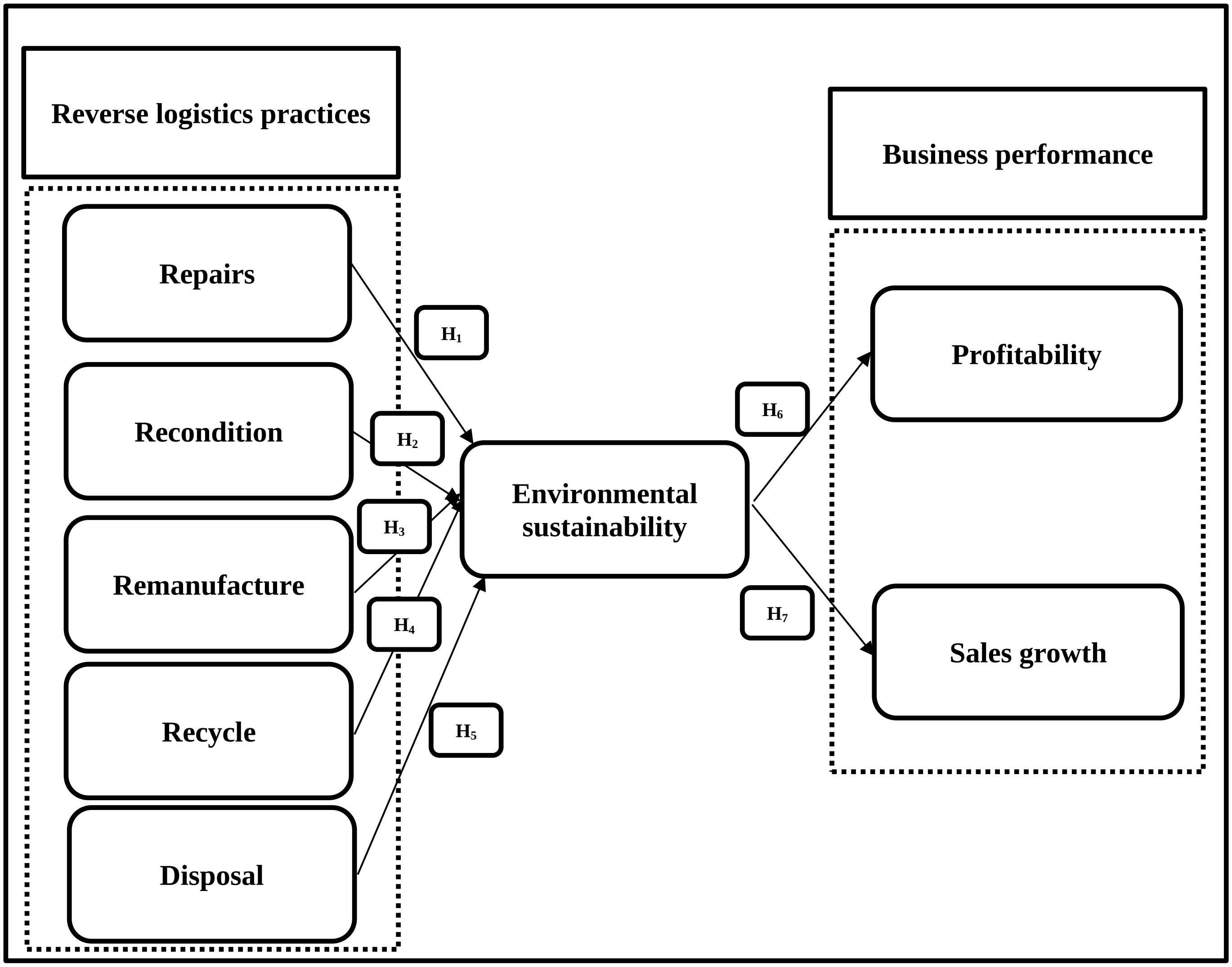
- to conduct a literature review on reverse logistics practices;
- to conduct a literature review on environmental sustainability; and
- to conduct a literature review on business performance.

1.4.2 Empirical objectives

In line with the purpose of the study, the following empirical objectives were set:

- to determine the relationship between reverse logistics practices such as repairs, recondition, remanufacture, recycle and disposal; and environmental sustainability in manufacturing firms in the Vaal triangle; and
- to establish the connection between environmental sustainability and business performance in manufacturing firms in the Vaal Triangle.

The conceptual framework (Figure 1) of the study was developed to highlight the causal connection that the dependent and independent constructs have with each other. The framework consisted of five predicting variables, namely, repairs, recondition, remanufacture, recycle, and disposal; a mediator in environmental sustainability; and business performance as an outcome.



1.5 HYPOTHESES STATEMENT

In light of the above Figure 1.1, the following hypotheses were stated:

H_1: Repairs exert a positive and significant influence on environmental sustainability in manufacturing firms in the Vaal Triangle region.

H_2: Recondition exerts a positive and significant influence on environmental sustainability in manufacturing firms in the Vaal Triangle region.

H_3: Remanufacture exerts a positive and significant influence on environmental sustainability in manufacturing firms in the Vaal Triangle region.

H_4: Recycle exerts a positive and significant influence on environmental sustainability in manufacturing firms in the Vaal Triangle region.

H_5: Disposal exerts a positive and significant influence on environmental sustainability in manufacturing firms in the Vaal Triangle region.

H_6: Environmental sustainability exerts a positive and significant influence on profitability in manufacturing firms in the Vaal Triangle region.

H_7: Environmental sustainability exerts a positive and significant influence on sales growth in manufacturing firms in the Vaal Triangle region.

1.6 LITERATURE REVIEW

1.6.1 Reverse logistics

The concept of reverse logistics has been extensively studied in various ways. Abraham (2011:185) called it the process whereby firms can become more environmentally efficient through recycling, reusing, and reducing the number of materials used. Besides, Hans, Hribernik, and Thoben (2010:276) found that it includes all the activities related to waste reduction, recycling, reusable packaging, and disposal of waste. According to Mangala, Govindan and Luthra (2016), reverse logistics operations play a crucial role in reducing operating expenses and improving overall performance. Furthermore, reverse logistics has been established as a valuable strategic approach that enables supply chains to reach their level of optimisation through its impact on increasing profit margin as well as adherence to environmental aspects (Gunasekaran & Spalanzani 2012:37). The present study identified the following as practices of reverse logistics: repairs, recondition, remanufacture, recycle, and disposal.

1.6.2 Environmental sustainability

Environmental sustainability has become an important aspect that needs to be considered by managers and academics alike. Its relevance to business success and compliance with sustainability practices has placed it as a cornerstone of ethical business practice (Caniato et al. 2012:665). According to Bai and Sarkis (2010:252), the adoption of environmentally related procedures has become a norm to any competitive supply chain organisation. Hall and Wagner (2012:183) established a significant association between integrative business strategy approach and implementation of sustainable environment concerns.

1.6.3 Business performance

Determining the performance objective of an organisation has become a constant process that any business engages in, in its efforts to remain successful. It, therefore, emphasises the importance and strategic value that business-related performance has in a firm's competitive aspiration (Lee, Kim, Seo & Hight 2015:29). Findings from Popovič, Hackney, Tassabehji and Castelli (2018:210) advanced access to relevant data, which information represents a crucial determinant of business sustained performance objectives.

1.7 RESEARCH METHODOLOGY

1.7.1 Research design

A research design is a plan of action that is laid out to ascertain a cause of a specific problem through the collection of data as well as its analysis (Creswell 2009:3). Given the fact that the present study intends to examine the direct and indirect association of constructs, the quantitative approach was deemed to be suitable as a method to conduct this research.

1.7.2 Sampling design

Sampling design is an approach that denotes the utilisation of numeric data to assess the perception of a study's target population (Creswell 2009:4). It also comprises the target population of the study, sampling frame, sample size, as well as sampling method (Zikmund 2003:367).

1.7.2.1 Target population

A study's target population is the total number of units from which a study's sample is derived (Bryman 2004:86). As such, the target population of this study consisted of all owners, managers, as well as supply chain professionals who have a significant understanding and experience in reverse logistics operations in the manufacturing sector in the Vaal Triangle.

1.7.2.2 Sampling frame

According to Kumar (2011:91), a sample frame is a list or register from which a study's identified sample is chosen. Based on that, the sample frame of the study was derived from all municipalities in the Vaal Triangle region through the Gauteng Enterprise Propeller (GEP) and the Department of Trade and Industry's database.

1.7.2.3 Sample size

Kumar (2011:194) defined a study's sample size as the actual number of respondents from which the research data will be collected. The study adopted the historical sample size technique to determine the sample size of this investigation. It considered studies from Asah, Fatoki, and Rungani (2015:308) on the impact of motivations, personal values, and management skills on the performance of SMEs in South Africa, using a sample size of N=350. Hamann, Smith, Tashman, and Marshall (2017:26) investigated why SMEs go green and had a size of N=500, while Gono, Harindranath, and Özcan (2016:719) focused on the adoption and impact of ICT in South African SMEs and used the size of N=130. Given the reviewed historical sample sizes, the present study size was pegged at N=350 respondents.

1.7.2.4 Sampling technique

The present study used the simple random probability technique to collect data from the selected population of the study.

1.7.3 Measurement instruments

The study made use of a structured questionnaire to gather data from the respective respondents. The questionnaire was divided into two sections, with the first (section A) pertaining to the demographic aspects of the targeted population. Section B, on the other hand, focused on the items related to the constructs of the study. Reverse logistics practice instruments were adopted from previous studies. For example, repairs were measured using a five-item scale; remanufacture and recondition both used an eight-item scale, while recycle used a nine-item scale; and disposal a four-item scale. All these measures scales were adopted from previous studies conducted by Guide

Jr, Jayaraman, Srivastava and Benton (2000:130); King, Burgess, Ijomah and McMahon (2006:260); Skinner, Bryant and Richey (2008:518); and Talbot, Lefebvre and Lefebvre (2007:631). Environmental sustainability was measured using a seven-item scale derived from Henriques and Sadorsky (1996:381). Business performance was perceived to be multidimensional, with dimensions such as profitability and sales growth used to measure performance. Sales growth used a seven-item scale adopted from King and Lenox (2001:205) while profitability used an eight-item scale derived from Daugherty, Autry and Ellinger (2001:116).

1.7.4 Data collection

A survey (self-administered) structured questionnaire was used to collect all relevant data. Interviews were conducted to collect preliminary data to facilitate questionnaire construction. The initial questionnaire was pre-tested on a sample group of fifteen respondents to determine its relevance, interpretation, and validity. All aspects of the survey were pre-tested, including question content, wording, response, form and layout, question difficulty, and instructions (Saen 2010:315).

Questionnaires were hand-delivered, and others were e-mailed to all the Vaal Triangle manufacturing firms that agreed to take part in the survey. Appointment with respondents was done using personal visits and telephonically, using a list of all the Vaal Triangle manufacturing firms obtained from the Vanderbijlpark information centre.

1.7.5 Data analysis

Data were analysed using SPSS 25.0. Descriptive research was first undertaken. Kannan (2009:347) describes this form of analysis as “the transformation of raw data into a form that will make it easy to understand and interpret.” This was followed by correlation and regression analyses to establish relationships between variables. Also, validity was tested using correlation and regression to determine both construct and predictive validities. Face and content validities were assessed using a panel review process (by logistics lecturers operating at the Vaal University of Technology) and a pre-testing of the questionnaires of the study. Construct reliability was tested using the Cronbach alpha.

1.7.6 Ethical considerations

Several ethical considerations were emphasised to offer an appropriate basis of the ethical concerns of the research and were submitted to the firms. The researcher protected the privacy of the information provided by the manufacturing firms to ensure adherence to the protection of individual rights of privacy and confidentiality. Finally, the researcher also ensured the voluntary involvement of firms targeted for this research.

1.8 CHAPTER CLASSIFICATION

Chapter one: Introduction and background to the study

This chapter embodies the theme of the study and places it into perspective. It also presents a systematic format for the study, focusing on the background, problem statement, study objectives, and summarised research methodology.

Chapter two: A Literature review on the constructs of the study

This chapter provides an overview of the identified reverse logistics practices and discusses the nature and background of reverse logistics.

Chapter three: Research methodology

This chapter describes the research methodology and design employed in the study. It aims to provide detailed and adequate insight and understanding of the basic methodological techniques and methods used during the study.

Chapter four: Data analysis and interpretation of results

This chapter comprises an analysis of the empirical investigation and findings based on the objectives, problems, and research questions. It aims to provide the layout and interpretation of the statistical results.

Chapter five: Conclusion and recommendations

Chapter five reviews the entire study and provides conclusions and recommendations regarding the study: the contribution of the study, suggestions, and implications for future research.

1.9 CONCLUSION

This chapter consists of nine sections that provided an overall view of the entire research project. The first two sections focused on introducing the problem under investigation as well as setting up the scene on how the study was to be conducted. The other sections dealt with objectives that underpin the research and the proposed conceptual framework. The chapter concludes with the methodology section that discussed most aspects related to how the investigation was planned as well as the identification of the respondents, analysis approach, and ethical considerations.

CHAPTER 2: LITERATURE REVIEW ON THE RESEARCH CONSTRUCTS

2.1 INTRODUCTION

This chapter deals with a review of the literature on the respective constructs of the study. Reverse logistics topics are discussed, including the dynamics and characteristics of the concept. Other aspects involve a review of the identified practices, namely repairs, recondition, remanufacture, recycle and disposal. Environmental sustainability and business performance constructs are also reviewed. The topics addressed include their operational conceptualisation and importance.

2.2 DEFINITION OF REVERSE LOGISTICS

There are many emerging definitions of reverse logistics, as it is one of the fastest developing fields of business logistics, with the result that it continuously changes in scope and significance (Pateman, Cahoon & Chen 2016:33). A preferred broad definition, as suggested by Abdullah, Diabat and Simchi-Levi (2012:39), is the management of all the activities in goods, demand information and money flowing in the opposite direction of the primary logistics flow. It involves reducing the generation of waste as well as managing the collection, transport, disposal, and recycling of both hazardous and non-hazardous waste in a way that maximises the long-term profitability of the business. Reverse logistics, therefore, comprises several aspects of logistics (Abdullah et al. 2012:39).

Gobbi (2011:20) defines reverse logistics as "the role of logistics in product returns, source reduction, recycling, materials substitution, reuse of materials, waste disposal and refurbishing, repair, and remanufacturing." This definition has some parallel with the one developed by Alinovi, Bottani and Montanari (2012:323), who viewed it as "the process whereby firms can become more environmentally efficient through recycling, reusing, and reducing the number of materials used."

Reverse logistics has also become a managerial priority because of the assets/value involved and the potential impact on customer relations (Fang, Zhang & Tang 2013:77). If the focus of logistics is the movement of material from the point of origin toward the end of consumption, then the focus of reverse logistics should be the movement of material from the point of use toward the point of origin. The term “reverse logistics” should be reserved for the flow of products and materials going “the wrong way on a one-way street” (Abraham (2011:185).

Drawing on the narrative above, and according to the context of this study, the operational definition of reserve logistics as supported by Soleimani, Seyyed-Estahani and Shirazi (2013:2) can be regarded as the procedure of planning, executing and monitoring the active cost movement of raw materials, inventory, semi-finished and finished goods, and information shared from the point of consumption to the point of origin.

2.3 THE IMPORTANCE OF REVERSE LOGISTICS

Two very different factors drive the economic demand for reverse logistics and repair process services. First, is the economic value of recycling and re-use, especially for valuable parts, subassemblies, and circuit boards, and whole units, typically found in the computer and high technology fields. Second, the legal requirements of the “green laws,” particularly in Europe, requires manufacturers to be fully responsible for the products produced over the life cycle (Wilcox, Horvath, Griffis & Autry, 2011:143).

Given economic and environmental contexts, some organisations are becoming aware of the importance of focusing their efforts on activities surrounding the return and processing of unused products. They seek to structure, organise, support and plan these activities to make more efficient use of available resources (labour, new, recovered and processed or valorised material, etc.) (Hazen et al., 2011:114).

With an adequate integration of reverse logistics activities, in an economic or environmental context, organisations will be able to notice a double effect with their supply chain. Firstly, while focusing efforts on returns of products and their processing, competitive strategies would be set up which, at various levels, would contribute to a better performance of current activities of the supply chain, concentrated, until now, primarily on the distribution of new products. Secondly, the new supply chain, which integrates reverse logistics, would orient itself to ensure robust management of any additional activities. This new supply chain aims to provide a clean and adequate distribution of recovered products. Organisations would thus be interested in the emergent field of reverse logistics (Alinovi et al. 2012:107). Hence, most organisations have implemented extreme measures to ensure control of all their returned products and packaging. This exercise, if performed successfully, helps improve customer loyalty to an organisation, promotes green logistics and can be lucrative to an organisation.

2.4 THE ROLE OF REVERSE LOGISTICS

Govindan et al. (2012:21) indicate that for many firms, the exercise of managing returns is not too high on their list of priorities. The fact is, in most firms, executives would rather spend their energies getting products out of the door to customers who want them.

In summary, logistics managers need to understand the following points as proposed by Govindan et al. (2012:21):

- Reverse logistics and repair services need to be integrated on a seamless basis; reverse logistics alone, and repair and disposal alone do not meet market needs.
- Existing vendors need to either partner with, acquire others to offer seamless services, or build internal capabilities.
- Logistics managers need to understand more fully the new demands in reverse logistics and repair processes.

Dealing with returns can prove to be more expensive than it looks, and firms with slim retail profit margins may feel they have too little to gain (Agrawal et al. 2016:41).

Another issue is that many logistics systems are not well-prepared to deal with the reverse logistics process, even if they do an excellent job with forwarding logistics management. Further, accounting for reverse logistics losses is not a simple matter, which makes the problem easy to ignore at the budget time (Govindan 2012:21). Therefore, intense competition amongst organisations in the 21st century and the quick-growing market penetration by emerging business forces logistics management to inevitably accommodate reverse logistics in their strategic budget planning for unforeseen and non-predictable returns.

2.5 THE ECONOMIC AND ENVIRONMENTAL CONCERN OF REVERSE LOGISTICS

The concept of reverse logistics is not new. The reuse of products, components, and materials have been previously applied, mainly for the economic benefits of reusing the product or material instead of its disposal (Bazan, Jaber & Zanoni 2016:4151). In addition to economic motivations, environmental concerns have directed the increase in the development of reverse logistics activities. Moreover, government pressure and legislation have contributed to the increased motivation for global environmental awareness and sustainability, influencing green supply chain management principles and practices (Sheu & Chen 2012:201). One such approach is the Extended Product Responsibility (EPR) legislation, which concentrates on the lifecycle and environmental management of products (Subramanian, Gupta & Talbot 2009:259).

This framework fundamentally holds producers physically and financially responsible for the environmental impact of their products after their life has reached an end (Atasu & Van Wassenhove, 2012:407). Concerns regarding declining landfill sites, depletion of resources, and damage to the ozone layer, along with environmental legislation, have led to the developments required for prolonging product life cycles, recycling, and reducing greenhouse gas (GHG) emissions (Bonney & Jaber 2011:43). Thus, nowadays the global environment is faced with challenges of global warming, climate change, and many other environmental deficiencies which can be lucratively alleviated by the active practice and execution of reverse logistics by all production firms.

Communities and customers are demanding that manufacturers take responsibility for the environmental impacts of their products (Agrawal, Singh & Murtaza 2016:93). Taking environmental concerns into account, reverse logistics can lead to cost savings and environmental improvements because the reverse logistics system retrieves resources that would not otherwise be used (Abraham, 2011:01; Das & Chowdhary 2012:56; Kassem & Chen 2013:51; Jayant, Gupta & Garg 2012:36; Kim, Goyal & Kim 2013:01; Lieckens & Vandaele 2012:43; Choudhary et al. 2015:114).

Lambert, Riopel and Abdul-Kader (2011:57) state that the recycling of scrap rubber for re-use in other roles, for producing energy or for recovering and replacing virgin material, is growing in importance as environmental legislation reduces disposal options. Nativi and Lee (2012:16) indicate that from streets to playgrounds, national free-ways to country roads there is debris from thousands of irresponsible people who discard their used plastic packets, glass bottles, polystyrene containers, and other non-biodegradable items out of their car windows without a second thought to the ecosystem and the environment. It is the end user's responsibility to litter correctly to make recycling possible and convenient.

A review by Dixit and Badgaiyan (2016:115) highlighted the rising consciousness of stakeholders (managers, legislative bodies, customers, etc.) of environmental concern and how this has increased attention to reverse supply chains. Recoverable-manufacturing systems are environmentally friendly and have been reported for several products, including copiers, automobile parts, computers, office furniture, mass transit, aviation equipment and tires (Govindan & Murugesan 2011: 55; Govindan, Palaniappan, Zhu & Kannan 2012:21; Alumur et al. 2012:70; Pochampally & Gupta 2012:01; Govindan, Sarkis & Palaniappan 2013:1; Mitra 2013:1; Choudhary et al. 2015:01). A wide range of firms has engaged in remanufacturing operations, including large multinational firms (Azadi & Saen 2011:01).

Bai and Sarkis (2011:19) provided an overview of the logistics problems firms face in recoverable operations. Lai, Wu and Wong (2013:09) describe several cases and models that link recovery strategies with reverse logistics network design. Lately, the recovery processes have been enthusiastically carried out by township and poor communities for the sake of making a small income to fulfil some of their needs. This also happens in landfill areas where waste is turned into good.

Ponce-Cueto, Manteca and Carrasco-Gallego (2011:593) discovered that concern for the environment had led many firms to define policies that protect the context within which they operate. This concern is reflected in all the activities of the product life cycle, both in those direct logistics as well as reverse logistics. According to Millet (2011:588), increasing environmental consciousness, limited availability of natural resources to manufacture new products, recovery quotas to avoid disposal, manufacturers assigned to be responsible for used products, and the material value of components included in returned products are incentives for product recovery.

Hazen et al. (2011:166) has noticed that the refurbishing decision falls into a general class of problems called product recovery problems that have generated some academic interest and enormous practitioner interest. Furthermore, Chatfield and Pritchad (2013:106) discovered that the recovery and processing of unused products are concerns that increasingly affect organisations, be it to improve customer service or to meet environmental pressures.

2.6 REVERSE LOGISTICS OPERATIONS

This section focuses on two principal activities known as the return of unsold goods and disposal as well as product return and exchange.

2.6.1 Return of unsold goods and disposal

As highlighted previously, reverse logistics includes managing, storing, processing, sorting, collecting, transporting, and providing proper final treatment for post-consumer products. It can take place using the original forward channel, through a reverse channel or a combination of both. Still, reverse and forward logistics have different flows (Zhang & Jing 2011:17; Fang & Jiang 2012:25). When products are of sufficiently high value and can be remanufactured for re-sale, efficient reverse logistics can even function as a profit centre (Ye, Zhao, Prahinski & Li 2013:01).

However, reverse logistics is generally poorly managed because more than one firm may get involved in the reverse logistics process, and thus a holistic approach is required (Teunter & Flapper 2011:13). By nature, the product return process is more complicated than forward logistics operations due to the presence of multiple reverse distribution channels (direct return to manufacturers versus an indirect return to regional collection points or centralised return centres), individualised returns with small quantities, extended order cycles associated with product exchanges, and a variety of disposition options (Rahman & Subramanian 2012:01).

Primary distribution occurs when goods flow from the point-of-origin (input or raw materials) to the point of consumption (end-user). The financial or money streamflow is in the opposite direction of the goods flow in primary distribution; for example, the end-user pays the upstream member of the supply chain, who in turn, pays the next member directly upstream. However, not all goods flow through the entire supply chain (from the raw material stage to the consumer). These secondary channels are often part of reverse logistics and comprise such diverse issues as product returns, recalls, and waste management (Das 2012:19).

In specific industries, goods are distributed to downstream members in the supply chain with the understanding that the goods may be returned for credit if they are not sold (Govindan & Soleimani 2016:14). Newspapers and magazines serve as examples. This acts as an incentive for downstream members to carry more stock because the risk of obsolescence is borne by the upstream supply chain members.

However, there is also a distinct risk attached to this logistics concept. The downstream member in the supply chain might exploit the situation by ordering more stock than is required and returning large volumes. In this way, the downstream partner is able to offer a high level of service without carrying the risks associated with large inventories. The supplier effectively finances the inventory for the downstream member. It is, therefore, essential to analyse customers' accounts for hidden costs (Barker & Zabinsky, 2011:59). For every item that is returned unsold, it affects the inventory carrying value such that the storage and transport cost are still in the responsibility of the supplier.

A different example of the return of unsold goods can be found in the bread industry. Old bread is often returned to bakeries where it is reprocessed into croutons. Collecting the old bread does not add any high cost because the delivery vehicle is already committed to calling at each point. The raw material (old bread) also does not add to the price because the alternative is to let the old food go to waste.

Bakeries that employ this concept can gain a competitive advantage by offering another product without having to carry added input costs (Barker & Zabinsky 2011:61). At present, returned products are generally collected at the point of sale, inspected and sorted by employees to the best of their knowledge. Moreover, the employee determines if the return is accepted and the actions to be taken (credited amount, exchanges, etc.). After that, a certain amount of time can pass before further measures are taken regarding these recovered products. These products are generally reintroduced directly into the market as new, and when this is not possible, resold at discounted prices. In fact, because of the uncertainty factors related to returned products (quality, quantity, and time) and each business unit seeks to minimise the impact of returns on their current activities, which are generally associated with the distribution of new products. Therefore, they will choose the most straightforward and quickest disposal means for the returned products without concern for other methods of reintroducing the product into the market. Thus, they function primarily on a local level. Hence, these activities are generally seen as sources of cost rather than income (Godichaud & Amodeo 2015:106).

2.6.2 Product returns and exchanges

It is reasonably imperative for manufacturing firms and retail businesses to analyse and understand the underlying reasons and causes of product returns and exchanges. It stems from damaged goods, incorrectly ordered goods, incorrectly supplied goods, warranty claims, product support service, or after-sales service. All these causes of returns and exchanges must be managed and controlled.

Product returns must be monitored to ensure that patterns of returns are identified and broken. This will enable management to manage the demand for reverse logistics capacity proactively. According to Halabi, Montoya-Torres, Pirachican, and Mejia (2013:106), there are various reasons for the returns and exchange of products. They identified damages, incorrect orders, and supply, warranties, and repairs, as the most common found triggers to product return.

Damaged goods

Goods can be damaged during transport or storage. The sooner the damage is detected, the cheaper it is to rectify the problem. As products flow through the logistics process, they gain in value. (If this is not the case, there should not be intermediate steps). This benefit is wasted if it is added to damaged goods, which will be returned at a later stage (Halabi et al. 2013:106).

Incorrectly ordered goods

Communicating an order by telephone or fax allows for inaccuracies in the capturing of order details into the order management system. The method with the least potential for errors is one whereby the customer captures the order, and whereby the order is transmitted and received in an electronic format. This can be achieved through direct linkage through Electronic Data Interchange (EDI), or via the Internet (Halabi et al. 2013:106).

Incorrectly supplied goods

The only difference between a wrong customer order specification, incorrect data capturing, and an incorrect pick is a party responsible for paying for the mishap. All parties lose out when goods are supplied incorrectly: The supplier must take the products back, and the customer has to wait for the appropriate order to be delivered (Halabi et al. 2013:106).

Warranties and repairs

The cost of warranties and repairs apply when customers reject products due to quality problems. It is in the best interest of a business to detect defective goods as soon as possible with the view to reduce the unnecessary cost of return. The firm also needs to decide whether returned products should be recycled, repaired, or disposed of (Halabi et al. 2013:106). However, of all the choices mentioned, cost factors, and the opportunity, the benefit income must be carefully considered.

2.7 REVERSE LOGISTICS PRACTICES

Reverse logistics activities form a dominant part of this research study, and this section discusses these in perspective.

For many products, a customer's relationship with the product's manufacturer does not end with product purchases. In fact, this relationship can be significantly influenced by the activities that occur after purchase, during the entire period of product ownership. After-sales services can encompass multiple activities, including customer support through training, product warranties, maintenance and repair, product upgrades, sales of complementary products, and product disposal. Management of these service activities can form an essential part of corporate strategy.

For instance, when customers perceive that an organisation supports its products, the products may be able to command premium prices (Govindan & Murugesan, 2011:55). Also, after-sales services represent significant opportunities to create and strengthen customer loyalty.

After-sales support services can also be the source of significant revenue potential, accounting for as much as 25% of revenue and 40% to 50% of profits for manufacturers (Pal, Sana & Chaudhuri, 2013:42). Moreover, Mangla, Govindan, and Luthra (2016:608) established the following as additional components:

- **Remanufacturing**

  Remanufacturing refers to all products that can be used for reproduction.

- **Refurbishing**

  Renewal renovates or restoration of products are similar words that best explain the word refurbishing.

- **Recycling**

  This refers to a complete reprocessing and reuse of a product.

- **Landfill**

  Landfill refers to the throwing away or destroying of non-used products.

- **Repackaging**

  A typical example of repackaging is all products that are containerised with the package that can be returned for a refund.

- **Returns processing**

  Return processing refers to every step that is undertaken every time a returned product is considered for reuse.

- **Salvage**

  Product recovery and reclaims are referred to by the use of the word salvage. Recycling and salvage are two words that can be used inter-exchangeably for the same meaning.

As the preceding discussion illustrates, there are many reverse logistics activities. However, the present study identifies repairs, recondition, remanufacture, recycling, and disposal as reverse practices.

2.7.1 Identified reverse logistics practices of the study

This section discusses the identified reverse logistics of the study which are repairs, recondition, remanufacture, recycling and disposal.

2.7.1.1 Repairs

Repairs are defined as the process of adjusting any malfunction occurring on a product or item to regain its functioning state (Khor & Udin 2012:7). These authors advanced that the use of repairs is essential in reducing environmental waste.

Repairs have also been regarded as a critical reverse logistics tool, which is designed at improving the overall state of a defection's product (Sangwan 2017:260). Besides, Ertogral and Ozturk (2019:832) argued that this practice plays a fundamental part in an organisation's ability to adhere to issues of sustainability.

2.7.1.2 Recondition

Product reconditioning refers to the process of putting back the product into working or sound quality condition. Two things that matter most to consumers are 'fitness for use' and manufacturer's 'warranty' of the final product (Gharfalkar, Ali & Hillier 2016:11). Khor and Udin (2012:7) refer to recondition as the process of restructuring or reassembling different parts of the function of an item or product to repair them so that they can be restored to their initial state. It is a process that involves significant utilisation of technology to be carried out effectively and efficiently (Sangwan 2017:260). This then indicates its value addition as a sound operating technique to regain product value. This view highlights the relevance and critical nature of these practices as vital to environmental sustainability.

2.7.1.3 Remanufacture

Remanufacture can be conceptualised as the process of reproducing a damaged item or product to restore it to its original state and preserve some value (Khor & Udin 2012:7). According to Jack, Powers, and Skinner (2010:228), the adoption of this system contributes significantly to increasing the competitive position of firms through its role in cost reduction. It also preserves the environment by using damage and other components parts which were due to disposed of (Lai, Wu & Wong 2013:106). Remanufacturing is the process of reproducing a product to its original state or the rebuilding of a product to specifications of the original manufactured product using a combination of reused, repaired and new parts (Chen, Wang & Ou 2014:13). This requires the repair or replacement of worn-out or obsolete components and modules.

2.7.1.4 Recycle

Recycling is defined as a set of procedures designed at collecting and sorting out parts as well as non-value-added materials and items for reuse (Khor, Udin, Ramayah & Hazen 2016:97). Recycling is encouraged and usually initiated by manufacturing, distribution and retail enterprises to establish their extended after-sale product responsibility. The purpose of recycling is to reuse materials from the return products. Engaging in recycling activities has proven to be essential in contributing to sustainability efforts by preserving any negative impact on the environment (Kannan, Govindan & Shankar 2016:281). Additionally, Prakash and Barua (2015:599) posited that recycling has a massive effect on sustainable development.

2.7.1.5 Disposal

Disposal refers to the process of adequately disposing of unwanted or non-valuable items or products (Khor & Udin 2012:7). A report from Khor et al. (2016:97) established the relevance of this function by stating that it is a core aspect that underpins the implementation of reverse logistics best practices. This, therefore, denotes the strategic value associated with this practice as a backbone to sustainable environmental practices. In instances when products cannot be repaired or restored for purposes of reuse, producers inevitably find themselves having to dispose of some of the products. Disposal is the act of getting rid of something that is no longer wanted or needed.

2.8. BARRIERS TO REVERSE LOGISTICS

A study conducted by Zhu and Xiuquan (2013:1389) has found many obstacles that impede the practice of reverse logistics. They include, amongst other aspects, such as firm policies, lack of systems, financial resources, personnel resources, and legal matters. Although practices related to reverse logistics have helped the cause of environmental protection, practising the much-needed approaches is not free from barriers. The study endorsed the findings from Bai and Sarkis (2013:1), who discovered 11 elements that represent boundaries to the effective implementation of reverse logistics activities. These barriers are elaborated as follows:

2.8.1. Lack of information and technological systems

Ramezani, Bashiri and Tavakkoli-Moghaddam (2013:328) mention that a severe problem faced by firms in the implementation of reverse logistics is the shortage of sound information systems. Efficient information and technological policy are vital for supporting reverse logistics during various stages of the product life cycle. During the product development phase, the critical variables to be considered are the material content and the product structure.

The type of materials and technology used for manufacturing determines the extent of the product recovery that is possible after the end-of-use/end-of-life of the product. Sarkis, Helms, and Hervani

(2010:337) also articulate that excellent information and technological systems can be beneficial for the product development programmes encompassing the design for the environment, recovery, re-use, and so on.

Besides, Piplani and Saraswat (2012:621) describe the use of information and new technologies to improve processes in the reverse chain for the situation where products and equipment need to be disassembled. Very few local firms have successfully automated the information surrounding the returns process. There is a shortage of sound reverse logistics information management systems commercially available. Thus, this is a very significant barrier affecting effective reverse logistics. Reverse logistics technology, according to Guarnieri, Silva and Levino (2016:1105), recycling and the related issue of sustainable development are increasing in importance around the world. For this reason, many laws have emerged over the past decades to bring attention to waste management.

Regarding electronic waste (e-waste), Sasaki and Araki, (2013:51) mention several initiatives in many countries. Many managers only consider reverse logistics from the time at which the waste is generated and must be sent for recycling or environmentally correct disposal. However, reverse logistics should be considered for the entire life cycle of the product, including as part of the product design (Alshamsi & Diabat, 2015:589). Therefore, IT should cover information on a product life span from production to disposal to address reverse logistics challenges.

2.8.2. Problems with the product quality

Another critical barrier affecting reverse logistics is the condition of the quality of the end-of-use/end-of-life returned products. The product quality is not uniform in reverse logistics compared to forwarding logistics, where the product quality is uniform. Mallenkopf et al. (2011:114) believe that the overall quality targets for remanufactured/recycled products must be, at the least, equivalent to the virgin products. Customers usually expect the same level of quality of a product from the manufacturer, regardless of the nature of the returned product.

Zhang, Huang and He (2012:166) describe the product recovery at the Norwegian national insurance administration where the Technical Aid Centers (TACs) had the task of distributing and servicing wheelchairs, hearing aids, and speech synthesisers were dependent upon the product quality; the TACs re-used some units, repaired others, and refurbished still others. When the returned products arrive at the distribution centre, a decision must be made for disposition.

2.8.3. Firm policy

Restrictive firm policies are an essential barrier to reverse logistics. The lack of the importance of reverse logistics and management inattention is related to the procedures followed by the firms. Firms want to create a brand image for the customers. They do not want to compromise the end-product quality by using the returned products. Thus, the policies developed by firms of producing only virgin products also have a significant effect of not handling the returned products and to recover the hidden secondary value from the returns (Rouf & Zhang, 2011:167).

Due to the advent of extended producer responsibility, many firms have started to integrate the recovery options for the products into their supply chain. There seems to be a paradigm shift by firms to change their rigid policies to incorporate the returns of the merchandise to recover value economically that could give them an edge over their competitors (Rouf & Zhang, 2011:168).

2.8.4. Resistance to change to reverse logistics

One of the main barriers seen in the implementation of reverse logistics is the resistance to change, with human nature being the fundamental barrier (Bai & Sarkis 2013:24). People avoid change when possible, and reverse logistics requires a radical shift in mindset and practice. With increased competition in the market and shrinking profit margins, firms are increasingly interested in savings with the recovery of the used products.

Most importantly, the adoption of reverse logistics practices results in indirect benefits to the environment. The lack of awareness of the benefits of reverse logistics, both from economic and environmental angles, could be a significant factor for resistance to change to reverse logistics. Reverse logistics systems initially involve high commercial investment. Financial constraints could also lead to resistance to change to reverse logistics (Shaik & Abdul-Kader, 2012:01).

2.8.5. Lack of commitment by top management

Lack of engagement by senior management is a primary barrier to successful reverse logistics. Schulz (2011:1) states that high management commitment is the dominant driver of corporate endeavours. A significant challenge seen in commercial recycling is the lack of commitment by top management. Efficient leadership is needed to provide clear vision and value to reverse logistics programmes. According to Bai and Sarkis (2013:15), senior management should demonstrate the commitment to change logistics activities on a par with other organisational goals by integrating all the members of the supply chain. They should provide continuous support for reverse logistics in the strategic plans, and action plans for successfully implementing them.

The assessment by Wilcox et al. (2011:145) shows that current and emerging expenditures for both reverse logistics and repair services (RLRS) combined with an assessment and evaluation of the existing and emerging competition and new market requirements and needs, clearly show that reverse logistics and repair will become a major business opportunity in the 21st century. Customers are looking for an integrated provider of all RLRS services with a global reach.

2.8.6. Lack of awareness about reverse logistics

Firms' supply chain's lack of knowledge about the benefits of reverse logistics is another barrier to reverse logistics. Even if firms know about them, giving relative unimportance to reverse logistics was the most substantial barrier to reverse logistics. Firms are finding that in a position, irrespective of whatever industry they are in, whether automobile, food processing, or paper industry, there is an increasing case of product recalls. Today, many consumer products have a shorter life cycle.

While customers have the benefits of greater product variety, it has resulted in an increase in unsold products, rate of returns, packing materials, and waste. This has given rise to an increase in the volume of product returns in the form of reverse logistics. Therefore, the management of parts or products coming back into the supply chain network from its outbound side is a matter of concern for many industries (Kim & Lee, 2013:198).

Product returns in the retail sector have become an "epidemic problem." Accordingly, to push returns through the pipeline in an effective and cost-efficient way and try to recover value, many firms are re-evaluating their reverse logistics processes. It has been suggested that if a firm's reverse logistics programme is not proactively managed, the result will be higher costs and missed opportunities for savings and profits (Feng, Zhang & Tang 2013:110).

2.9. ENVIRONMENTAL SUSTAINABILITY

In this section, reviewed literature on environmental sustainability is reviewed, with a specific focus on the understanding of the concept in terms of its definition as well as its relevance in supply chain management.

According to a report by the World Commission on Environment and Development in 1987, the concept of environmental sustainability refers to an organisation's ability to maintain or preserve its direct or indirect environment from any harm or damage to its ecosystem. Such is the value that this concept has in today's supply chain. This view was supported by Bai and Sarkis (2010:252), who advanced that managing and protecting the environment has become one of many vital strategic drives of businesses. Sarkis, Gonzalez-Torre, and Denso-Diaz (2010:163) echoed this sentiment by stated that firms' stakeholders had become more engaged in the preservation of the environment and enforce the adoption of sound ecological practices.

Furthermore, Piecyk, McKinnon and Allen (2010:68) posited that improper environmental management could result in unreliable logistics activities, which may correlate to poor performance. At the same time, Hall and Wagner (2012:184) postulated that firms should integrate ecological concerns as part of their core business strategy to be able to comply with today's norms and regulations. This further highlights the critical nature and role that this notion has on the success of firms' supply chain.

Severo, de Guimaraes, Dorion, and Nodari (2015:118) argue that the implementation of clean and efficient production processes and procedures minimise the negative production practices and their subsequent effects on the environment. Also, green supply chain management aspects have been found to significantly influence the protection of the environment and result in increased performance (Yang, Lin, Chan & Sheu 2010: 210). Faisal (2010:508) established that a sustainable environment is a driver to ensure environmentally related consumers, which results in improving firms' brand images. Severo et al. (2015:120) submitted that sustainability approaches have a positive and significant influence on business performance through their role in customer satisfaction and loyalty. The role of environmental sustainability and performance has also been examined by Laosirihongthong, Adebanjo and Tan (2013:1), who acknowledged the impact of brand image as an essential determinant of performance.

2.10. BUSINESS PERFORMANCE

According to Beamon (1998:281), business performance refers to an organisation's ability and capability to conduct its operation activities effectively and efficiently. The author further suggested that performance can be assessed through factors such as efficiency, customer satisfaction, or flexibility (Beamon 1999:275). Gunasekaran, Patel, and Tirtiroglu (2001:71) offered a similar view by stating in their findings that business performance can be ascertained through aspects such as inventory and manufacturability as well as prompt delivery schedule and integration with strategic partners.

Business performance has been regarded as an essential strategic tool used by organisations' main stakeholders to evaluate the overall performance objective and success of their firms (Lee, Kim, Seo & Hight 2015:30). These authors further stressed that measuring business performance calls for evaluation, control, budgeting, motivation, promotion, celebration, learning, and enhancing the competitive position of a firm. Besides, Chen, Chiang, and Storey (2012:1165) pointed out that engaging in continuous assessment of operational activities in a critical determinant factor ensures a sustainable competitive advantage over a long period. This review emphasises the role of monitoring the excellence of business activities has in determining the survival of an organisation.

In his study on antecedents of business performance, Prajogo (2016:242) postulated that both product and process innovations' strategies have a significant influence on business performance. Similar findings from Mahmoud, Blankson, Owusu-Frimpong, Nwankwo, and Trang (2016:629) found that innovative capability exerts a considerable impact on business performance. Additionally, firms that demonstrate sound capabilities to integrate innovation technics and practices in their operation strategies tend to be better positioned to develop core and hard-to-imitate outputs (Hult, Hurley & Knight 2004:429; Mahmoud et al. 2016:629).

Information technology has proven to be the cornerstone of every successful operation performance (Mithas, Ramasubbu & Sambamurthy 2011:237), done through its impacts on speeding-up communication and fostering information exchange across different business functions (Popovič, Hackney, Coelho & Jaklič 2014:270). As a result, firms can increase their overall performance objectives through the exchange of quality and relevant information and data required to conform to customers' and consumers' specifications and requirements (Popovič, Hackney, Coelho & Jaklič 2012:729).

2.11. CONCLUSION

This chapter provided a review of literature on the constructs of the study, namely, reverse logistics practices such as repairs, recondition, remanufacture, recycle and disposal. Other variables discussed were environmental sustainability and business performance. Aspects discussed included, among others, the definition and operational characteristics of these variables. Specific emphasis was put on the concept of reverse logistics in which topics such as its importance, barriers to its adoption and its practices and operation characteristics were outlined. Other points reviewed regarding reverse logistics consisted of its environmental and economic impacts. The next chapter concentrates on the research methodology that sets the scene on how the investigation was conducted.

3. RESEARCH METHODOLOGY

3.8. INTRODUCTION

A research methodology is defined by Kim and Lee (2010:02) as the application of various methods, techniques and principles to create scientifically obtained knowledge using objective methods and procedures within a particular discipline. It is essential to realise that different studies will use different methods or techniques because they have different aims. The methods must be appropriate for the tasks. Chen and Bell (2011:93) explain methodology as the ability to show the appropriateness of the techniques used to gather data and the methodological approaches employed. Figure 3.1 offers a general perspective of the critical aspects that encompass this section.

This chapter aims to provide detailed and adequate insight and understanding of the basic methodological, technical techniques and methods used during the study. Issues discussed include the research paradigms, approach, objectives, and design. The application and purpose of the research method and an overview of the procedures for statistical analysis are provided. This chapter is of great significance in the sense that it highlights all methods and techniques which are required to conduct a sound research project.

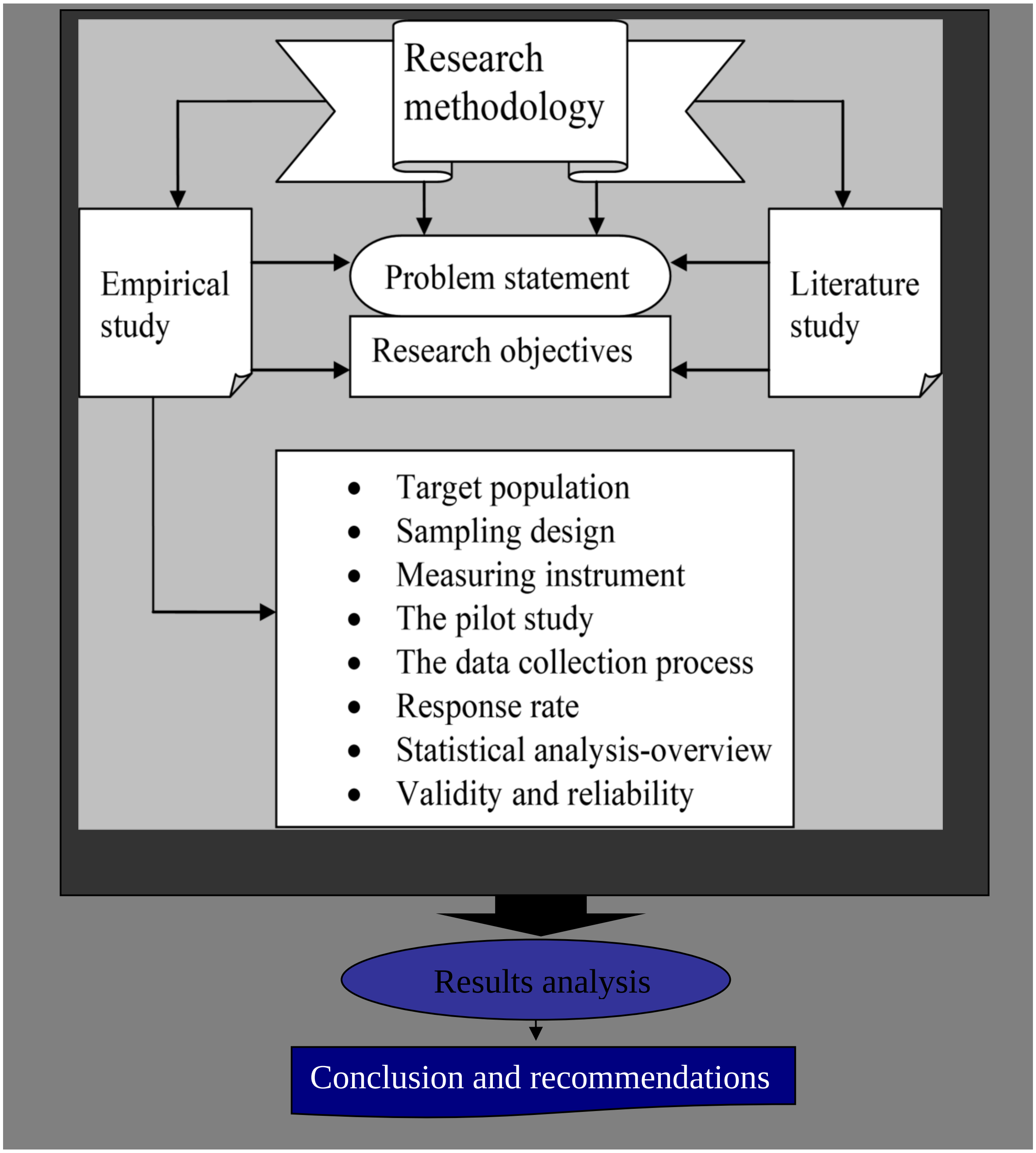


Figure 3.1: The process for research methodology

Source: Author's own compilation

3.9. RESEARCH PARADIGMS

According to Gummesson (2000:18), a research paradigm is derived from initial work from Thomas Kuhn in 1970 in which it is regarded as the understanding of individuals' thoughts' process on a specific phenomenon. There are several research paradigms such as functionalist sociology, radical structuralism, radical humanism and interpretivism (Burrell & Morgan 1979:1). In the present study, the functionalist sociology was selected in which phenomenological and positivism paradigms were adopted. Positivism is regarded as a scientific research paradigm, which necessitates factual scientific points to ascertain the causal relationship of factors to solve a predetermined problem (Creswell 2003:6). In contrast, phenomenology emphasises the comprehension of individuals' behaviour (Lopez & Willis 2004:726).

Based on the discussion above, the present study opted for the positivist paradigm on the basis that the study seeks to examine the causal association between reverse logistics practices and business performance, with the mediating role of environmental sustainability.

3.10. RESEARCH APPROACH

Zou, Sunindijo, and Dainty (2014:318) established that a research approach consists of three research methods, namely, qualitative, quantitative and mixed method. Qualitative research is a method which is based more on analysing perceptions with less utilisation of numerical aspects to collect and determine trends (Bryman & Bell 2007:28). Some techniques include case study, grounded theory, ethnography, and narrative (Creswell 2009:1). Zou et al. (2014:318) also defined a quantitative approach in terms of the adoption of numerical data and information to assess a problem. A mixed method is regarded as a combination of both discussed approaches (qualitative and quantitative). Some techniques related to this method include facilitation, complementarity, and triangulation (Bryman 2008:607). This study opted for a quantitative approach because it is based on the testing of the causal relationship between predictor variables (reverse logistics practices), mediator (environment sustainability) and outcome (business performance).

3.11. RESEARCH DESIGN

According to Creswell (2009:3), a research design is a proposal of an action-plan designed at establishing how a study is undertaken. As stated in Section 3.3, the study adopted a quantitative approach in which a cross-sectional survey is approved to conduct the research (Bryman & Bell 2007:71). This technique is suitable because it enables the researcher to gather data from a defined sample using a structured questionnaire, as indicated by Bryman and Bell (2007:53).

3.11.2. Sampling design

Figure 3.2 illustrates the sample design of the study. Sampling design consists of the following, as suggested by Zikmund (2003:367): the target population, sampling frame and sample size

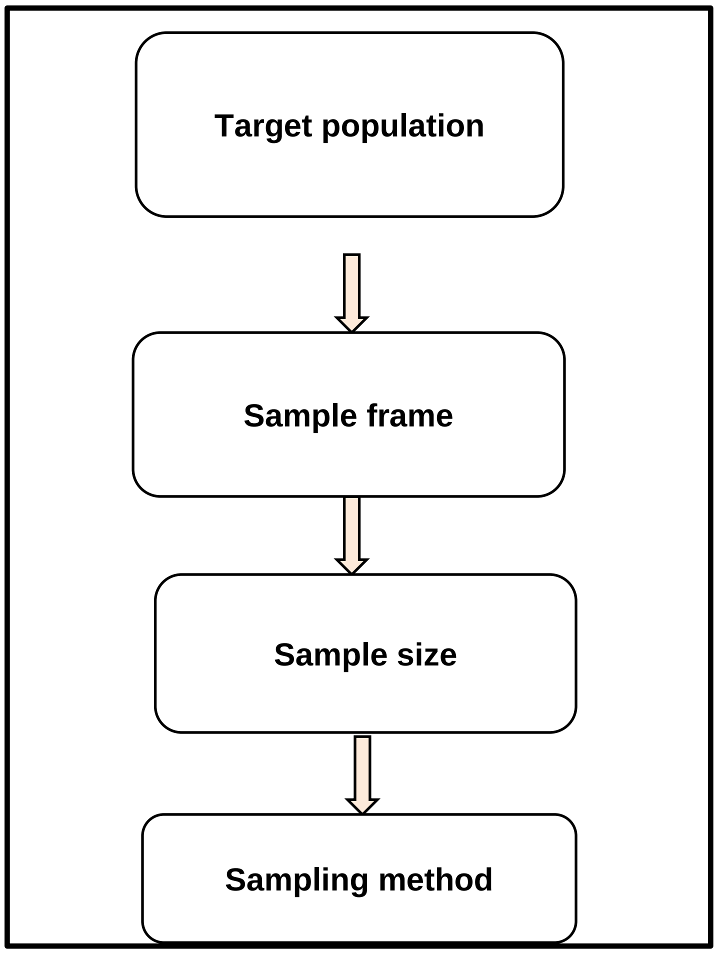


Figure 3.2: Sampling design illustration

Source: Zikmund (2003:367)

3.11.2.1. Target population

According to Giannetti, Bonilla and Almeida (2012:232), the target population is a clearly defined group of entities that have some of the characteristics relevant to the studies in common. Roghanian and Pazhoheshfar (2014:328) view the target population as an identified group of elements that are of interest to the researcher. Regardless of how well the research instrument is designed, the data will lose value if the wrong people are targeted (Giannetti et al. 2012:232). Nikolaou, Evangelinos and Allan (2011:140) comment that the researcher needs to be precise in specifying exactly what elements of the population are of interest and what factors are to be excluded.

The target population for this study consisted of all employees drawn from manufacturing firms in the Vaal Triangle manufacturing sector who have a certain level of experience in supply chain management. Only accessible and cooperative firms around the Vaal Triangle industry were included since it was inconvenient to cover all the manufacturing firms in this area.

3.11.2.2. Sample frame

Kumar (2011:91) defines a sample frame as a list of the selected sample of the study. A list of manufacturing firms situated in the Vaal Triangle area was obtained from the Sedibeng district department and Vanderbijlpark information centre. The Vaal manufacturing firms' supply chain practitioners operating in the Vaal Triangle region were identified; and out of a list of 58 manufacturing firms, at least 30 had active contact details and addresses.

3.11.2.3. Sample size

Kumar (2011:94) defines a sample size as the number of respondents that participate in the study and drawn from the sample frame. The historical sample approach was used to determine the sample size of this study. Table 3.1 shows the different studies that were taken into consideration when determining the sample size of the study.

Table 3.1: Historical sample sizes determination

Authors	**Title of studies**	**Sample sizes**
Wooi and Zailani (2010)	Green supply chain initiative	600
Hamann, Smith, Tashman, and Marshall (2015)	Why do SMEs go green? An analysis of wine firms	500
Mafini and Loury-Okoumba (2018)	Extending green supply chain management activities to manufacturing small and medium enterprises in a developing economy	400

Source: Authors own compilation

Given the historical sample sizes indicated in Table 3.1, the study sample size for the current study was pegged at n=350.

3.11.3. The sampling procedure

This study was conducted using a simple random sampling technique, which Bai and Sarkis (2013:94) describe as the most basic one. The simple random sampling technique is a form of a probability sampling procedure (Zikmund, Babin, Carr & Griffin 2010:395). The probability sampling approach refers to the selection of a sample from a targeted population in which all elements within the sample have an equal chance of being selected (Quinlan 2011:209). Respondents were randomly selected from the lists of supply chain professionals obtained from the selected manufacturing firms. Wherever some respondents declined to participate after being selected, the procedure was repeated until a representative sample size of 350 consented to participate in the study. Out of this number, a total of 201 respondents provided satisfactory responses in the final survey (c.f. Sect 4.2).

3.11.4. Measuring instrument

The study made use of a structured questionnaire to gather data from the respondents (c.f. Appendix 1). The survey questionnaire was divided into two sections, with the first (Section A) dealt with the demographic details of the respondents whereas Section B, focused on the items related to the constructs of the study.

Measurement scales for reverse logistics practices were adopted from various previous studies. For example, repairs were measured using a five-item scale; recondition used an eight-item scale, remanufacture both used a seven-item scale; recycle used a nine-item scale; and for disposal a four-item scale. All these practices were adopted from studies by Guide Jr, Jayaraman, Srivastava, and Benton (2000); King, Burgess, Ijomah, and McMahon (2006); Skinner, Bryant and Richey (2008:518); and Talbot, Lefebvre, and Lefebvre (2007). Response options were presented on a five-point Likert scale anchored by 1= not considering it; 2= planning to consider it; 3= considering it currently; 4= initiating implementation, and 5= implementing successfully.

Environmental sustainability was measured using an eight-item scale derived from a study by Henriques and Sadorsky (1996). Business performance was considered to be multidimensional, and two dimensions, namely, profitability and growth were used to measure it. Growth was measured using a seven-item scale adapted from a study by King and Lenox (2001), while profitability used an eight-item scale derived from Daugherty, Autry, and Ellinger (2001). Table 3.2 provides an overall view of the study measurement instruments and the sources from which these items were derived. The two business performance constructs were also measured using a five-point Likert scale configured as 1= not at all; 2= a little bit; 3= to some degree; 4= relatively significant; and 5= significant.

Table 3.2: Measurement instrument

Section	**Constructs**	**Number of instruments**	**Sources**
B	Repairs	5	Guide Jr, Jayaraman, Srivastava, and Benton (2000) King, Burgess, Ijomah, and McMahon (2006) Skinner, Bryant, and Richey (2008); and Talbot, Lefebvre, and Lefebvre (2007)
	Recondition	8	
	Remanufacture	7	
	Recycle	9	
	Disposal	4	
C	Environmental sustainability	8	Henriques and Sadorsky (1996)
D	Business performance		King and Lenox (2001) Daugherty, Autry, and Ellinger (2001)
	Profitability	8	
	Sales growth	7	

3.11.5. Data collection and method

Mahmoudzadeh et al. (2013:399) stated that the data collection plan specifies the details of the task. In essence, it answers the questions of *who, what, when, how, and where?* As indicated previously, a questionnaire was designed using the information obtained from secondary data sources and obtained questions intended to address the research objectives. Questions were asked in s a way that gave the researcher the data which are transformed into information, which was then analysed and discussed in chapter five. Questionnaires were distributed to the selected respondents in the targeted manufacturing firms around the Vaal Triangle area between March and September 2019. Respondents completed the survey in their own time and at their own pace because they requested enough time to answer these questionnaires thoroughly. Providing ample time for respondents to complete the questionnaires made them more observant and provide valuable information (Sharma & Singh, 2013:829).

3.11.6. Data analysis

The data collected were analysed using the Statistical Package for Social Sciences (SPSS) version 25.0. Descriptive statistics were used to assess data related to the demographic characteristics as well as the perceptions of the respondents towards the constructs. Next, the study made use of correlation and regression analysis to ascertain the identified causal relationships of the constructs of the study (reverse logistics practices to environmental sustainability and business performance).

3.11.6.1. Reliability

Reliability can be defined as the degree to which measures are free from errors, which then results in more reliable outcomes (Ang 2014:176). As such, reliability was determined using Cronbach's alpha value, in which the cut off range must be equal or above 0.7 (Fornell & Larcker 1981:39).

3.11.6.2. Validity

Validity is the level to which measurement instruments of the variable confirm its measures (Scholtes, Terwee & Poolman 2011:239). Besides, Easterby-Smith, Thorpe, and Lowe (2002:1) suggest that validity assessment can be established in three ways known as content, convergent, and criterion validity. For the purpose of this study, specific attention was directed to construct validity. According to Churchill (1979:64), construct validity is defined as a construct’s ability to measure and accurately assess what it is intended to measure. Construct validity was measured using correlations (c.f. Tables 4.13). Also, regression analysis was used to determine predictive validity (c.f. Table 4.14). Lastly, content and face validities were also assessed. Content validity was tested using a panel review consisting of lecturers drawn from the logistics department at a selected university of Technology. Face validity was tested using a pre-test study of the questionnaires, whereby twenty (20) respondents formed part of the pre-testing process.

3.12. 4. ETHICAL CONSIDERATIONS

The study upheld several ethical considerations. These include, amongst others, the protection of respondents' confidentiality in terms of the information that was given, as indicated by Mason (1986:1). The respondents contributed to the study voluntarily and were not forced to do so in any shape or form. This was achieved by informing them on the purpose, needs, and relevance of the survey. This resulted in the respondents to better understand the nature and their contribution to the research. They were able to make informed decisions regarding their participation and contribution to the study. Moreover, all respondents were assured that their identity would remain confidential and that anonymity would always be maintained. They were further informed that information gathered would not be used against them under any circumstances but would be solely for the research. Lastly, the study adhered to the principle and rules of plagiarism, in which steps to minimise that practice were taken in the form of reference checks.

3.13. 5. CONCLUSION

This chapter aimed to discuss the research methodology followed in the present study. It showed that it followed a positivist paradigm based on the quantitative method, apart from using a survey design. The chapter also revealed that the sample consisted of randomly selected supply chain management professionals drawn from manufacturing firms based in the Vaal Triangle region. Data were collected using an adapted three-section questionnaire administered to respondents between March and September 2019. The relevant data were captured, edited, coded, and finally analysed using the Statistical Packages for the Social Sciences Version 25.0. Reliability was tested using the Cronbach alpha, whereas construct validity was tested using a combination of correlation and regression analyses. Several ethical considerations were followed to ensure that the study was conducted within the confines of acceptable research practices. The next chapter discusses how the collected data were analysed.

4. DATA ANALYSIS AND RESULTS

4.8. INTRODUCTION

In the previous chapter, the research methodology used was described together with the empirical design. A questionnaire was designed to determine the reverse logistics activities of manufacturing firms around the Vaal. The current chapter aims to present the results and their interpretation based on the statistical analyses performed. It presents the results of the analysis of descriptive statistics. Thereafter, correlation analysis is presented to determine the association between predicting, mediating, and outcome constructs. Regression analysis is also given to determine relationships between independent and dependent constructs. An overall discussion of the findings and the link to the literature review is presented to support the results obtained.

4.9. RESPONSE RATE

The total number of questionnaires distributed to the manufacturing firms was 350 from the total number of the selected industrial, mechanical, and engineering manufacturing firms around the Vaal Triangle area, and 244 were returned. From the returned questionnaires, 43 were discarded as they were incomplete, culminating in 201 responses used in the final analysis. This gave a response rate of 57%, and the detailed information is illustrated in Table 4.1.

Table 4.1: Response rate information

Respondents	Rate
Employees available for research	350
Total responses	244
Usable responses	201
Response rate	57%

4.10. DESCRIPTIVE STATISTICS

In this chapter, the results of descriptive analyses are discussed. These include the firm profile and demographic details of respondents (Section A of the questionnaire), reverse logistics product disposition (Section B of the questionnaire) business performance of reverse logistics (Section C of the survey), (c.f. Appendix 1). The responses came from supply chain management professionals in all types of manufacturing industries.

4.10.2. Profile of Participating Firms

Section A of the questionnaire focused on the firm profile and demographic details of the respondents. These demographic details were analysed using descriptive statistics. The section addressed information on four variables, including individual respondent organisation details of gender, age, and the highest level of education. The results of the analysis of the firm profile are reported in Table 4.2.

Table 4.2: Profile of Organisation and Respondents

Variable and Category	Frequency	Percentage
Industry classification		
Steel Manufacturing	24	11.9
FMCG	32	15.9
Precast/construction	21	10.5
Agriculture	39	19.4
Transport/ Automotive	44	21.9
Electrical, Gas, and Water	27	13.4
Other	14	7.0
Totals	**201**	**100**
Annual turnover of organisation		
less than 10m	10	5.0
Between 10 and 20m	22	11.0
Between 21 and 30m	34	16.9
Between 31 and 40 m	58	29.0
Between 41 and 50 m	40	20.0
Above 50m	37	18.4
Totals	**201**	**100**
Number of employees in organisation		
Less than 20	22	10.9
21 to 50	17	8.5
51 to 100	41	20.4
101 to 200	63	31.3
201 to 300	29	14.4
Above 300	29	14.4
Totals	**201**	**100**

As shown in Table 4.2, most respondents were drawn from firms in the Transport/Automotive industry (21.9%; n=44), followed by those in agriculture (19.4%; n=39) and the FMCG industry

(15.9; n=32). In terms of the annual turnover of these firms, those that make a turnover of between R31 million and R50 million were the largest number in the sample (29%; n=58). With respect to the number of employees, most of the firms employed between 101 and 200 people (31.3%; n=63).

The demographic details of the actual respondents are presented in Table 4.3.

Table 4.3: Demographic Details

Variable and Category	Frequency	Percentage
Gender		
Male	139	71.6
Female	55	28.4
Totals	**201**	**100**
Age group		
<18-25 years of age	8	4.0
26-30 years of age	17	8.5
31-35 years of age	30	14.9
36-40 years of age	47	23.4
41-50 years of age	60	29.9
51> years and above	39	19.4
Totals	**201**	**100**
Level of education		
Matric / Grade 12	26	12.9
Degree	101	50.2
Masters	6	3.0
Professional Qualification	9	4.5
Diploma	48	23.9
Post Graduate Diploma	3	1.5
PhD	6	3.0
Other	2	1.0
Totals	**201**	**100**
Number of years working in the organisation		
Less than two years	50	24.9
2 to 5 years	85	42.3
6 to 10 years	45	22.4
11 to 15 years	14	7.0
16 to 20 years	3	1.5
Above 20 years	4	2.0
Totals	**201**	**100**
Position in the organisation		
Owner	20	10.0
Warehouse Manager	5	2.5
Supply Chain Manager	17	8.5
Stock Controller/Manager	6	3.0

Variable and Category	Frequency	Percentage
Disposal Controller/Manager	7	3.5
Procurement Manager	6	3.0
Technical/Quality Manager	19	9.5
Logistics Manager	53	26.4
Operations Manager	21	10.4
Workshop Manager	4	2.0
Customer Service Manager	4	2.0
Managing Director	12	6.0
Other	27	13.4
Totals	**201**	**100**

The results in Table 4.3 indicate that of the 201 respondents who had answered the questionnaires, 71.6% (n=139) were male and 28.4% (n=55) female. This shows a broad representation of the male gender in this study. Both male and female employees working in the logistics establishments industry were thus fairly represented in terms of gender.

Of the 201 respondents who participated in this study, 12.5% (n=25) were aged between 18-30 years, 38.3% (n=77) between 31-40 years, 49.3% (n=99) between 41-50 years and above. These results indicate that the respondents who mostly participated are dominated by the number of employees older than 40 years. The results further indicate that a small percentage of respondents were younger than 30 years of age, the average age of respondents being between 31 and 40 years of age.

Table 4.3 also shows that of the 201 respondents who completed the questionnaires, 12.9% (n=26) were holders of matric /grade 12, 50.2% (n=101) degrees, 23.9% (n=48) diplomas, and 13% (n=26) were holders of postgraduate, professional qualifications, Master's, PhDs and others combined. Therefore, these results indicate that a large and dominating number of respondents held degrees and diplomas with only a small percentage of matric holders. The remaining but also a small percentage of respondents (13%; n=26) equivalent to matric/grade 12 were postgraduate, professional and others collectively.

Most of the employees have been employed in the firms for periods ranging between two and five years (42.3; n=85). In terms of occupational area, many of the respondents were logisticians (26.4%; n=53) followed by the operational department (10.4%; n=21) and the owners (10%; n=20) who knew and understand the movement and logistics of commodities better. Technical and quality section participation (9.5; n=19) also plays an integral part in product performance and customer satisfaction in the market. Supply chain department respondents (8.5%; n=17) are also personnel directly responsible for the warehousing, distribution, and transportation of goods, which generally signifies relevance to the core focus of this research study.

4.11. DESCRIPTIVE STATISTICS FOR THE RESEARCH CONSTRUCTS

It is quite apparent that returned products require unexpected and unplanned attention, starting from warehouse for storage space to the production department for these to be reproduced or repaired, which will delay the production process of scheduled products (Esmaeiliana, Behdad & Wang 2016:79). This section discusses the results of the analysis of descriptive statistics for the research constructs.

4.11.2. Repairs

The percentages standard deviation and mean scores for repairs conducted by participating firms are indicated in Table 4.4.

Table 4.4: Product Repairs

Item code	Item description	Not considering it	Planning to consider it	Considering it currently	Initiating implementation	Implementing successfully	Standard deviation	Mean ($\bar{x}$)
REP1	Correction of faults in a product.	0.5	0.5	2.5	36.7	59.8	0.625	4.55
REP2	Restoring products to working order.	0.5	0.5	2.0	36.7	60.3	0.616	4.56
REP3	Prolonging the product's lifecycle.	1.5	0.5	3.0	42.7	52.3	0.721	4.44
REP4	Replacing broken parts that have failed.	0.5	0.5	1.5	39.7	57.8	0.609	4.54
REP5	Involving disassembly at product level.	1.5	0.5	2.5	38.7	56.8	0.717	4.49
Overall Scale							0.658	4.52

As shown in Table 4.4, almost 37% (n=73) of the respondents indicated that their firms are initiating the implementation of correcting the faults in their products while at least 59% (n=119) of the respondents showed that their firms are successfully implementing the correction of faulty products. Regarding item REP2, slightly above 60% (n=120) of the respondents mentioned that their firms successfully restore their products to working order. In comparison, 37% (n=73) of the respondents indicated that their firms are initiating the implementation of restoring their products to working order.

Concerning prolonging the product's lifecycle REP3, around 43% (n=85) of the respondents suggested that their firms are starting the implementation of extending the product's lifestyle, and about 52% (n=104) felt that their firms are implementing it successfully. Most respondents, almost 58% (n=115) stated that their firms successfully replace broken parts that have failed in their products, and slightly 40% (n=79) indicated that their firms are initiating implementation to repair defective parts that have been unable to be repaired. Regarding REP5 involving disassembly at product level, it is implemented successfully as shown by 57% (n=113) of the respondents. Last but not least, almost 40% (n=70) of the respondents indicated that their firms are initiating implementation.

The overall mean score for the scale is $\bar{\mathbf{x}}$=4.52; SD= 0.658. This result demonstrates that most manufacturing firms are successfully implementing product repairs. It means, therefore, that most firms either initiate implementation or are successfully implementing repairs' processes.

4.11.3. Reconditioning

The percentages, standard deviation and mean scores for product reconditioning conducted by participating firms are indicated in Table 4.5.

Table 4.5: Product Reconditioning

Item code	Item description	Not considering it	Planning to consider it	Considering it currently	Initiating implementation	Implementing successfully	Standard deviation	Mean ($\bar{x}$)
REC1	Collecting used products from customers for reconditioning.	4.0	2.0	1.0	46.7	46.2	0.913	4.29

REC2	Working for returning used products to a satisfactory working condition.	3.0	2.5	0.5	46.7	47.2	0.864	4.33
REC3	Inspecting critical modules in the products.	1.0	2.0	0.5	47.0	49.5	0.647	4.44
REC4	Extending the functional use of the products.	0.5	1.5	1.0	48.5	48.5	0.646	4.43
REC5	Replacing all major components that have failed or that are on the point of failure.	0.5	2.0	3.0	44.2	50.3	0.557	4.54
REC6	Involving disassembly up to module level.	0.5	2.5	4.0	44.5	48.5	0.599	4.45
REC7	Involving product upgrade within specified quality level.	0.5	0.5	2.0	41.7	55.3	0.618	4.51
REC8	Warranty for reconditioned products is less when compared to remanufactured product.	3.0	1.0	2.0	44.2	49.7	0.836	4.37
Overall Scale							0.71	4.42

Table 4.5 indicates the response of firms on the product reconditions concerning collecting used products from customers for reconditioning. Approximately 46% (n=92) of the respondents reported that their firms initiate and successfully implement the collection of used products from customers for reconditioning. Almost 47% (n=93) of the respondents confirmed that their firms are initiating implementation and successfully implementing the return of used products to a satisfactory working condition. A large number of respondents, about 50% (n=99), agreed that their firms successfully practice the inspection of critical modules in the products whereas 47% (n=94) respondents indicated that their firms are initiating implementation. In terms of REC4, the extension of the practical use of the products, 48% (n=97) of the respondents felt that their firms are initiating implementation, and the same number successfully implement the extension of functional use of the products. More than 50% (n=100) of the respondents indicated that their firms are replacing all major components that have failed or that are on the point of failure successfully. In comparison, 44% (n=88) felt that their firms are initiating implementation.

On code REC6 involving disassembly up to module level, about 44% (n=88) of the respondents indicated that their firms re-initiating implementation and 48.5 (n=97) of the respondents stated that their firms successfully implement disassembly up to the module level. On item REC7 (involving product upgrade within the specified quality level), about 55% (n=110) of respondents showed that their firms perform this practice successfully, and those slightly above 41% (n=83) felt that their firms initiate implementation to involve product upgrade within disassembly up to module level. Last in the table is whether the warranty for reconditioned products is less when compared to remanufactured products. Slightly above 44% (n=88) of the respondents showed that firms initiate implementation, and almost 50% (n=100) of the respondents indicated that their firms implement this practice successfully.

The overall mean scores and standard deviation for reconditioning scale is $\bar{x}$= 4.42; SD=0.71. This result demonstrates that most manufacturing firms are successfully initiating and implementing product reconditioning.

4.11.4. Remanufacture

The percentages, standard deviation and mean scores for remanufacturing as performed by participating firms are indicated in Table 4.6.

Table 4.6: Remanufacture

Item code	Item description	Not considering it	Planning to consider it	Considering it currently	Initiating implementation	Implementing successfully	Standard deviation	Mean ($\bar{x}$)
REM1	Collecting used products from customers for remanufacturing.	5.6	0.5	1.5	42.4	50.0	0.972	4.31
REM2	Working to returning products to at least their original performance specifications	4.5	0.5	0.5	48.7	45.7	0.894	4.31
REM3	Inspecting all modules and parts in the product.	0.5	1.5	5.0	49.7	43.2	0.691	4.34
REM4	Involving product upgrade up to as-new quality level.	1.5	2.0	0.5	51.3	44.7	0.678	4.38
REM5	Ensuring that warranty for remanufactured products is highest compared to other disposition options.	2.0	1.5	1.5	50.3	44.7	0.822	4.33
REM6	Work of building a new product on the base of a used product.	2.5	1.0	3.5	43.2	49.7	0.852	4.36
REM7	Suppliers are required to collect back remanufacturable products.	3.0	2.0	0.5	41.7	52.8	0.922	4.37
Overall Scale							0.833	4.34

In Table 4.6, 50% (n=99) of the respondents revealed that their firms are successfully implementing the collection of used products from customers for remanufacturing, and 42%

(n=84) felt that their firms are initiating implementation of collecting used products from customers for remanufacturing. About 49% (n=97) of the respondents indicated that almost all their firms are initiating application to returning products to at least their original performance specifications. Nearly 46% (n=91) of respondents revealed that their firms are successfully implementing to returning products to at least their original performance specifications. With respect to REM3, which involves inspecting all modules and parts in the product, about 50% (n=99) of the respondents suggested that their firms are initiating implementation to inspect all modules and parts in the product. Furthermore, around 43% (n=86) of respondents indicated that their firms successfully implement the inspection of all modules and components in the product.

More than half of the respondents, 52% (n=103) showed that their firms initiate the implementation of involving product upgrades up to the ‘as-new’ quality level. About 45% (n=89) of respondents indicated that their firms successfully implement product upgrades up to as-new quality level. With respect to item REM5, 50% (n=99) of the respondents stated that their firms are initiating implementation to ensure that warranty for remanufactured products is highest compared to other disposition options. At least 44% (n=89) of the respondents suggested that their firms successfully implement to ensure that warranty for remanufactured products is highest compared to other disposition options. Almost 50% (n=99) of the respondents believed that their firms successfully implement the work of building a new product on the base of a used product, and 43% (n=86) of the respondents indicated that their firms do initiate implementation. On item REM7 which elicited whether suppliers are required to collect back re-manufacture products; 52% (n=105) of the respondents indicated that their firms initiate implementation while 41% (n=83) confirmed that their firms successfully implement receiving again remanufacture products.

In Table 4.6, the overall mean for the response for product remanufacture is $\bar{\mathbf{x}}$=4.34; SD=0.83. This result generally depicts that most manufacturing firms are successfully implementing product remanufacturing. Hence most firms have corporate capabilities, organisational skills, and areas of market awareness in place, and they find strategic reasons to engage in remanufacturing.

4.11.5. Recycle

The percentages, standard deviation, and mean scores for recycling as performed by participating firms are indicated in Table 4.7.

Table 4.7: Recycle

Item code	Item description	Not considering it	Planning to consider it	Considering it currently	Initiating implementation	Implementing successfully	Standard deviation	Mean ($\bar{x}$)
RECY1	Collecting used products from customers for recycling.	3.5	2.0	2.0	33.0	59.5	0.973	4.41
RECY2	Collecting used packaging from customers for recycling.	3.0	3.0	6.0	37.5	54.5	0.995	4.35
RECY3	Procedures for recycling have been established.	2.5	0.5	4.5	40.2	52.3	0.815	4.39
RECY4	Procedures for handling hazardous materials for end-of-life products have been established.	0.3	0.2	4.0	38.2	57.3	0.626	4.52
RECY5	Recycling procedures in order to reduce the amount of energy required for extracting virgin material.	1.0	0.5	4.0	44.0	50.5	0.711	4.42
RECY6	Material recycling which is the re-melt of materials to make new products.	2.5	1.5	3.5	38.2	54.3	0.84	4.4
RECY7	Energy recycling which is the extraction of heat from burning materials.	2.5	2.0	3.5	38.7	53.3	0.856	4.38
RECY8	Disassembly up to material level.	4.0	1.0	5.1	34.8	55.1	0.939	4.36
RECY9	Reusing materials from used products and components.	2.5	0.5	3.0	37.4	56.6	0.803	4.45
Overall Scale							0.840	4.41

As shown in Table 4.7, almost 60% (n=119) of the respondents indicated that their manufacturing firms successfully implement the collection of used products from the customer. Approximately 55% (n=109) of them suggested that their firms successfully collect used packaging from customers for recycling (RECY2). More than half of respondents, 52% (n=104) revealed that their firms successfully established procedures for recycling (RECY3). About 57% (n=114) of them showed that their firms successfully established procedures for handling hazardous materials for end-of-life products (RECY4).

Slightly above 50% (n=101) of respondents suggested that their firms successfully implement recycling procedures to reduce the amount of energy required for extracting virgin material (RECY5), and about 44% (n=88) felt that their firms are initiating implementation. Material recycling (RECY6), which is the re-melt of materials to make new products was confirmed by 54% (n=108) of the respondents. About 53% (n=106) of them also indicated that their firms are successfully implementing energy recycling, which is the extraction of heat from burning materials (RECY7). Above 55% (n=109) of the respondents further felt that their firms are successfully disassembling up to material level (RECY8). Lastly, regarding RECY9, almost 57% (n=112) of respondents indicated that their firms are reusing materials from used products and components, implemented successfully.

The overall mean for the recycle scale in Table 5.6 is $\bar{x}$=4.41; SD=0.84. This result depicts that manufacturing firms are successfully implementing product recycling.

4.11.6. Disposal

The percentages, standard deviation and mean scores for disposal as performed by participating firms are indicated in Table 4.8.

Table 4.8: Disposal

Item code	Item description	Not considering it	Planning to consider it	Considering it currently	Initiating implementation	Implementing successfully	Standard deviation	Mean ($\bar{x}$)
DISP1	The amount of waste for disposal is minimised.	0.5	0.5	0.5	19.4	79.1	0.497	4.77
DISP2	Appropriate storage of waste.	0.5	3.0	2.0	16.9	77.6	0.463	4.81
DISP3	Appropriate dumping of waste.	0.5	2.0	2.0	18.9	76.6	0.476	4.79
DISP4	Appropriate treatment of waste.	0.5	0.5	0.5	20.4	78.1	0.536	4.75
Overall Scale							0.493	4.78

Table 4.8 discusses the response regarding how firms dispose of products to waste. Only one respondent, 0.5% (n=1), agrees that their firm's returned products are disposed of to landfill. A considerable number of respondents, 79% (n=159) endorse that their firms successfully keep the amount of waste for disposal minimised. About 19% (n=40) of the respondents felt that their firms are working to reduce the amount of waste for disposal as much as possible. Almost 78% (n=158) of respondents felt that their firms have appropriate storage of waste, and slightly 17% (n=34) are initiating implementation. Nearly 77% (n=157) of them admit that their firms have adequate space for the dumping of waste, and around 19% (n=38) felt that their firms are starting implementation.

Just above 78% (n=158) of respondents agree that their firms have appropriate treatment of waste, and slightly above 20% (n=41) believed that their firms are in the process of initiating implementation.

The overall mean for the disposal scale is $\bar{\mathbf{x}}$=4.78; SD=0.49, which implies that a significantly large number of firms are successfully managing the challenges of waste disposal.

4.12. Business Performance of Reverse Logistics

This section discusses the business performance in terms of the environmental sustainability, profitability and sales growth.

4.12.2. Environmental sustainability

Recoverable manufacturing systems minimise the environmental impact of the industry by reusing materials, reducing energy use, and reducing the need for landfill industry products (Souza 2013:07). Recoverable manufacturing is an environmentally, economically sound way to achieve many of the goals of sustainable development. The percentages, standard deviation and mean scores for the environmental sustainability of firms are indicated in Table 4.9.

Table 4.9: Environmental sustainability

Item code	Item description	Not at all	A little bit	To some degree	Relatively significant	Significant	Standard deviation	Mean ($\bar{x}$)
ES1	Significant reduction of air emission.	5.1	26.8	24.2	31.8	12.1	1.002	3.19
ES2	Significant reduction of waste-water pollution.	5.1	21.2	31.8	28.3	13.6	1.03	3.24
ES3	Significant reduction of solid waste generation.	5.1	12.1	39.4	31.8	11.6	1.052	3.33
ES4	Significant reduction of hazardous waste consumption.	5.1	14.6	35.9	32.3	12.1	1.011	3.32
ES5	Minimal occurrence in environmental accidents, namely spills.	4.0	17.2	30.8	33.8	14.1	0.942	3.37
ES6	Minimal occurrence in fines or penalties pertaining to improper waste disposal.	4.0	14.1	32.3	36.9	12.6	0.903	3.4
ES7	Recognition or reward for superior environmental management.	2.5	13.2	35.0	38.1	11.2	1.115	3.42

ES8	Significant improvement in commitment towards environmental management standards or practices.	3.0	8.0	39.7	38.2	11.1	1.091	3.46
Overall Scale							**1.013**	**3.41**

Table 4.9 indicates the responses towards the environmental sustainability of manufacturing firms relative to this research study. About 32% (n=63) of respondents agree that their firms had achieved some significant reductions in air emission. Almost about 32% (n=63) of the respondents concur to some degree that their firms had witnessed a reduction of wastewater pollution. Almost 39% (n=78) of respondents to some degree agree that their firms had achieved a significant reduction of solid waste generation. Just around 36% (n=71) of them agree to some degree that their firms had attained a reduction in hazardous waste consumption. More than 33% (n=67) agree that their firms had attained a significant reduction in the occurrence of environmental accidents, for example, spills.

Above 36% (n=73) of the respondents recognised that their firms had achieved the minimum occurrence of fines or penalties on improper waste disposal. Just over 37% of the respondents agree with the recognition or reward for superior environmental management is essential to their firms. Almost 40% (n=79) of the respondents agree to some extent that their firms had achieved a significant improvement in commitment to environmental management standards or practices.

The overall mean score of the environmental sustainability scale is $\bar{x}$=3.41; SD=1.013. This result demonstrates that most respondents agree that the environmental sustainability of their firms is satisfactory.

4.12.3. Profitability

Returned products may negatively affect the profitability of a firm since products returned have to be refunded, replaced, or repaired, and therefore all those expenses may have an impact on the firm's profit. According to the literature discussed in chapter two, the active practice of logistics activities results in sound profitability. Nevertheless, this is not necessarily the case with all the production and retail business. The percentages, standard deviation and mean scores for the profitability of firms are indicated in Table 4.10.

Table 4.10: Profitability

Item code	Item description	Not at all	A little bit	To some degree	Relatively significant	Significant	Standard deviation	Mean ($\bar{x}$)
PR1	Significant improvement in revenue from after sale services.	1.0	7.5	28.0	52.5	11.0	0.813	3.65
PR2	Significant improvement in reclaiming reusable products.	2.0	12.0	30.0	42.5	13.5	0.94	3.54
PR3	Significant reduction in inventory investment.	3.5	13.1	35.7	33.7	14.1	1.001	3.42
PR4	Significant reduction in cost of goods sold for recovered products.	3.5	10.6	31.8	39.9	14.1	0.981	3.51
PR5	Significant reduction in the cost for purchasing raw materials, components, or subassemblies.	3.0	10.1	29.1	43.2	14.6	0.961	3.56
PR6	Significant reduction in the cost of packaging.	1.5	14.0	27.5	44.0	13.0	0.94	3.53
PR7	Significant reduction in cost for waste treatment	0.5	12.6	28.6	41.2	17.1	0.929	3.62
PR8	Significant reduction in cost for waste disposal.	3.0	6.0	31.0	45.0	15.0	0.915	3.63
Overall Scale							0.936	3.58

Table 4.10 indicates that more than 52% (n=105) of the respondents agree that firms had experienced a substantial improvement in revenue from after-sale services. Just over 42% (n=85) of respondents agree that firms had experienced considerable development in reclaiming reusable products. Almost 36% (n=71) of respondents felt that their firms had witnessed a significant reduction in inventory investment. Just about 40% (n=79) agree that their firms had experienced a relatively substantial decrease in the cost of goods sold for recovered products.

More than 43% (n=86) of the respondents agreed that their firms had posted some relatively significant reductions in the cost of purchasing raw materials, components, or subassemblies. Exactly 44% (n=88) of them indicated that their firms had experienced a considerable reduction in the cost of packaging. Slightly above 41% (n=82) of respondents agree that their firms had a considerable decrease in the cost for waste treatment and lastly 45% (n=90) felt that their firms had managed to reduce the cost for waste disposal significantly.

The overall mean score for the profitability scale is $\bar{x}$= 3.58; SD=0.936 which generally means that most respondents agree their firms had achieved relatively significant profits.

4.12.4. Sales Growth

Products and services have no value (as discussed in chapter two) unless they have customers when (time) and where (place) they wish to utilise them (which refers to the forward logistics function). Clearly, reverse logistics will be perceived as a negative impact on sales growth. The percentages, standard deviation and mean scores for the sales growth of firms are indicated in Table 4.11.

Table 4.11: Sales Growth

Item code	Item description	Not at all	A little bit	To some degree	Relatively significant	Significant	Standard deviation	Mean ($\bar{x}$)
SG1	Significant improvement in sales of used products at secondary market.	2.0	12.6	17.6	57.3	10.6	0.907	3.62
SG2	Significant improvement in sales of new products through price discounts.	4.5	12.5	24.0	48.5	10.5	0.992	3.48
SG3	Significant improvement in sales of new technologies by means of trade-in programmes.	5.0	13.5	31.5	40.0	10.0	1.003	3.37
SG4	Significant improvement in market share.	2.0	13.6	27.6	42.2	14.6	0.968	3.54
SG5	Significant improvement in relationship with customers to encourage repeat buyers.	2.5	10.1	31.8	39.9	15.7	0.958	3.56
SG6	Significant improvement in corporate environmental reputation among environmentally conscious customers.	1.5	13.0	23.0	46.5	16.0	0.953	3.63
SG7	Significant improvement in sales growth.	2.5	10.5	23.0	47.0	17.0	0.965	3.66
Overall Scale							0.961	3.60

Table 4.11 shows that most of the respondents, over 57% (n=114) agree that their firms had experienced a relatively significant improvement in sales of used products at the secondary market. Slightly above 48% (n=97) of the respondents agree that their firms had experienced a considerable improvement in the sales of new products through price discounts. Exactly 40% (n=80) of respondents indicated that their firms had witnessed the substantial growth in sales of new

technologies using trade-in programmes. More than 42% (n=84) of respondents said that their firms had witnessed a relatively significant improvement in market share.

Almost 40% (n=79) of respondents agree that they had noticed a substantial development in relationships with customers to encourage repeat buyers in their firms. Above 46% (n=93) of them suggested that their firms had posted substantial improvements in incorporating environmental reputation among environmentally conscious customers. Exactly 47% (n=94) of respondents noted that their firms had experienced a relatively substantial improvement in sales growth.

The overall mean score for the sales growth scale is $\bar{x}$=3.60; SD=0.96, which implies that a reasonably large number of firms had experienced a substantial improvement in the growth of sales in general.

4.13. Measurement of Scale Accuracy

Scale accuracy was assessed by considering the validity and reliability of the measurement scales.

4.13.2. Reliability

Reliability can be defined as the degree to which measures are free from errors, which then results in more reliable outcomes (Ang 2014:176). In this study, reliability was measured using Cronbach's alpha coefficient, in which the minimum cut off range must be equal to or above 0.7 (Fornell & Larcker 1981:39). The results of the reliability tests are presented in Table 4.12.

Table 4.12: Reliability analysis results

Section	**Construct**	**Number of items**	**Cronbach Alpha (α) value**
B	Repairs	5	0.850
	Recondition	8	0.858
	Remanufacture	7	0.888
	Recycle	9	0.882

Section	Construct	Number of items	Cronbach Alpha (α) value
	Disposal	4	0.933
C	Environmental sustainability	8	0.941
D	Business performance		
	Profitability	8	0.906
	Sales growth	7	0.922

As alluded to above, the Cronbach Alpha value should either be equal to or above 0.7 in order for a measurement scale to be considered reliable As shown in Table 4.12, alpha values for all measurement scales were above the prescribed minimum threshold value (Repairs= 0.850; Recondition= 0.858; Remanufacture= 0.888; Recycle= 0.882; Disposal= 0.933; Environmental sustainability= 0.941; Profitability= 0.906 and Sales growth= 0.922). Hence, all measurement scales used in this study were considered to be reliable.

4.13.3. Validity

Validity is the level to which measurement instruments of the variable to confirm its measures (Scholtes et al. 2011:239). In this study, four validities, construct, predictive face and content validity were assessed, as recommended by Easterby-Smith, Thorpe and Lowe (2002:1.

4.13.3.1. Construct validity

Construct validity is defined as a construct's ability to measure and accurately assess what it is intended to measure (Churchill 1979:64). As such, for the purpose of this study, construct validity was tested using inter-factor correlations. As shown in the correlation matrix in Table 4.13, most of the inter-factor correlations were positive and less than 1. This, then, indicated an adequate level of validity. All ascertained by using the correlation matrix.

4.13.3.2. Predictive validity

Predictive validity was tested using regression analysis to test the accuracy of predictions made in this study. As shown in Table 4.14, the beta values of the majority of the constructs were positive and less than 1. This result then indicated adequate predictive validity.

4.13.3.3. Face and content validity

In this study, face validity was also assessed using a panel review consisting of logistics lecturers from the Logistics department at the Vaal University of Technology. The content and structure, as well as the layout of the questionnaire, were examined. This was done to ensure that no ambiguity could appear to the response items and increase the sound comprehension of the items measuring the respective variables.

Content validity was tested through the pre-testing of the questionnaires of the study. Twenty (20) respondents formed part of the pre-testing process. This ascertained the soundness of the previous methods taken to ensure that the respondents of the survey understand and capture the actual meanings of the questions asked.

4.14. CORRELATION ANALYSIS

Correlation analysis tests for the strength and direction of relationships between constructs (Holtan 2010:23). The correlation coefficient is regarded as the level of association between research constructs (Bless & Khathura 2007:23). Besides, it assesses the strength and direct connection between variables (Gratton & Jones 2010:92). Table 4.13 presents the results of the correlation analysis.

Table 4.13: Correlations: reverse logistics practices, environmental sustainability, and business performance

Constructs	**Recondition**	**Remanufacturing**	**Recycling**	**Disposal**	**Repairs**	**Environment sustainability**	**Profit**	**Sales**
Recondition	1.000	.498**	.253**	.151*	.577**	***.077***	.253**	.231**
Remanufacturing	.498**	1.000	.601**	.314**	.439**	***.028***	.269**	.092
Recycling	.253**	.601**	1.000	.341**	.368**	***-.086***	.116	.031
Disposal	.151*	.314**	.341**	1.000	.292**	***.031***	.017	-.040

Constructs	Recondition	Remanufacturing	Recycling	Disposal	Repairs	Environment sustainability	Profit	Sales
Repairs	.577**	.439**	.368**	.292**	1.000	***-.039***	.127	.205**
Environment sustainability	.077	.028	-.086	.031	-.039	1.000	**.523****	**.408****
Profit	.253**	.269**	.116	.017	.127	.523**	1.000	.691**
sales	.231**	.092	.031	-.040	.205**	.408**	.691**	1.000
	N=303 ** Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.01 level (2-tailed) *low *r* = 10-.29; ** medium r = .30-.49; * strong r = .50-1.0**							

As revealed in Table 4.13, overall, there was no correlation between reverse logistics practices and environmental sustainability. Specifically, the correlation matrix (Table 4.15) reveals a weak negative correlation (r=-0.86; p=0.224) between recycling and environment sustainability. This result suggests an inverse relationship between these two constructs, such that if recycling is increased, there will be a decrease in environmental sustainability amongst manufacturing firms in the Vaal Triangle. The results also show that there is no correlation (r=0.028; p=0.696) between remanufacturing and environmental sustainability. This result implies that changes in remanufacturing will not result in an increase or decrease in environmental sustainability. Recondition was also found to have a weak correlation (r=0.077; p=0.275) with environmental sustainability. This indicates that an increase in recondition processes does not attract an increase in sustainability.

The results of the correlation analysis further showed that disposal has no association with environmental sustainability (r=0.031; p=0.664). This result demonstrates that an increase in disposal activities will not lead to an increase in environmental sustainability in manufacturing firms. Lastly, repairs were also found to have an almost zero correlation (r=0.039; p=0.585) with environmental sustainability. Further, an increase in repairs will not affect result in environmental sustainability in manufacturing firms in the Vaal Triangle Region.

On the correlation between environmental sustainability and performance, there was a significant strong positive correlation (r=0.523; p=0.000) between environmental sustainability and profit.

This result demonstrates that the profits of the manufacturing firms are likely to increase when the firm adopts environmental sustainability practices. Also, there was a significant and moderate positive correlation (r=0.408; p=0.000) between environmental sustainability and sales. This result illustrates that the sales of manufacturing firms are likely to rise as the firm becomes more involved in environmental sustainability activities.

The results above provide a contrasting perspective to previous studies by Lee and Lam (2012:589), who found that effective and efficient management reverse logistics activities correlate to an increase in sustainable environmental practices. In their study on reverse logistics network design, Yu and Solvang (2016) endorsed the view that reverse logistics adoption contributes significantly to maintain environment related-issues. These authors further advanced that such reverse practices are vital to the overall performance objectives of green approaches.

4.15. REGRESSION ANALYSIS RESULTS

Regression analysis refers to a statistical procedure that is employed to ascertain the direct association between two or more research constructs (Muijs 2010:61). The results of the regression analysis are provided in the following tables:

Table 4.14: Regression Model 1: Reverse Logistics Practices and Environmental Sustainability

Independent Variables: Reverse logistics practices	Dependent Variable: Business Performance			Tol	VIF
	Beta	T	Sig		
Recondition	.133	1.424	.156	.574	1.742
Remanufacture	.096	.911	.363	.449	2.228
Recycle	-.120	-1.056	.292	.386	2.588
Disposal	.077	.982	.327	.804	1.243
Repairs	-.112	-1.218	.225	.590	1.696
R= .181; R squared= .033; Adjusted R squared= .003; Sig. P<0.05; Tol=Tolerance; VIF-Variance inflation factor					

Given the tabulated results of the regression model (Table 4.16), reverse logistics practices (adjusted $R^{2=}$0.003) described approximately 3.3% of the variance (related to the practices) that influence the environmental sustainability of manufacturing firms in the Vaal Triangle region. This confirms that there was no meaningful relationship between reverse logistics practices and environmental sustainability in this study, since almost 96.7% of the variance in environmental sustainability is explained by other factors that were not taken into consideration. Tolerance and the variance inflation factor values were used to determine the effects of multicollinearity in this study. Tolerance values were greater than the recommended minimum threshold value of 0.2 while all VIF values were less than the maximum cut off value of 10. Hence there were no multicollinearity problems in this regression model.

In Regression Model 2. environmental sustainability was entered as the independent variable while profit was entered as the dependent variable. The results are shown in Table 4.15.

Table 4.15: Regression Model 2: Environmental sustainability and Profit

Independent Variable: Environmental sustainability	**Dependent Variable: Profit**			**Tol**	**VIF**
	Beta	**T**	**Sig**		
Environmental sustainability	0.523	8.650	0.000	1.000	1.000
R=.523 R squared=.273; Adjusted R squared=.270; Sig. P<0.05; Tol=Tolerance; VIF-Variance inflation factor					

Given the tabulated results of the regression model (Table 4.15), environmental sustainability (adjusted $R^{2=}$0.270) explained roughly 27% of the variance in the profit made by manufacturing firms. This result implies that 27% of the profit made by a manufacturing firm is a result of its environmental sustainability activities. The remaining 73% of the variance in profit is accounted for by other activities that were not considered in this study.

The analysis of the regression model shows that environmental sustainability was statistically significant in predicting business performance (β =0.523; t=8.650; p=0.000). This result implies that environmental sustainability predicts manufacturing firm profits or that the benefits made by these firms are as a result of environmental sustainability activity. Thus, if a manufacturing firm invests in environmental sustainability, it is likely to realise significant profits.

In Regression Model 3. environmental sustainability was entered as the independent variable while sales was entered as the dependent variable. The results are shown in Table 4.16.

Table 4.16: Regression Model 3: Environmental Sustainability and Sales Growth

Independent Variables: Environmental sustainability	**Dependent Variable: Business Performance**			**Tol**	**VIF**
	Beta	**T**	**Sig**		
Environmental sustainability	.408	6.307	.000	1.000	1.000
R=.408; R squared=.167; Adjusted R squared=.162; Sig. P<0.05; Tol=Tolerance; VIF-Variance inflation factor					

Given the tabulated results of the regression model (Table 4.16), environmental sustainability (adjusted $R^{2=}$0.162) explained 16% of the variance in the sales made by a manufacturing firm. This result implies that 16% of the sales made by manufacturing firms is a result of its environmental sustainability activities. The remaining 83% of the variance in sales is accounted for by other factors that were not considered in this study.

Analysis of the regression model shows that environmental sustainability was statistically significant in predicting business performance (β =0.408; t=6.307; p=0.000). This result implies that environmental sustainability predicts sales or that the benefits made by manufacturing firms are as a result of environmental sustainability activity. If a manufacturing firm invests in environmental sustainability, it is likely to realise significant growth in sales.

These results above are consistent with the findings from Pullman, Maloni, and Carter (2009:38), who found that environmental sustainability contributes to the realisation of the performance objectives of businesses. This view was supported by Lieb and Lieb (2010:525), who endorsed the significance and importance of environmental sustainability as a critical driver to business sustainability.

4.16. CONCLUSION

The purpose of this chapter was to investigate the influence of reverse logistics practices on environmental sustainability and business performance in manufacturing firms in the Vaal

Triangle region. The main findings showed no correlation between reverse logistics practices and environmental sustainability. Specifically, the correlation matrix (Table 4.15) revealed a weak negative association/correlation (r=-0.86; p=0.224) between recycling and environment sustainability. The results also showed that there is no correlation (r=0.028; p=0.696) between remanufacturing and environmental sustainability. Disposal has no association with environmental sustainability (r=0.031; p=0.664). Lastly, repairs had a weak negative association (r=0.039; p=0.585) with environmental sustainability.

Furthermore, the results revealed a significant strong positive relationship between environmental sustainability and performance (β =0.523; p=0.000) between environmental sustainability and profit. However, a significant but moderate positive relationship (β =0.408; p=0.000) between environmental sustainability and sales was revealed. These results illustrated that the profits of the manufacturing firms are likely to increase when the firm adopts environmental sustainability practices, and their sales are likely to rise as the firm becomes more involved in environmental sustainability activities.

The regression analysis conducted on three models showed the following results. For the first model based on reverse logistics practices (adjusted $R^{2=}$0.003) described approximately 3.3% of the variance (related to the practices) that influence the environmental sustainability of manufacturing firms in the Vaal Triangle region. Regarding the regression analysis of the second model, it was found that environmental sustainability (adjusted $R^{2=}$0.270) explained roughly 20% of the variance in the profit made by a manufacturing firm. This result implied that 27% of the profit made by manufacturing firms is a result of its environmental sustainability activities.

Lastly, environmental sustainability (adjusted $R^{2=}$0.162) explained roughly 16% of the variance in the sales made by a manufacturing firm. This result suggested that 17% of the sales made by the firms is a result of its environmental sustainability activities.

The next chapter offers conclusions and recommendations derived from the results of the study.

5. CONCLUSIONS AND RECOMMENDATIONS

5.8. INTRODUCTION

This final chapter provides an overall conclusion of the objectives and results of the study. The section focuses on the conclusive remarks based on the results obtained. It addresses the limitations faced during the completion of the investigation and considers recommendations for further research.

5.9. REVIEW OF THE STUDY

The purpose of the study was to investigate the influence of reverse logistics practices on environmental sustainability and business performance in manufacturing firms in the Vaal Triangle region. The study was divided into six chapters. The first chapter introduced the research by highlighting the background, the problem statement, the research objectives, the research design, and ethical considerations considered in concluding the project. The second chapter offered a literature review on the identified reverse logistics practices; and a discussion of the nature and background of reverse logistics.

The third chapter described the research methodology and design employed in the study. The chapter detailed the main methodological, technical techniques, and methods used during the study. The fourth chapter discussed the analysis of the empirical investigation and findings based on the objectives, problems and research questions. It focused on the results obtained from the analysis conducted. The aim was to provide the layout and interpretation of the statistical analysis. The final chapter reviews the entire study and provides conclusions regarding the study. The contribution of the study, suggestions and implications for future research are also provided.

5.10. CONCLUSIONS BASED ON THEORETICAL OBJECTIVES

The conclusions derived from the theoretical objectives of the study were:

- to conduct a literature review on reverse logistics practices;
- to conduct a literature review on environmental sustainability; and
- to conduct a literature review on business performance.

5.10.2. Conclusions on the literature review on reverse logistics practices

The study reviewed various sources of literature on reverse logistics practices. It emerged that reverse logistics may be perceived as the process whereby firms can become more environmentally efficient through recycling, reusing, and reducing the number of materials used (Bottani & Montanari 2012:323). According to Fang, Zhang, and Tang (2013:77), reverse logistics has become a managerial priority because of the assets/value involved and the potential impact on customer relations. If the focus of logistics is the movement of material from the point of origin toward the point of consumption, then the focus of reverse logistics should be the movement of material from the point of consumption toward the point of origin. The term "reverse logistics" should be reserved for the flow of products and materials going "the wrong way on a one-way street" (Abraham 2011:85).

The literature also showed that reverse logistics activities form a dominant part of this research. This section discusses these activities in perspective. For many products, a customer's relationship with the product's manufacturer does not end with product purchases. Their relationship can be significantly influenced by the activities that occur after purchase during the entire period of product ownership. After-sales services can encompass multiple activities, including customer support through training, product warranties, maintenance and repair, product upgrades, sales of complementary products, and product disposal. Management of these service activities can form an essential part of corporate strategy. As such, the present study identified repairs, recondition, remanufacture, recycling, and disposal as reverse practices.

Repairs are defined as the process of adjusting any malfunction occurring on a product or item to regain its functioning state (Khor & Udin 2012:7). The use of repairs is essential in reducing environmental waste. Repairs have also been regarded as a critical reverse logistics tool, which is designed at improving the overall state of a defection's product (Sangwan 2017:260). Besides, Ertogral and Ozturk (2019:832) argued that repairs play a fundamental part in an organisation's ability to adhere to issues of sustainability. Khor and Udin (2012:7) referred to recondition as the process of restructuring or reassembling different parts of the function of an item or product to repair them so that they can be restored to their initial state. It is a process that involves significant utilisation of technology to be carried out effectively and efficiently (Sangwan 2017:260). Besides, remanufacture can be conceptualised as the process of reproducing a damaged item or product with the objective of restoring it to its original state and preserve some value (Khor & Udin 2012:7).

The adoption of this system contributes significantly to increasing the competitive position of firms through its role in cost reduction (Jack, Powers & Skinner 2010:228). Recycling is viewed as a set of procedures designed at collecting and sorting out parts as well as non-value-added materials and items for reuse (Khor, Udin, Ramayah & Hazen 2016:97). Engaging in recycling activities has proven to be essential to contribute to sustainability efforts by preserving any negative impact on the environment (Kannan, Govindan & Shankar 2016:281). Furthermore, disposal refers to the process of properly disposing of unwanted or non-valuable items or products (Khor & Udin 2012:7). A report from Khor et al. (2016:97) established the importance of disposal by stating that it is a core aspect that underpins the implementation of reverse logistics best practices.

5.10.3. Conclusions on the literature review on environmental sustainability

The literature reviewed in the study established the prominence of environmental sustainability in organisations. As pointed out by the World Commission on Environment and Development in 1987, engaging in sustainable environment practices calls for overall preservation of businesses' direct ecosystems. This rational was endorsed by Bai and Sarkis (2010:252) and Sarkis, Gonzalez-Torre and Denso-Diaz (2010:163). They opine that the reduction of firms' pollution activities has become a vital strategic drive to sound operating practices. Given these insights, it is confirmed that complying with environmental regulations is critical for ensuring the effectiveness of business activities.

5.10.4. Conclusions on the literature review on business performance

Business performance has been regarded as an essential determinant factor to successful organisational operations as well as a survival prospect. As such, its evaluation is based on some tools such as control, budgeting, motivation, promotion, celebration, and learning; all designed at boosting companies' competitive aspiration (Lee, Kim, Seo & Hight 2015:30). Lastly, Chen, Chiang and Storey (2012:1165) advanced that seamless monitoring and assessment of operational activities and processes are paramount to ensuring sustainable business success. This points to the significance of business performance as a critical antecedent factor to successful supply chain network performance.

5.11. CONCLUSIONS BASED ON EMPIRICAL OBJECTIVES

The conclusions derived from the empirical objectives of the study discussed in this section were:

- to determine the relationship between reverse logistics practices such as repairs, recondition, remanufacture, recycle and disposal; and environmental sustainability in manufacturing firms in the Vaal Triangle; and
- to ascertain the connection between environmental sustainability and business performance in manufacturing firms in the Vaal Triangle.

5.11.2. Conclusions on the relationship between reverse logistics practices and environmental sustainability

Given the results obtained in chapter four, and precisely in Table 4.14, the study established that the identified reverse logistics practices (repairs, reconditioning, remanufacturing, recycling and disposal; adjusted $R^{2=}$0.003) described approximately 3.3% of the variance (related to the practices) that influence the environmental sustainability of manufacturing firms in the Vaal Triangle region.

The results revealed a weak negative association/correlation (r=-0.86; p=0.224) between recycling and environment sustainability. No correlation (r=0.028; p=0.696) was also observed between remanufacturing and environmental sustainability. Disposal has no association with environmental sustainability (r=0.031; p=0.664). Lastly, repairs had a weak negative association (r=0.039; p=0.585) with environmental sustainability. The study, therefore, concludes that these factors are not antecedents or drivers of environmental sustainability in the manufacturing sector in the Vaal Triangle.

These results offer a different view from a number of studies that have viewed reverse logistics as an essential enabling component to sustainability initiatives (Sarkis et al., 2010:337; McKinnon 2010:1). Piyathanavong, Garza-Reyes, Kumar, Maldonado-Guzmán and Mangla (2019:507) advocated the crucial role that reverse logistics has as a useful contributor to environmental concerns. In contrast with this study, these results highlight the importance that reverse logistics aspects have in enhancing business performance.

5.11.3. Conclusions on the relationship between environmental sustainability and business performance

Considering the results obtained, it was established that environmental sustainability exerts a positive and significant influence on business performance. This was mainly through its effects on profits and sales, with both dimensions been found to be significantly influenced by the level of environmental practices profit (β =0.523; t=8.650; p=0.000) and sales (β =0.408; t=6.307; p=0.000). This result further indicated that the benefits made by manufacturing firms in terms of profits and sales are also attributable to environmental sustainability activities. Thus, if a manufacturing firm invests in environmental sustainability, it is likely to cause a significant increase in its profits margin and sales.

The results of this study are consistent with a survey by Perera, Del Pino, and Oliveira (2013:1), who argued that environmental engagement is at the forefront of any profit maximisation prospect. This view was confirmed further by Vijfvinkel, Bouman and Hessels (2011:3), who suggested that sustainable environment activities contribute to firm overall performance objectives. Mariadoss, Tansuhaj and Mouri (2011:1305) also argued that adhering to environmental sustainability strategies enables organisations to strengthen their competitive position through an improvement of their financial performances. Thus, environmental sustainability is critical in its ability to lead to enhancement in profits and sales.

5.12. RECOMMENDATIONS

Based on the conclusions of the previous section, it is essential then to provide recommendations to ensure that future studies can obtain positive results and strengthen the positive findings obtained.

5.12.2. Recommendations on the relationship between reverse logistics practices and environmental sustainability

The results of the study revealed in Table 4.13 and 14 in the previous chapter (4) that reverse logistics exerted no influence on environmental sustainability. This finding was found to be contrary to previous studies such as Sarkis et al. (2010:337); McKinnon (2010:1); and Piyathanavong et al. (2019:507), who all endorsed that reverse logistics activities contribute significantly to better environmental sustainability. However, as indicated by the study (regression model, Table 4.13), reverse logistics practices (adjusted $R^{2=}$0.003) described approximately 3.3% of the related practices that influence the environmental sustainability of manufacturing firms in the Vaal Triangle region. This, therefore, indicated that about 96.7% of the changes are explained by other reverse practices that were not considered for this study.

As such, one of the main recommendations concerning the findings is that manufacturing firms in the Vaal Triangle should focus on different reverse logistics practices apart from those that were indicated in this study. These potential practices could be aligned with the ones that were found to contribute to roughly 3.3% of the variance; which include recondition (r=0.077; p=0.275) and disposal (r=0.031; p=0.664).

5.12.3. Recommendations on the relationship between environmental sustainability and business performance

As demonstrated in Table 4.15 and 16, environmental sustainability exerted a positive and significant influence on business performance. This was established through its effect on profitability and sales growth. It was concluded precisely that environmental sustainability (adjusted $R^{2=}$0.270) explained roughly 20% of the variance in the level of profitability made by a manufacturing firm. This further indicated that 27% of the profit made by manufacturing firms in the Vaal Triangle was the result of their environmental sustainability activities. In addition, it was determined that environmental sustainability (adjusted $R^{2=}$0.162) contributed to approximately 16% of the variance in the sales made by a manufacturing firm. This then meant that 17% of the sales made by manufacturing firms in the Vaal Triangle are a result of its environmental sustainability processes.

Based on these findings, it is plausible to deduce that manufacturing firms operating in the Vaal Triangle need to maintain their level of environmental commitment for them to sustain their operational success; and in the process, strengthen their competitive advantage aspirations. This can be achieved through the adoption of green practices such as green purchasing, green manufacturing, green distribution and offering green training solutions to employees.

Environmental sustainability should be promoted throughout manufacturing firms until it becomes an embedded value and culture. Employees that champion sustainability can be rewarded so that the workforce can realise the value of promoting the care of the environment. The observation of government regulations can be promoted further on manufacturing firms to ensure that all employees become conscious of these laws and observe them in their daily routines.

5.13. LIMITATIONS OF THE STUDY

The study offers insightful findings on the adoption of reverse logistics practices in the manufacturing sector in the Vaal Triangle. In view of the merits of the results, it is important to highlight the challenges and drawbacks that could have negatively hampered the completion of this research. One of the main issues was the limited geographical scope of the study. In this instance, the research focused on one region in the Gauteng province, which was the Vaal Triangle. This could raise questions on the relevance of the representation of the target population, given the fact that the Vaal Triangle represents a section or portion of the entire province. The other aspect is related to the selection of reverse logistics practices. As it was observed on the conclusive findings, the identified practices had no association with the firms' ability to sustain their environment. A broader selection of reverse logistics activities could have yielded better and more accurate results.

5.14. IMPLICATIONS FOR FURTHER RESEARCH

The overall findings of this research provide an interesting insight into the relevance and need to further explore and adopt reverse logistics practices, because of their value to environmental sustainability initiatives. Further, is the crucial influence that environmental sustainability plays in enhancing business performance objectives. This fact offers uncharted areas for manufacturing firms to tap into and expand, not only their operational strategies but also align their core business visions and missions towards renewable and eco-friendly business practices. Moreover, as established in the study, greater emphasis needs to be directed to a vast array of reverse logistics activities to determine adequate aspects that significantly contribute to environmental friendliness and subsequently correlate to sustainable business success and competitive advantage.

5.15. CONCLUSION

Reverse logistics is an important facilitator to economic friendliness and sustainable operating practices. However, contrary to the general assumption on the importance and vital role that these practices have on business performance, the present study painted a different perspective. Based on the scope of the research, it concluded that the identified practices, notably repairs, remanufacturing, recycle, recondition and disposal have little influence and correlation on environmental sustainability. This result offered a basis for more interrogation into to relevance of the scope of the study in yielding the same outcomes as its generally agreeable findings. Additionally, it found that environmental sustainability exerts a positive and significant influence on business performance through the growth of sales and the increase in the level of profitability in manufacturing firms. It is, therefore, conceivable to deduce that this study provides valuable views into the dynamics and effective implementation of reverse logistics practices in manufacturing firms.

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APPENDIX 1

RESEARCH QUESTIONNAIRE

Dear participant,

I am a postgraduate student at the Vaal University of Technology studying towards a Magister Technologiae: Logistics Management. The title of my research project is **“Reverse Logistics activities in manufacturing firms in the Vaal triangle area”**.

You are invited to participate in this research study by completing the attached survey questionnaire. This questionnaire consists of four sections. Before you complete the enclosed questionnaire, I wish to confirm that:

- Your participation in this study is voluntary, and you are free to withdraw at any time.
- Your anonymity will be maintained, and no comments will be ascribed to you by name in any written document or verbal presentation. Nor will any data be used from the questionnaire that might identify you to a third party. Please do not write your name anywhere on the questionnaire.
- On completion of the research, a copy of the completed research report will be made available to you upon request.
- Completion of the questionnaire will take approximately 15 minutes.

If you have any query concerning the nature of this research or unclear about any question please feel free to contact me at tvseeku@gmail.com or 082 684 1823.

Your response and time are much appreciated. Thank you!

Yours sincerely,

Victor Seeku

<u>Section A – Company profile and demographic characteristics</u>

1- Position in the organisation

Designation	Please tick	Designation	Please tick
Owner		Logistics Manager	
Warehouse Manager		Operations Manager	

Supply Chain Manager		Workshop Manager	
Stock Controller/Manager		Customer Service Manager	
Disposal Controller/Manager		Managing Director	
Procurement Manager		Other(please indicate)	
Technical/Quality Manager			

2- What is the industry classification of your organisation? (Please tick)

Manufacturing		Transport	
Construction		Electricity, Gas and Water	
Retail		Finance and Business services	
Agriculture		Other (please indicate)	
Government			

3- What is the number of employees in your organisation? (Please tick)

Less than 20		101 to 200	
21 to 50		201 to 300	
51 to 100		Above 300	

4- What is the annual turnover of your organisation? (Please tick)

Less than 10 m		Between 31 and 40 m	
Between 10 and 20m		Between 41 and 50m	
Between 21 and 30m		Above 50 m	

5- Indicate your Gender (Please tick)

Male		Female	

6- Indicate your age group (please tick)

18 to 25 years		36 to 40 years	
26 to 30 years		41 to 50 years	
31 to 35 years		Above 50 years	

7- Indicate your level of education (please tick)

Matric		Diploma	
Degree		Post graduate diploma	
Masters		PhD	
Professional Qualification		Other (please indicate)	

8- How long have you been working for this organisation? (Please tick)

Less than 2 years		11 to 15 years	
2 to 5 years		16 to 20 years	
6 to 10 years		Above 20 years	

<u>Section B – Reverse Logistics Product Disposition</u>

Please tick appropriately the extent to which products or commodities are often restored, recycled or disposed in your organisation. (Five-point scale:1- not considering it; 2 - planning to consider it; 3 -considering it currently; 4 - initiating implementation; 5 -implementing successfully).

	Repairs	1	2	3	4	5
R1	Correction of faults in a product.					
R2	Restoring products to working order.					
R3	Prolonging the product's lifecycle.					
R4	Replacing broken parts that have failed.					
R5	Involving disassembly at product level.					
	Recondition	1	2	3	4	5
RC1	Collecting used products from customers for reconditioning.					
RC2	Working for returning used products to a satisfactory working condition.					
RC3	Inspecting critical modules in the products.					
RC4	Extending the functional use of the products.					
RC5	Replacing all major components that have failed or that are on the point of failure.					
RC6	Involving disassembly up to module level.					
RC7	Involving product upgrade within specified quality level.					
RC8	Warranty for reconditioned products is less when compared to remanufactured product.					
	Remanufacture	1	2	3	4	5
RM1	Collecting used products from customers for remanufacturing.					
RM2	Working for returning products to at least their original performance specifications (as set by manufacturers of these products)					
RM3	Inspecting all modules and parts in the product.					
RM4	Involving product upgrade up to as-new quality level.					
RM5	Ensuring that warranty for remanufactured products is highest compared to other disposition options.					
RM6	Work of building a new product on the base of a used product.					
RM7	Suppliers are required to collect back remanufacturable products.					
	Recycle	1	2	3	4	5
RE1	Collecting used products from customers for recycling.					
RE2	Collecting used packaging from customers for recycling.					
RE3	Procedures for recycling have been established.					
RE4	Procedures for handling hazardous materials for end-of-life products have been established.					
RE5	Recycling procedures in order to reduce the amount of energy required for extracting virgin material.					
RE6	Material recycling which is the re-melt of materials to make new products.					
RE7	Energy recycling which is the extraction of heat from burning materials.					
RE8	Disassembly up to material level.					

		1	2	3	4	5
RE9	Reusing materials from used products and components.					
	Disposal	1	2	3	4	5
D1	The amount of waste for disposal is minimised.					
D2	Appropriate storage of waste.					
D3	Appropriate dumping of waste.					
D4	Appropriate treatment of waste.					

Section C –Environmental Sustainability

Please tick appropriately how you rate the application of environmental sustainability in your organisation. (Five-point scale: 1 - not at all; 2 - a little bit; 3 - to some degree; 4 - relatively significant; 5 - significant).

	Environmental sustainability	1	2	3	4	5
ES1	Significant reduction of air emission.					
ES2	Significant reduction of waste-water pollution.					
ES3	Significant reduction of solid waste generation.					
ES4	Significant reduction of hazardous waste consumption.					
ES5	Minimal occurrence in environmental accidents, namely spills.					
ES6	Minimal occurrence in fines or penalties pertaining to improper waste disposal.					
ES7	Recognition or reward for superior environmental management.					
ES8	Significant improvement in commitment towards environmental management standards or practices.					

Section D –Business performance of reverse logistics

Please tick appropriately how you rate the performance of your organization with regard to reverse logistics. (Five-point scale: 1 - not at all; 2 - a little bit; 3 - to some degree; 4 - relatively significant; 5 - significant).

	Profitability	1	2	3	4	5
P1	Significant improvement in revenue from after sale services.					
P2	Significant improvement in reclaiming reusable products.					
P3	Significant reduction in inventory investment.					
P4	Significant reduction in cost of goods sold for recovered products.					
P5	Significant reduction in the cost for purchasing raw materials, components, or subassemblies.					
P6	Significant reduction in the cost of packaging.					
P7	Significant reduction in cost for waste treatment					
P8	Significant reduction in cost for waste disposal.					
	Sales growth	1	2	3	4	5
SG1	Significant improvement in sales of used products at secondary market.					

SG2	Significant improvement in sales of new products through price discounts.					
SG3	Significant improvement in sales of new technologies by means of trade-in programmes.					
SG4	Significant improvement in market share.					
SG5	Significant improvement in relationship with customers to encourage repeat buyers.					
SG6	Significant improvement in corporate environmental reputation among environmentally conscious customers.					
SG7	Significant improvement in sales growth.					

Thank you for taking the time to complete this questionnaire. Your views are much appreciated

APPENDIX 2

DECLARATION BY LANGUAGE EDITOR

8 Belle Ombre Road
Tamboerskloof
Cape Town
8001.

18 March 2020.

LANGUAGE EDITING

This is to certify that I language-edited the dissertation "Reverse logistics activities in manufacturing firms in the Vaal Triangle area," by Victor Seeku for the MTech degree in Logistics, Faculty of Management Sciences, Vaal University of Technology.

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