ASSESSING THE TECHNOLOGIES TRANSFORMING THE LOGISTICS INDUSTRY IN NELSON MANDELA BAY

by

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ABSTRACT

Supply chain disruptions such as those emanating from the current Covid 19 pandemic have made the logistics industry to undergo fast and unprecedented change. In such unpredictable times, innovation and technology adoption has emerged as one of the major trends and key solutions to lead the way for the future of logistics. This is also because a successful and efficient logistics strategy requires the use of technology, as well as the strategic value derived from a firm's capacity. This in turn enables firms to recognise possibilities and challenges resulting from technological advancement in order to attain long-term competitiveness. The industry is implementing these technologies with caution in order to provide faster, cheaper, more dependable and long-term supply.

This study sought to investigate whether Nelson Mandela Bay (NMB) is keeping up with the current logistics technology trends and systems that are transforming logistics firms in South Africa, the African continent and the rest of the world. To achieve this primary objective, the study also sought to achieve the following sub-objectives, namely: to identify the logistics technologies transforming logistics firms in NMB; to assess the role of logistics technologies affecting logistics firms in NMB. The study also sought to ascertain the challenges of using logistics technologies transforming the logistics firms in NMB; and examine the effect of logistics technology adoption and use on business performance of logistics firms in NMB.

The study used an online closed-ended questionnaire distributed via google forms to collect primary data from a sample of 132 respondents across all the logistics firms (which consisted of warehousing, transport and packaging firms) in NMB. The study targeted those respondents involved in the management of the targeted logistics firms. The empirical results show that technology use in logistics firms has advanced a lot to vehicle tracking, packaging, inventory control, and communication systems, as well as robotics among logistics firms in NMB. The results also identified logistics technologies such as the Internet of Things, Robotic Process automation, Digital Supply Chain Twins, Vendor managed system and RFID as some of the major technologies currently transforming the logistics firms in NMB. The study found that many challenges exist with logistics technology adoption, and cited lack of investment towards logistics technology; the fear of

losing jobs as people get replaced by technology such as machines and robots; high logistics costs as some of the major challenges. More so, the study results reveal that logistics technology adoption and use play a positive and significant role in logistics firms. The study further reports a significant and positive effect of logistics technology adoption and use on business performance of logistics firms. This study concludes that though still at infancy stage, logistics firms in NMB are keeping upbreast with the current logistics technological trends. The study suggests that firms need to speed up the adoption of the needed logistics technologies available to their respective business in order to remain efficient and effective.

DECLARATION: PLAGIARISM

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the owner of the copyright thereof (unless to the extent explicitly otherwise stated) and that I have not previously in its entirety or in part submitted it for obtaining any qualification at this institution, or at another institution.

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- I'd want to thank Almighty God for giving me the perseverance and motivation to finish this thesis. This research will help me advance my career as a businessman and the future expansion of my business.

  Psalm 116:12. King James Version ... What shall I render unto the Lord for all his benefits toward me?
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ACRONYMS AND ABBREVIATIONS

3D	3 Dimensional
4IR	Fourth Industrial Revolution
AMR	autonomous mobile robots
AR	augmented reality
AS/RS	automated storage and retrieval system
CAGR	compound annual growth rate
DRP	distribution requirements planning
EDI	electronic data interchange
EFA	exploratory factor analysis
ERP	enterprise resource planning
FDX	Fedex
GDP	gross domestic product
GPS	Global Positioning system
ICT	information and communications technology
IoT	Internet of things
ISO	International Organization for Standardization
KMO	Kaiser-Meyer-Olkin
LPI	Logistics Price Index
MR	mixed reality
NMB	Nelson Mandela Bay
RBV	resource-based view
RFID	radio frequency identification
RPA	robotics process automation

RV	relational view
SaaS	software as a service
SCM	supply chain management
SPSS	Statistical Package for the Social Sciences
SWOT	strengths, weaknesses, opportunities and threats
TMS	transportation management system
UPS	United Parcel Service
VIF	variance inflation factor
VR	virtual reality
VRIO	value, rarity, imitability and organisation
WES	warehouse execution system
WMS	warehouse management system

CHAPTER 1
INTRODUCTION AND BACKGROUND OF THE STUDY

1.1 INTRODUCTION AND BACKGROUND

The current global shift towards competitiveness and efficiency forces companies to change their old ways and come up with new ideas that should be reviewed and made better, faster and more reliable almost daily as they compete on a global scale. Thus, as the contemporary customers keep demanding better quality, eco-friendly products at lower prices and with shorter lead times, innovation and adoption of new technologies seem to be the key solution even for logistics firms searching to move, store, handle, pack and deliver more items with less assets, while fulfilling the citizens' right to a healthy environment (Botha, Bimha, Chodokufa, Cohen, Cronje, Eccles, Grobler, Le Roux and Rudansky-Kloppers, 2016). More so, technology advances seem to be the future of logistics with the end-users demanding a more streamlined environment where logistics cannot fall short in any of these demands. Kersten, Blecker and Ringle (2015:7) believe that logistics is ready to receive the rewards of innovation in the coming year, and understanding the suggestions of these logistics innovation patterns will be critical to progress or fail in business.

In South Africa, logistics are described as a major strategic resource which is crucial in providing the economy with global value and cost competitive advantages (Havenga, de Bod, Simpson, Viljoen and King, 2016). Kalkan (2018) associates the logistics industry with "speed, flexibility and technology" across the globe. Thus, undoubtedly, the adoption and use of technologies play an enabling role for logistics companies in terms of meeting customers' needs, reducing total logistics costs, improving resource utilisation efficiency (De Villiers, Nieman and Niemann, 2017), fulfilling customers' orders on time, reducing response time, timeous sharing of quality and accurate information, as well as effective tracking and tracing of inventories (Kalkan, 2018). Soon competitiveness and efficiency will be measured through the success of using technology and not on age-old agreements along with handshakes with promises to deliver. However, end users would expect to get the same service from logistics service providers that they receive from their logistics competitors. One of the

opportunities of staying in-touch with technologies is greater market share as customers always seek the better and quicker process, for example the Uber eats allows the customer to enjoy their favourite meal without leaving the comfort of their home or office. According Introna (1991:33), technology use will only add meaning (and value as such) if users (and designers) fully understand the systems involved (logistics and information). Technological development, specifically digitalisation, has significant consequences for labour markets. Recent studies prove that technology advancements in the last few decades improved things for the better and created millions of jobs through these advancements (Zawawi, Wahab, Al Mamun, Ahmad and Fazal, 2017).

Natural disasters, life-threatening diseases, and political conflicts have all been known to disrupt supply chains and logistics activities in the past. However, the COVID19 pandemic has been described as a unique event that has had a global impact on firms and their supply chains due to the cessation of nearly all production and logistics activity (Singh, Kumar, Panchal and Tiwari, 2020). Technology forms a critical part in keeping firms and their supply chains functional during the COVID 19 pandemic, and these technologies may have a long-term impact on business performance and their resilience beyond the COVID 19 pandemic.

Therefore, it is imperative for logistics firms to adopt new technological advancements such as artificial intelligence, advanced analytics, Internet of Things, robotics process automation, autonomous things, digital supply chain twin, immerse experience, radio frequency identification (RFID) and blockchain in order to remain competitive and boost their business performance. Choi and Song (2018:1) explain that exploring technological developments is critical to a successful technology strategy in logistics, with the strategic significance of discerning possibilities and threats from technological growth to attain sustainable competitiveness. Logistics also progressively require methodological assistance and adequate information to decrease the complexity and burden of exploring technology trends, given the fast speed of growth and varying technological alternatives. Assessing the technological effect will be essential in developing policies that encourage effective labour markets for the advantage of the entire workforce, employers and societies (Petropaulos, 2018:3). In light of the above, this study sought to assess the current technologies, their challenges, role in

transforming and their effect on business of logistics firms in Nelson Mandela Bay (NMB).

1.2 PROBLEM STATEMENT

Since 2011, South Africa's logistics costs have been increasing significantly year after year, from 11.2% in 2011 to 13.4% in 2013, and are currently reported to be 18% (World Bank Report, 2019; Havenga et al., 2016; Stellenbosch University, 2015). These logistics costs entail the cost of logistics activities such as transportation, packaging, warehousing, procurement, inventory management, reverse logistics, logistics communication, customer service, materials handling, plant and site selection, and demand forecasting costs. South Africa's National Treasury Report (2019) reveals that growth in transport services which is a major logistics activity in South Africa declined from 1.4% for the first three quarters of 2017 to 0.9% of the first three quarters of 2018. The World Bank Report (2019) also reported that South Africa has a low business confidence, and this is partly attributed to the slow pace of structural reforms reported to be holding back investment growth in South Africa. Since technology (such as the blockchain technology, Internet of Things, and RFID) adoption is said to present a wide range of opportunities, ranging from cost saving, resource utilisation efficiencies, and improved responsiveness to enhanced information sharing, among others (De Villiers et al., 2017), could the adoption and use of technology be the missing link to solve the challenge of the ever-increasing logistics costs in South Africa?

With reports showing that Africa generally has a low technology adoption (World Bank Report, 2019) due to lack of proper technology infrastructure, people fear that technology will replace humans in the future, challenges of maintaining data accuracy and quality, and the irrational fear or anxiety induced by the side effects of using sophisticated contemporary technology commonly described as technophobia (Oceanus, 2019). The questions to be answered are: is the logistics industry in NMB keeping up with the current logistics technology trends and systems that are transforming South Africa, the African continent and the rest of the world? What logistics technologies are currently transforming logistics (transport, warehousing and packaging) firms in NMB? What role do such logistics technologies play in

transforming the logistics firms in NMB? What challenges emanate from the use of such logistics technologies? and How does the adoption and use of such technologies affect the business performance of the logistics firms in NMB? In a quest to find solutions to the ever-rising logistics costs, and dwindling growth of logistics contribution towards GDP in South Africa, this study therefore sought to provide answers to the above questions through an assessment of current logistics technologies, their challenges as well as their role in transforming logistics firms in NMB. This study assessed the adoption and usage of current technologies (artificial intelligence, advanced analytics, Internet of Things, robotic process automation, autonomous things, digital supply chain twin, immerse experience, RFID and blockchain). The study also sought to ascertain the effect of technology adoption and usage on the business performance of logistics firms in NMB.

1.3 PURPOSE OF THE STUDY

The aim of the study was to assess the technologies transforming the logistics industry in Nelson Mandela Bay. The study sought to paint a picture of how using logistics technological advances simplifies logistical processes. The findings of this study will benefit the logistics firms, their employees, policy makers, researchers, society and students pertaining to the understanding of technology within the logistics field. Change is upon us and the “adapt or die” principle will apply in the business world, organisations and humans need to keep up with the technological advances to remain efficient and competitive. This study assessed the adoption and usage of current logistics technologies (artificial intelligence, advanced analytics, Internet of Things, robotic process automation, autonomous things, digital supply chain twin, immerse experience, RFID and blockchain) transforming logistics firms (particularly those offering transportation, warehousing and packaging services) in NMB. The demand for more effective and efficient logistics firms is growing and the only way to keep up is for logistics managers to be better equipped with technology.

1.4 RESEARCH OBJECTIVES

1.4.1 Primary objective

Broadly, this study sought to investigate whether NMB is keeping up with the current logistics technology trends and systems that are transforming logistics firms in South Africa, the African continent and the rest of the world.

1.4.2 Secondary objective

The following were the secondary objectives of the study:

- To identify the logistics technologies transforming logistics firms.
- To assess the role of logistics technologies affecting logistics firms.
- To ascertain the challenges of using logistics technologies transforming the logistics firms.
- To examine the effect of logistics technology adoption and use on business performance of logistics firms.

1.5 RESEARCH QUESTIONS

1.5.1 Primary research question

- Is NMB keeping up with the current logistics technology trends and systems that are transforming logistics firms in South Africa, the African continent and the rest of the world?

1.5.2 Secondary research questions

- What are the current logistics technologies transforming logistics firms?
- What is the role of technologies affecting logistics firms?
- What are the challenges of using logistics technologies transforming the logistics firms?
- What effect does technology adoption and use have on business performance of logistics firms?

1.6 HYPOTHESES

This study claims that:

H01: The adoption and use of logistics technology plays an insignificant role in logistics firms.

H1: The adoption and use of logistics technology plays a significant role in logistics firms

H02: The adoption and use of logistics technology has a negative effect on the business performance of logistics firms.

H2: The adoption and use of technology has a positive effect on the business performance of logistics firms.

1.7 LITERATURE REVIEW

1.7.1 Supply chain

Branch (2009:28) argues that the supply chain has been defined as the sequence of events in a goods flow, which adds value to the value of a specific good. These events may include conversion, assembling and/or disassembling and movements and placements. The global supply chain crosses international boundaries. Basically, the supply chain is linking the producer/manufacturer/ supplier with the distributor/consumer involving a dedicated service; moreover it is completely transparent with each element of the supply chain throughout the transit (Sadler, 2015).

The supply chain itself includes organisations that are involved in all flows of products, services, related information and finances from the supplier of suppliers to the final customers (actually more like a “web” than a “chain”) (Felea and Albastroiu, 2013). Supply chain activities transform natural resources, raw materials, and components into a finished product that is delivered to the end customer. For example, I once heard a major paper goods manufacturer describe their supply chain for toilet paper as ranging from “stump to rump” (Myerson, 2015:4).

1.7.2 Logistics

Logistics can be broadly defined as the time-related positioning of resources ensuring that material, people, operational capacity and information are in the right place at the right time in the right quantity and at the right quality and cost (Mangan, Lalwani, Butcher and Javadpour, 2008). Branch (2009) believes this embraces the ultimate objective of global supply management, which is to link the marketplace, the distribution network, the manufacturing/processing/assembly process and the procurement activity in such a way that customers are serviced at a higher level and yet lower cost. Logistics therefore contribute to a company's relative cost position and create a basis for differentiation providing a 'value-added' activity and competitive advantage (Branch, 2009).

1.7.3 Fourth Industrial Revolution

"The fourth industrial revolution, however, is not about smart and connected machines and systems. Its scope is much wider, occurring simultaneously are waves of further breakthroughs in areas ranging from gene sequencing to nanotechnology, from renewables to quantum computing" (Skilton and Hovsepian, 2018). The combination of various technologies and their interaction across the physical, digital and biological domains is what makes the fourth industrial revolution profoundly different from the previous three revolutions (Skilton and Hovsepian, 2018).

The fourth industrial revolution (4IR) is now acknowledged worldwide as a basic shift in the manner we live, operate and relate to each other. It is inevitable that it will bring about change in desirable and undesirable ways, as with any revolution. The impacts of this revolution's shift are already apparent in how societies produce, distribute, and consume the complete variety of products and services that support human life and drive human development. However, within distinct socio-technical systems and between distinct nations, there are significant variations in the rate of change in manufacturing systems, a specific region of intense change leads many to frame and manage the transition brought about by this revolution (Sima, Gheorghe, Subić and Nancu, 2020). Future communication systems and networks will be at the centre of the 4IR, using techniques like artificial intelligence and distributed ledgers to

decentralise and automate network management, data analytics, and shared knowledge (Department of Telecommunications and Postal Services Report, 2018).

1.7.4 Supply chain technology trends

Gartner (2019), identified the top strategic supply chain technology trends that have wide effect on the sector, but have not been commonly adopted yet. These techniques experience important changes in capacity or maturity or reach critical tipping points, namely artificial intelligence, advanced analytics, Iot (Internet of things), robotic process information, autonomous things, digital supply chain twin, immersive experience and blockchain (Businesslive, 2019).

- **Artificial intelligence**

There is common literature in the area of artificial intelligence and there are many definitions of artificial intelligence. In the early 1960s, Marvin Minsky indicated that “artificial intelligence is the science of making machines do matters that would require brain if finished via men” (Woodford, 2021). In the 1990s when Bransford (1999) said “What is synthetic intelligence? It is regularly difficult to construct a definition of a self-discipline that is pleasing to all of its practitioners. AI research encompasses a spectrum of associated topics. Broadly, AI is the computer-based exploration of methods for fixing challenging tasks that have historically depended on human beings for solution (Bartneck, Lütge, Wagner and Welsh, 2021). Such duties include complicated logical inference, diagnosis, visual recognition, comprehension of herbal language, game playing, explanation, and planning” (Silva and Fonsec, 2019).

- **Advanced analytics**

With increasing awareness of data science’s significance, the field is becoming increasingly advanced, we now process bigger quantities of information on a regular basis and use more complicated algorithms (Günther, Rezazade Mehrizi, Huysman and Feldberg, 2017). This fresh landscape has its own set of difficulties: the processing of information needs large-scale infrastructure, robust multi-level security, and more advanced multi-functional algorithms. Yuvaraj (2020), states that Cloud offers strong instruments to address all these problems. In this talk, we will see how

data science and Cloud work together to assist you handle your big data and transform it on a large scale into useful ideas (Singhal, Dhameja and Panda, 2018:21).

Singhal, Dhameja and Panda (2018:26) argue that big data is a trendy subject nowadays, regardless of what individuals mean when using this word, furthermore, being large is only a matter of quantity, although in the size limit, there is no clear consensus. On the other side, by using a brute force strategy, it is simple to capture big quantities of information (Bosnjak, Sres and Brumen, 2018). The true objective, therefore, should not be big data, but to ask ourselves what the correct data is and how much of it is required for a particular issue (Botelho and Bigelow, 2022). Data is being generated and captured from everyone and everywhere, such as online social networks, sensor devices, health data, human genome sequencing, phone logs, government records, and professionals such as scientists, journalists, and authors, to name a few examples (Wani and Jabin, 2017). With regard to the challenges, we are exploring the trade-offs associated with big data's primary issues: scalability, redundancy, bias, bubble filter, and privacy (Botelho and Bigelow, 2022).

- **Internet of things (IOT)**

The simplest definition is the Internet of Things (IoT), a network of physical objects embedded in electronics, software, sensors, and network connectivity that allows these objects to gather and exchange data, often using the Internet (C3 Solutions 2019).

Hafdi (2019) brings forth that the inputs are replaced by the relevant sensor(s) in the case of an IoT system therefore, it is possible to eliminate the chance of human errors to a large extent. Tripathy and Anuradha (2018), posits that the camera functions as an input sensor whenever we use a vision-based IoT scheme further, the case of an IoT system, unlike a computer system, the processing application is located on a central server (or cloud system). Thus, a typical IoT-enabled system comprises sensors, an integrated system, (wireless) communication, internet information storage into a cloud server, a cloud platform analytics software system to make informed choices, and an optional (mobile) receiver end device (Gillis, 2021). The embedded

system connected to the object can detect and monitor the necessary information continually (Tripathy and Anuradha, 2018:3).

- **Robotic process automation**

Robotic process automation (RPA) utilises state-of-the-art software systems to manage extremely organised, routine and repetitive computer duties automatically (DOGUC, 2020). A robot can take the wheel and get the work done for assignments that are mainly guided by regulations, schedules, or occurrences. In reality, typical back office staff spend up to 80% of their day on such daily operations (Kaelble, 2018). These staff fill in forms, make repetitive calculations, and process orders — everything that is essential to client satisfaction but tedious to staff. This workforce is accurate and boredom-friendly and immune. It can be scaled much easier than a human workforce as well. RPA can conduct almost any complicated rule-based job and can do so by interacting with any application software or website. It is a robotic link to the computer user interface's human world (Kaelble, 2018).

- **Autonomous things**

An important area of application is ‘autonomous’ software including bots (Ju, 2021). Trade, finance and stock markets are largely run by algorithms and software. Nikolova (2018) argues that without human intervention and control from outside, smart systems today conduct dialogues with customers in online call-centres; speech recognition interfaces and recommender systems of online platforms, e.g. Siri, Alexa and Cortana, make suggestions to users. Beyond the straightforward questions of data protection and privacy, we may ask whether people have a right to know whether they are dealing with a human being or with an AI artefact (Ridley, 2019). Moreover, the question arises whether there should be limits to what AI systems can suggest to a person, based on a construction of the person's own conception of their identity (Statement on artificial intelligence, robotics and autonomous' systems, 2018) .

According to the Statement on artificial intelligence, robotics and autonomous' systems (2018) at the national level initiatives are uneven. Some governments are prioritising the development of laws for robotics and artificial intelligence, even passing legislation (for example, to regulate self-driving cars on public highways), while others

have yet to address the issue (Feijóo et al., 2020). Europarl (2022), states that the lack of a harmonised European approach has prompted the European Parliament to call for a range of measures to prepare for the regulation of advanced robotics, 11 including the development of a guiding ethical framework for the design, production and use of robots.

CNBC NEWS (2019) revealed that a plant in Valencia, Spain, Ford has just introduced a new autonomous robot called Survival, the robot supplies workers around the plant with components and equipment, which Ford says enables its staff to concentrate on more complicated duties. The robot was constructed completely by staff of Ford and is part of the push of the company to create a fully autonomous car by 2021 (CNBC NEWS, 2019).

- **Digital supply chain twin**

According to Tao and Zhang (2019), it is implemented as a pragmatic manner of seamless inclusion and fusion, as the digital supply chain is a centred application of the cyber-physical system and offers more practical values and details of execution. With regard to the digital supply chain, a virtual mirror model with the ability to analyse, evaluate, optimise and predict, etc. exists for each physical object (Jones et al., 2020). The two components communicate with each other and in forming a closed loop stay synchronous; furthermore data can be acquired and merged from both the physical and virtual sides to produce more extensive information (Trauer et al., 2020). In reality, the digital twin can be regarded as a cyber-physical system paradigm, as it is made up of the most significant parts of cps and becomes more concrete (Kan and Anumba, 2019). To date, a growing number of organisations and businesses have become conscious of digital twin values, investing a big quantity of resources in appropriate studies and implementation (Jones et al., 2020). In the future, more digital twin capabilities will be explored and the integration and fusion of physical and virtual spaces will play a growing role in the industry.

- **Immersive experience**

Reality is defined as a set of all that is real and has existence unlike imaginary. Liberatore and Wagner (2021), explains that Immersive Reality is a path breaking

technology which bridges the gap between imagination and reality. Virtual reality (VR), augmented reality (AR) and the latest mixed reality (MR) together are called immersive reality. It has been a quite a few years that the way that people interact with content has not changed. This study highlights how immersive technologies are going to alter how we interact with content fundamentally. For example, companies such as GE Renewable Energy and its technology partner Upskill worked together to develop head-mounted display which helped employee to receive wiring installation instructions instead of reading a traditional paper manual (Sekhar, Sankar Ch and Rao, 2018). Using a virtual reality headset, we can take ourselves to imaginary environment (Martin, 2019). Another development in this field is Microsoft HoloLens which is self-contained holographic computer, helps us in accessing digital content and interact with the holograms in the world around us (Park, Bokijonov and Choi, 2021). The design of all these products has the same goal – being part of human efforts to create better world for people to live in. These kinds of developments can transform the current entertainment, gaming, education, training, real estate, hospitality, shopping experience, healthcare, marketing experiences and travel communication businesses (Martin, 2019). As there are two sides for a coin, there are many issues which immersive reality must tackle before it makes a global presence (Rao, Sekhar and Sankar, 2018).

- **Blockchain**

According to Singhal, Dhameja and Panda (2018), blockchain arrived in 2009 through a straightforward mailing list with Bitcoin, a digital cryptocurrency. People could see their true potential soon after it was launched, and it wasn't limited to cryptocurrency. Some businesses have come up with various blockchain product flavours such as Ethereum, Hyperledger, etc (Mohammed, Abdulateef and Abdulateef, 2021). On their Azure and Bluemix cloud platforms, ##s, Microsoft and IBM developed SaaS (Software as a Service) services (Vennam, 2020). Different start-ups were created and blockchain initiatives were taken by many established businesses that concentrated on solving some company issues that had not been solved before.

It is now too late to simply say that blockchain has tremendous potential to disrupt nearly every sector in some manner or the other; the revolution has already begun (De

Villiers and Calitz, 2020). It has had a major impact on the market in financial services. Naming a worldwide bank or financial entity that does not explore blockchain is hard (Mercuri, Della Corte and Ricci, 2021). In addition to the financial market, projects in fields such as media and entertainment, power trading, prediction markets, retail chains, loyalty reward schemes, insurance, logistics and supply chains, medical records, as well as government and military applications have already been/are already being taken (Singhal, Dhameja and Panda, 2018).

1.7.5 African literature

According to the 2016 Logistics Performance Index (a tool intended by the World Bank to assist nations assess their supply chain and logistics system's strength and effectiveness), South Africa came out on top with the best transport and logistics system in sub-Saharan Africa. Kenya, Botswana, Uganda, and Tanzania followed. Of these, Kenya's logistics sales have grown significantly, bringing in more than R131 billion in 2015. Compared to 2010, this was a 13% rise in compound annual growth rate (CAGR). But in the logistics industry, it is not just sub-Saharan Africa that performs so well (Mngomezulu, 2019). Even Angola experienced an 18% rise in CAGR in Southern Africa, earning R156 billion in income from logistics and supply chain. Antonio J. Silva Transport and Logistics (AJS) is the leading logistics and transportation company in the supply chain corporation in Angola, which increased its income by 50% between 2016 and 2018; proof of the potential of Angola (Mngomezulu, 2019).

Mngomezulu (2019) explains that North Africa is there. According to specialists, Algeria is one nation that has great logistics and supply chain opportunities for the future in Africa. With its burgeoning middle-class population, the nation has a big market of educated and worldwide conscious people that have started to demand quality, world-class products and services. They showed themselves to be active online as well as offline. Existing logistics businesses, like the GEFCO Group, have secured this through their extremely lucrative, two-year-long balance sheets. In reality, as a testament to Algerian supply chain and logistics industry's profitable opportunities, the Algerian government endorsed the 2017 R46 million El Hamdania port project to promote North Africa's huge quantities of trade in.

Adewole and Struthers (2019:25) explain that technology plays a vital role in the value chain within the product and service offering of an organisation. Well-coordinated and integrated logistics, aided by information and communications technology (ICT) implementation, will bring the fundamental benefit of more effective, cost-effective supply chain activities. This merely implies that technology will help unify an organisation's objective and its supply chain associates and help them prevent duplication of effort, decrease resource waste and allow better sharing of data. Furthermore, the suitable implementation of electronic technology will improve the velocity of motion through the demand and supply pipeline, facilitate planning, decrease uncertainty and variability, and remove obstacles that can lead to elevated rates of inventory holding between manufacturing, warehouse and retail outlets. Advanced digital techniques in Africa will assist business models. Technology will drive a drastic change in the manner in which trade takes place. In an intense competitive setting, worldwide businesses are experiencing enhanced market volatility, forcing fresh pressures and fresh company methods.

Africa will therefore need to navigate the present transition and reinvent its logistics activities landscape to assist transform trade and economic development across the continent in order to achieve financial and results. International businessmen in and with Africa would need to work with domestic and regional African governments to mix freight logistics and supply chain policies with fresh techniques to bring trade advantages to Africa. By creating partnership commitments between company investors and African governments, the burden of trading and investment costs will be shared in fresh logistics capacities, driving higher market success (Adewole and Struthers, 2019:25).

1.7.6 South African literature

As a third world country, South Africa has always placed technology at the back and very little change is made unless it has been attempted and tested in nations of the first world, but South Africa is expanding rapidly and some innovations are being grown by our own home-grown logistics firms.

South African start-up WumDrop has introduced its Deliver 2 Me service that enables customers to deliver packages to the recipients' precise place by determining their precise Global Positioning System (GPS) location on their smartphones (Jackson and Jackson, 2022). Apparently the service also monitors packages along its path apart from recognising the precise places of the recipients – providing that the start-up dubs are a no address option.

There is one sector in South Africa that is strongly connected to the logistics industry, which is a problem, and it is the South African Post Office's delivery of mail. Mail transit from points of origin to the eventual recipients of postal commodities is a "special" type of supply chain, yet it is no different than any other supply chain (Khotsa, 2018). There are regular complaints about the South African Post Office in journals, the media and other forums about the absence of adequate service and even a complete absence of service (Mabasa, 2021). Examples of complaints include: there is a complete lack of prompt shipment; the service is not reliable as some goods are never delivered and are presumed to be lost; client service is awful and visibility in the supply chain, i.e. monitoring and monitoring registered products, is bad and so on (Ittmann, 2018).

Because of their essential significance, the complexity of supply chains is little appreciated – they only become visible when they become disrupted and difficult. Logistics continues to be one of the key development facilitators

Against this context and given that the South African economy has not performed well in recent years, this climate has placed a huge burden on the country's logistics and supply chain management sector. Nevertheless, while maintaining expenses under control, the industry has tried to continue offering a quality and reliable service. It is clear from the results that South Africa has managed to improve their overall ranking to 20th out of 160 countries which is indeed remarkable and is a significant improvement from the 34th ranking in 2014 (Ittmann, 2018). Improvement was recorded in all six measurement indicators (De Villiers, 2017).

According to De Villiers (2017), the successful implementation of world-class logistics and supply chain management solutions requires collaboration between numbers of

stakeholders in the supply chain, such as logistics service providers, cargo owners, local, provincial and national government as well as regional cooperation. Collaboration between supply chain stakeholders has been cited as a key driver for long-term investments such as the logistics technologies among firms (Min et al., 2005). The role of the private sector stakeholders is of particular importance when it comes to the funding of logistics technological infrastructure and services, as well as governance and compliance to remain within the law.

1.8 DELIMITATION/SCOPE OF THE STUDY

The current study assessed the logistics technologies adopted and used among logistics firms, their role in the logistics industry and their effect on business performance. This study sought to also portray an overview of the change within the logistics field due to these technological advances. The study was limited only to the logistics industry, particularly the transport, warehousing and packaging logistics service providers in NMB listed in the Nelson Mandela Bay Business Chamber as well as Local Business Directory in 2019.

1.9 SIGNIFICANCE OF THE STUDY

This study, on the assessment technologies transforming the logistics industry in NMB, can be used to enlighten organisations and people connected to the logistics sector or even the general public about how technology advancements can disentangle and simplify processes within organisations and enhance the jobs of employees. The study's goal was to identify the current technologies transforming logistics firms in NMB in order to help motivate employees to develop an interest in technological advancements to improve overall competence, develop employability skills, implement a career plan and participate in a career pathway in preparation for the 4IR. The study aimed to assess the role technology has in logistics firms and wants to emphasise to organisations that they will fall behind the rest of the world should they choose to carry on using outdated methods. This study also plans to put people at ease by making them see that technology is not the enemy that wants to replace humans but a tool to improve the way business is being done. Through

research the study has intended to reveal the effects logistics technology adoption and use has on business performance of logistics firms in NMB

1.10 THE ASSUMPTIONS

The change in the logistics sector pertaining to technology advances is unavoidable with an increase in customers demanding more streamlined services. Logistics service providers and suppliers are moving towards systems and AI to increase competitiveness.

This study was based on the following assumptions

- Employees fear that technology will replace them.
- Some of the older customers do not want change because of the lack of technology knowledge.
- Logistics managers that do not have the qualifications and technology know-how are avoiding change.
- Logistics managers look forward to cost savings due to staff reductions.
- Many people are unaware of these technological advances.
- More than half of the NMB population has never bought anything online.

1.11 CHAPTER OUTLINE

Chapter 1: Introduction and background of the study

In this chapter the research context is explained and carefully described. The chapter includes background to the study, the problem statement, aim of the study, research objectives, and significance of the study.

Chapter 2: Supply chain and logistics overview and logistics theories

This chapter provides an overview of the global, African and South African logistics industry. The chapter also discusses the theories used to explain the relationship between the research variables.

Chapter 3: Logistics technologies' adoption/use and firm performance

This chapter illustrates what research has been done previously on the logistics study topic. All the data quoted is in line with this study's topic and further explains its need and significance. The literature provides a framework on which to build the research. The chapter includes major trends in the logistics field.

Chapter 4: Research design and methodology

This chapter discusses the research design, approach, sampling design, data collection and analysis procedures, validity and reliability, delimitation as well as the ethical considerations.

Chapter 5: Empirical results of the study

This chapter presents the findings and statistical reviews created from the questionnaires completed by the participants from the respective logistics firms.

Chapter 6: Conclusions and recommendations

Provides the conclusions and recommendations based on the findings of the research.

CHAPTER 2 SUPPLY CHAIN AND LOGISTICS OVERVIEW AND LOGISTICS THEORIES

2.1 INTRODUCTION

As more and more supply chain disruptions (such as the Global Financial Crisis of 2008, September 11th attacks and the Covid-19 pandemic) emerge, the role and importance of the logistics industry are becoming evident worldwide (Meyer, Walter and Seuring, 2021). The logistics industry comprises packaging, warehousing and transportation firms, among others. According to Sezer and Abasiz (2017), the logistics industry accounts for a significant portion of the gross domestic product (GDP) of developed countries, and aids productivity and cost savings.

The current Covid-19 pandemic and the drive to move towards sustainability in all business operations worldwide are some of the driving forces towards technology use even in the logistics industry. Technology use along with the strategic value emanating from a firm's ability to discern opportunities and challenges from technological growth to achieve sustainable competitiveness is crucial for an effective and efficient logistics strategy (Nagy et al., 2018). As it was in any other industry, prior to the Covid-19 pandemic, technology adoption was one of the least prioritised innovations. However, due to the disruptions in movement and restrictions resulting from the Covid-19 pandemic, the logistics industry had to prioritise technology adoption and use in most of its activities. This chapter provides an overview of the global, African and South African logistics industry. The chapter also discusses the theories used to explain the relationship between the research variables.

2.2 OVERVIEW OF THE LOGISTICS INDUSTRY

2.2.1 Logistics on a global scale

According to Lukashevich (2017), global logistics is realised on the basis of a specific concept that encompasses economic, organisational, spatial geographical, technical, technological, personnel, financial, political, moral and ethical aspects and characteristics, as well as development factors and driving forces. The logistics and transportation business in the United States is very competitive, and multinational

corporations who invest in it need to position themselves to better ease the movement of goods throughout the world's largest consumer market (Invest in the United States, 2021).

In Germany, the logistics industry is regarded as the country's largest economic sector, with a workforce of approximately three million people. The German logistics market has a high weight, with roughly 25% of the turnover shares in Europe (in 2019), of which Germany produced €279 billion (Deller, 2021). They also have a leadership position worldwide in infrastructure quality and logistics technology (Research Germany, 2021). As a result of its geographic location, as well as its remarkable infrastructure and technological capabilities, Germany has emerged as Europe's most important logistics market, with road freight transit leading the way, followed by rail and inland conduits because of the expanding e-commerce business industry (Germany Freight and Logistics Market, 2021).

According to Japan Logistics (2021), over the last decade, the Japanese logistics sector has experienced extraordinary developments, with an ever-increasing need for logistical space fuelled by structural changes such as the rise of e-commerce. Japan Logistics Fund Incorporation (2020) further mentions that COVID-19's spread has altered lives, causing political and economic upheavals in Japan and throughout the world, and emphasizing the necessity of operating regimes that are prepared to deal with unexpected risks and changes in the operating environment.

Table 2.1 highlights the top five logistics firms in the world, of which four out of the five originate from United States but have offices worldwide.

Table 2.1: Top 10 largest logistics companies in 2021

Rank 2021	Company	Gross Revenue (Millions)	Net Revenue (Millions)	Employees	Country of origin
1	J.B.Hunt Transport Services	9,198	3,045 est	23	United States
2	C.H. Robinson Worldwide	15,490 est	2,241	9,114	United States
3	Ceva Logistics	7,4	3,412	78	France
4	FedEx Corporation (FDX)	7,87	3	245	United States
5	United Parcel Service, Inc (UPS)	11,048	5,565 est	77	United States

Source: Top50 Logistics (2021); FedEx (FDX) (2021); (Smith, 2021)

- **Johnnie Bryan (J.B.) Hunt transport services**

Johnnie Bryan (J.B.) Hunt Transport Services, Inc. is a Standard and Poor's SandP 500 firm that delivers innovative supply chain solutions to a wide range of customers across North America. Using a multimodal, integrated approach, the firm uses technology-driven approaches to provide the optimum solution for each customer, increasing efficiency, flexibility, and value in their operations (J.B. Hunt Transport Services Inc, 2021). J.B. Hunt Transport Services is investing $500 million in technology over the next five years to improve the carrier's operating systems, develop cloud-based infrastructure, and create innovative and disruptive technologies, including "Marketplace," which is part of the carrier's J.B. Hunt 360 transportation management system (Della Rosa, 2017). McKevitt (2017) explains that J.B. Hunt 360/ Market place will connect shippers and carriers by leveraging real-time data and artificial intelligence to match freight with capacity and align loads with carriers in order to save time and money. Based on the company’s 2020 annual report, J.B. Hunt established a strategic partnership with Google to support efforts to grow its freight technology development (J.B. Hunt Transport Services, 2021). This partnership is ground-breaking, as it will enable the industry's most advanced machine learning and artificial intelligence-based transportation management system to be amplified and accelerated.

- **Charles Henry (C.H.) Robinson worldwide**

Companies of various sizes in a wide range of sectors rely on C.H. Robinson Worldwide for freight transportation and logistical solutions. North America, Europe, Asia, Oceania, and South America are all served by the company's network of offices. The company provides a global portfolio of services based on custom, market-leading technology developed by and for supply chain professionals by utilising its knowledge, data, technology, and scale. To improve supply chain results, this company uses its worldwide network of supply chain specialists to collaborate with its customers (C.H. Robinson, 2020). According to PaySpace Magazine (2021), C.H. Robinson Worldwide's top customers include Microsoft, Walmart, Lowe's, HSNi, Sunny Delight, Evergreen Packaging, Tesco, Coca-Cola, Ocean Spray, and Newell Brands. According to Maiden (2019), the company has been a technology pioneer in freight brokerage for years, and the most recent versions of its tech services can give shippers and capacity suppliers with an all-encompassing digital platform from which to transfer freight. The company has always emphasised technology as a means of providing excellent service to customers, with the goal of removing friction from the supply chain (Miller, 2019).

- **Ceva logistics**

CEVA offers distribution, pick-and-pack, materials management, international insurance, worldwide project management, and trade facilitation services, among other things (Ceva Logistics, 2020). When building an integrated supply chain solution, the company takes into consideration the stage of supply chain development which changes over time to suit its customers' changing requirements. CEVA takes into account its customers' developing supply chain demands and seamlessly construct logistics solutions that best match their needs (Seamlessly Designing the Best Fit Solutions for you, 2021). CEVA Logistics targeted rock-solid reliability for the electronic data interchange (EDI) services that connect its extensive network of clients and trading partners to drive expansion, allowing for 90% faster responses to seasonal peaks in EDI requirements, allowing for more headroom for growth (CEVA Logistics, 2021).

- **FedEx corporation (FDX)**

FedEx offers a diverse range of transportation, e-commerce and business services through a network of operating firms that compete, collaborate, and innovate digitally under the trusted FedEx brand (FedEx, 2021). FedEx Express, FedEx Ground, FedEx Freight, FedEx Services and Corporate, Other, and Eliminations are the company's segments (Forbes, 2021). According to Roy (2021), FedEx's significance and impact have only risen in an era fuelled by e-commerce, but the logistics behemoth is eager to accelerate its growth and is banking on customer-centric innovations to help it do so. FedEx believes that technology allows logistics firms to deliver a more pleasant customer experience from start to end. Yahoo (2021) posits that FedEx is investing in new technology to improve its efficiency and financial performance. In the second quarter of fiscal 2020, FedEx launched its dynamic route optimisation technology, which gives FedEx delivery drivers real-time information on the most efficient routes to take when delivering packages.

- **United parcel service Inc (UPS)**

United Parcel Services (UPS) focuses on domestic ground package delivery and has a bigger fleet of trucks as well as supply chain and freight services ranging from supply chain management, customs brokerage, to freight distribution (Easyship, 2021). United Parcel Services (2020) claims that they operate one of the world's largest airlines and the world's largest fleet of alternative-powered vehicles, which deliver packages every business day for 1.6 million shipping customers to 9.9 million delivery customers in over 220 countries and territories. In 2019, they delivered an average of 21.9 million pieces per day, or 5.5 billion packages, setting a new record (UPS, 2020). UPS has made many technology adoptions in the recent years. Some of the recent smart technologies deployed by UPS in its facilities include: the warehouse execution system (WES), autonomous guided vehicles, automated sorting systems autonomous mobile robots (AMR), among other automation technologies. The AMR technology takes instructions from the Locus Robotics to pick up goods, transport them for consolidation of customer order and pack them out (Edwards, 2020). Implementing smart technologies such as the WES enables UPS to identify and make cost efficient and effective decisions on any potential supply chain disruptions before

they can even occur (Edwards, 2020). This is because the WES technology allows UPS to monitor its warehousing capacity, requirements of order fulfilment, identify any backlogs, check labour status, balance the flows of inventories continuously, and improve customer service in real time (UPS launches smart warehouse technology, 2020). It is with no doubt that implementing such smart technologies gives UPS a competitive edge over its rivals, and helps it to sustain both cost and differential advantages in its operations.

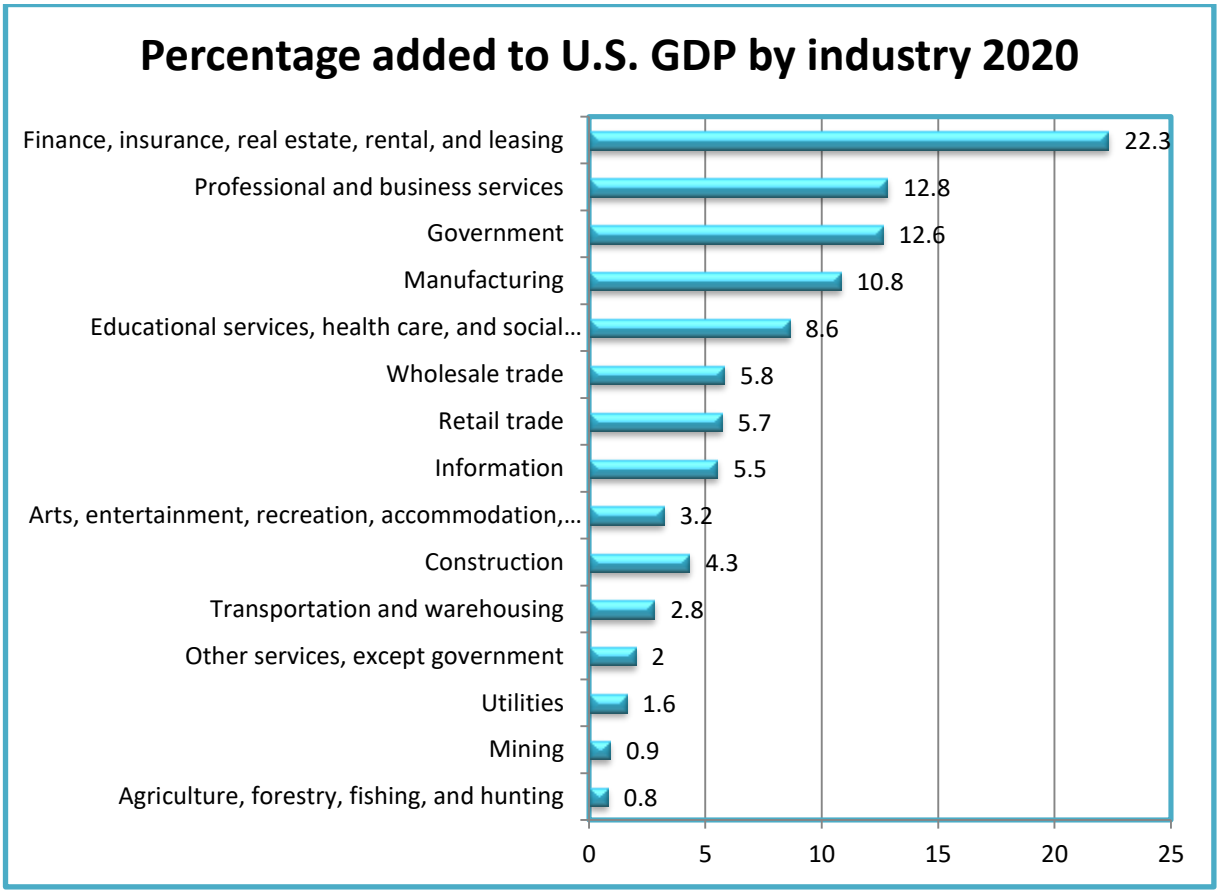

Figure 2.1: Sectors that made up the US GDP in 2020

Source: Statista (2021)

Figure 2.1 depicts the main sectors that contributed to the United States GDP in 2020, with the Transportation and Warehousing sector accounting for 2.8% of GDP. While this is not one of the highest performing sectors, it is the backbone of at least six of the top ten sectors. The following sectors would not function as efficiently or effectively without the Transportation and Warehousing sector: Agriculture, forestry, fishing, and

hunting; Utilities; Construction; Arts, entertainment, leisure, lodging, and food services; Retail trade; Wholesale trade; Educational services, health care, and social assistance; and Manufacturing. According the State of Logistics 2021 report, logistics contributed 7.4% of GDP which was actually a decline. Logistics shrunk by 4%.

2.2.2 Logistics around Africa

Desjardins (2020) explains that Africa is a large continent with 54 nations and a total area of 30.37 million km2, and the structural transformation process has taken place in Africa in a variety of ways. The presence or absence of many factors causes countries' economies to develop at different speeds with foreign and domestic investment, employment from non-farm informal rural businesses, governance and reformative policies, global commodity prices, and agricultural expansion are among the factors (Jayne, Chamberlin and Benfica, 2018). Leading global transportation, freight, and logistics companies are increasingly interested in investing in Africa, where there is the potential for significant returns, particularly in nations that have historically been underserved in terms of logistics (Dewberry, 2020). The inclusion of multi-nationals and global players will push African transport infrastructure to integrate with multi-model terminals, strengthening logistics supply chains, and investments in African ports have been mostly reactive and driven by supply side factors (Dewberry, 2020). This is set to change as demand side variables exert growing pressure; by 2040, port demand volume is expected to have increased by 6-8 times, posing a problem for Africa, as insufficient ports might result in annual GDP losses of over 2% (Botes, Buck and Shaw, 2018). Given the wide range of goods available in Africa, particularly agricultural commodities, it is clear that commerce has not increased at the projected rate.

2.2.3 Logistics on a South African scale

With hundreds of kilometres of road and rail, a vast marine network spanning 2,800 kilometers of coastline, and some of the world's busiest domestic air routes, South Africa's freight and logistics business is undoubtedly one of the country's most important contributors to GDP (BusinessTech, 2021). According to Gain (2020), the logistics sector in South Africa is very advanced and is equally as essential as other

industries, especially when it comes to the critical role logistics plays in boosting South Africa's economy. At a macro level, South Africa's economy would implode if specialised corporate logistics operations like procurement, storage, and transportation were inefficient, as the movement of goods, services, and people is reliant on them (Stone, 2011:13). In 2019, South Africa accounted for 10.89% (US$39.1 billion) of the total logistics costs (US$359 billion) in Africa. As such any form of inefficacies in the logistics industries can significantly increase the total costs, and reduce the industry's GDP contribution in the South African economy, which ultimately diminishes the continent's performance. At the micro level and owing to the role of logistics in each business' success, most organisations have traditionally prioritised increasing the efficiency of the logistics function (Wittmann, 2010).

Table 2.2: List of top five largest companies in South Africa

	Company	Gross Revenue (Millions)	Net Revenue (Millions)	Employees	Country of origin
1	Transnet	75 000	3900	56 414	South Africa
2	Imperial Logistics	46 380,00	118	25 000	South Africa
3	Value Logistics	2880	947,8	3 636	South Africa
4	Barloworld Logistics	35 300	682	9 543	South Africa
5	OneLogix Group Limited	2 622	135,1	2 843	South Africa

Sources: (Imperial, 2021; Barloworld, 2020; OneLogix, 2021; Value, 2021 and Transnet, 2021)

As shown in Table 2.2, South Africa is home to a few large logistics companies that operate across the country. The industry is intertwined with a variety of other businesses, serving as a "feeder-network" for a variety of industries, including retail, agriculture, manufacturing, and so on.

- **Barloworld logistics**

Barloworld is a prominent international brand distributor that specialises in industrial processing, distribution, and service. Barloworld Logistics was founded in 2001 and has grown into a significant supply chain solutions business in southern Africa. Partnerships with blue chip clients like Illovo, Nike SA, PPC, Mars, BP, Toyota SA, Unilever, Corobrik, and Barloworld Equipment demonstrate not only our capabilities,

but also our commitment to delivering successful supply chain solutions that work well into the future (Barloworld, 2020).

- **OneLogix group limited**

OneLogix Group Limited is a logistics services provider located in South Africa. The company's activities include specialised logistics for passenger and commercial vehicles, liquid bulk logistics, fresh produce logistics, general freight transportation, and commercial vehicle maintenance. Anomaly logistics and primary goods logistics are two of the company's segments. The company's businesses include abnormal logistics, primary products logistics and logistics services. The company's brands include Onelogix VDS, Onelogix CVDS, Madison, Onelogix United Bulk, Onelogix Cargo Solutions, Jackson and Onelogix Linehaul (Editorial, 2021).

- **Imperial logistics**

Imperial's approach capitalises on competitive advantages, presenting the company as the "Gateway to Africa" for their global clients, principals, and customers. Imperial Logistics provides clients access to some of the world's fastest-growing and most difficult markets, eliminating the complexities of operating in these areas and collaborating with them to enhance people's lives and the development of African countries (Imperial, 2021). All of the company's strategy pillars rely on our digital platforms and capabilities, and upgrading them will add value across our six value lenses, enabling growth, boosting efficiency, enhancing experience, managing risk, growing our brand, and optimising capital (Imperial, 2020). Imperial's differentiation, market relevance, client experience, revenue and growth will all be determined by its technological prowess. The company's digital emphasis areas were created with these imperatives in mind, with the goal of speeding up the company transformation from a digital deficit to a digital advantage by utilising specialised digital excellence in segments of the business to benefit 'One Imperial' (Imperial, 2019).

- **Value logistics**

Value Warehousing provides flexible storage, warehousing, and distribution solutions to match the demands of our customers. We have warehouses strategically located in

the Western Cape, KwaZulu-Natal, Eastern Cape, and Gauteng, with over 350 000 sqm of capabilities and facilities, enabling for easy delivery of our clients' products to their customers (Studio, 2021). IT infrastructure and state-of-the-art Warehouse Management Systems Value Logistics warehouses are linked to the company's logistics network to ensure accuracy and efficiency in the execution of numerous activities, such as barcode scanning and batch tracking (Value Logistics, 2018).

- **Transnet**

Transnet SOC Ltd is a major South African rail, port, and pipeline corporation with headquarters in Johannesburg's Carlton Centre. Transnet's digital strategy seeks to foster a reciprocal culture of digital ideation and cooperation with sector leaders, as well as to promote different "shared" online, platform-based digital logistics technologies with important industry partners. To that end, the company will create strategic alliances in order to develop new technology goods and services, as well as to improve digital skills and capabilities in accordance with industry trends, while commercialising new digital products and services to provide business value for clients (Transnet, 2021). In a press release, Transnet mentioned that the company is looking into technology to deliver services in the most cost-effective way possible (Transnet, 2017). The company's growth strategy, which aims to increase revenue to R100 billion by 2020, will focus on private-public partnerships and tapping into markets outside of the Southern African Development Community (Transnet, 2017). Molatwane Likhete, a Transnet spokesperson, acknowledged that new technology adoption would be difficult, both within Transnet and across the industry, and that the company would likely conduct pilot projects with a smaller group of customers and suppliers to demonstrate that the technology could address current operational challenges and significantly reduce the cost of doing business (Mackenzie, 2018).

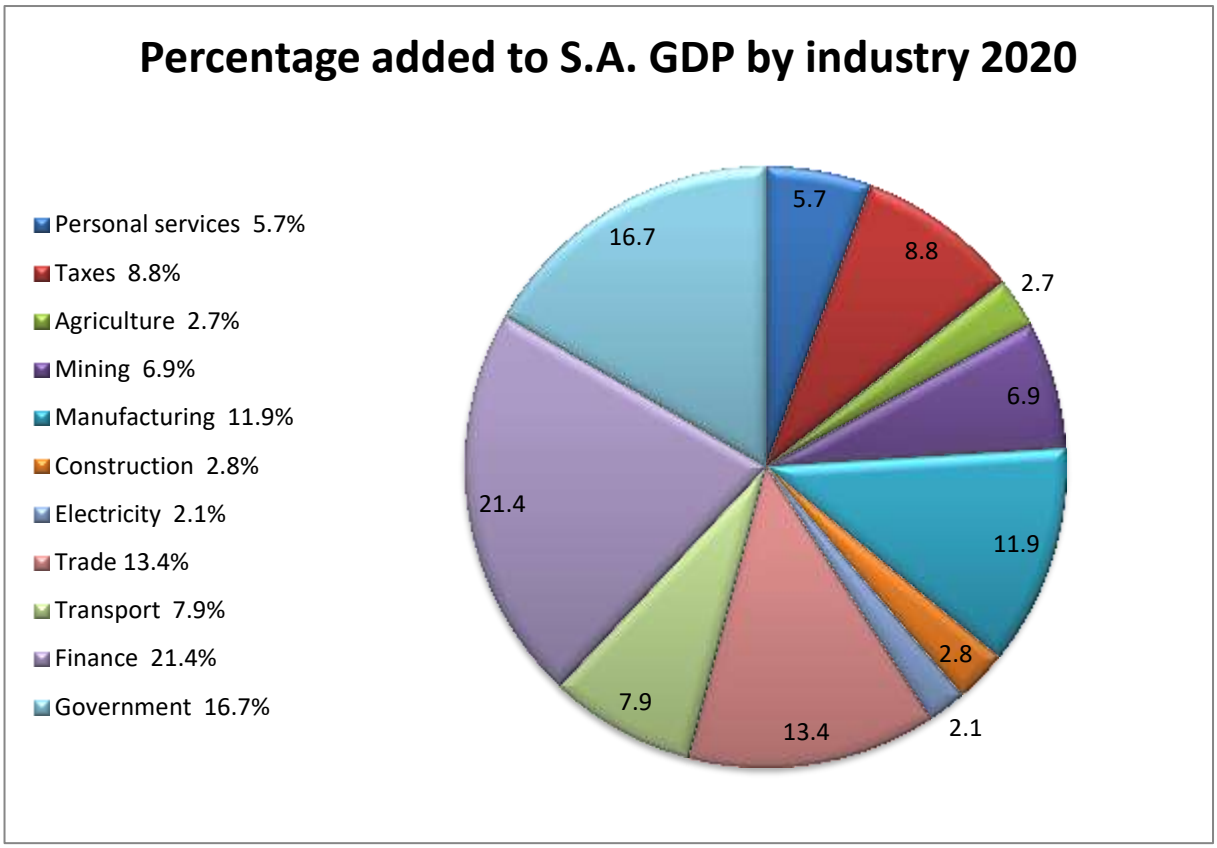

Figure 2.2: Sectors that made up the South Africa (S.A) GDP in 2020

Source: (Krogman, 2021)

As shown in Figure 2.2, in 2020, the transport sector was ranked 6th key sector and co-contributed 7.9% towards the South African GDP. Transport forms part of the logistics industry. The logistics industry is intertwined with a variety of other businesses and functions as a feeder-network for a variety of industries, including retail, agriculture and manufacturing, among others. The transported quantities are reported under the retail category when large merchants like Shoprite or Pick ‘n Pay transport and store products (Business for South Africa, 2020). Furthermore, because producers and consumers are far apart in the interconnected globe of the twenty-first century, basic economic concepts of supply and demand cannot be satisfied without transportation and logistics. Logistics and supply chain management are key contributors to a country's competitiveness and play a large part in every economy. The only way to meet product demand is to supply goods and services in a timely and cost-effective manner.

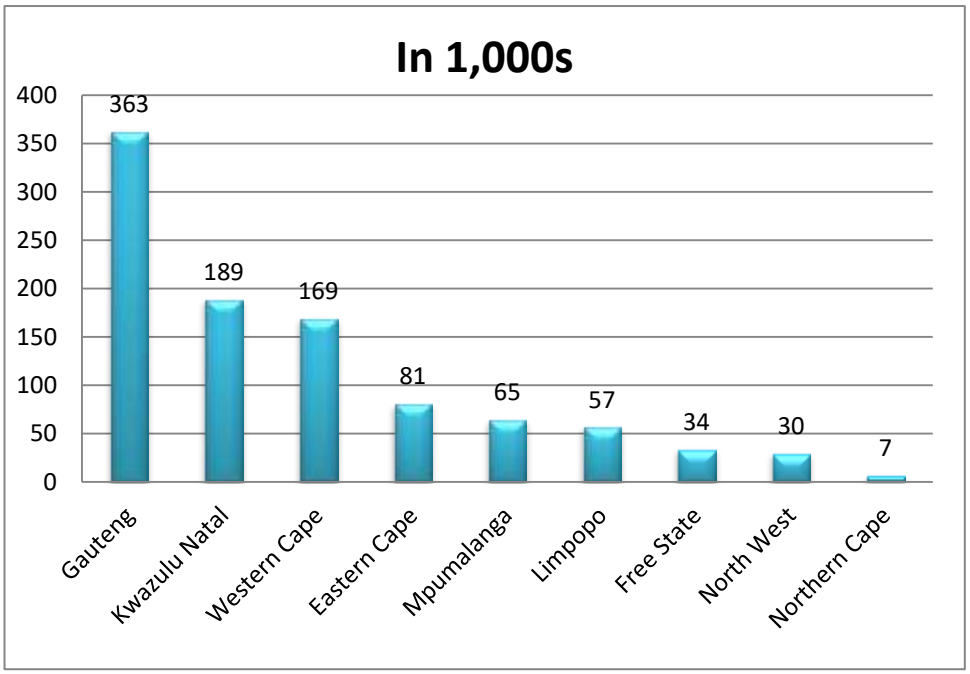

Figure 2.3: Number of people employed in the transportation and logistics industry in South Africa in Q1 2020, by province

Source: Statista (2021)

In the last quarter of 2020 (Oct - Dec) the labour force of South Africa was 22 257 000 (Businesstech, 2021). As shown in Figure 2.3 there are 995 000 people employed in the Transport and Logistics sector which means 4.47% of the South African workforce is employed by this sector. According to StatsSA (2020), the transport sector employed 966 000 in Quarter 3 (Jun - Sep) of 2018, 983 000 in Quarter 2 (Apr - Jun) of 2019, 975 000 people in Quarter 3 of 2019 (Jun - Sep); and 1011 000 people in Quarter 4 (Oct - Dec) of 2019. This proves that the logistics industry grew from the start of 2018 to the end of 2019. South Africa's total logistics volumes increased by 3.1% in July 2019 compared to the same period the previous year, owing mostly to the country's land transport industry, which increased by 4.6% (Businesstech, 2019). Further results show that in Quarter 2 (Apr – Jun) of 2021, 885 000 people were employed by the logistics sector; 903 000 people were employed in the transport sector in Quarter 1 (Jan - Mar) of 2021, while in Quarter 2 (Apr - Jun) of 2021, 969 000 people were employed by the transport sector (StatsSA, 2021). The statistics portray a clear picture that the hard lockdown had an impact on the logistics operations in South Africa resulting in layoffs and job losses. The decline is evident by comparing the

growth in the industry in 2018 and 2019 shown above and the sudden drop in employment in the logistics sector. Luke (2020) claims that as a result of the rules related with COVID-19 causing substantial economic recession in the country, it is unavoidable that logistics companies experience major disruptions. For example, the banning of alcohol sales has rendered reliable forecasting and planning difficult for logistics firms in South Africa during the current COVID-19 pandemic.

Ernst and Young (2020) stated that in the logistics sector, technology adoption has prompted the establishment of new job categories known as Industry 4.0 job roles, which include data analysis and data management, software development, and digitalisation and automation. Companies will soon begin to develop specialised in-house teams and full-time Industry 4.0 roles as Industry 4.0 maturity levels rise, resulting in closer integration between technology and operations.

2.2.4 Logistics industry performance, trends and future

The Logistics Price Index (LPI) is an interactive benchmarking tool designed to assist countries in identifying the issues and possibilities they face in their trade logistics performance, as well as what they can do to improve it (LPI, 2019). Table 2.3 below presents the ranking of countries based on the LPI scores in 2018.

Table 2.3: Logistics industry performance

Rank (2018)	Country	Code	LPI score 2020	LPI score 2018	LPI score 2016	LPI score 2014	LPI score 2012
1	Germany	DEU	4.20	4.12	4.23	4.12	4.03
6	Netherlands	NLD	4.02	4.09	4.19	4.05	3.94
10	Singapore	SGP	3.20	4.00	4.13	4.00	4.13
14	United States	USA	3.89	3.89	3.99	3.92	3.93
26	China	CHN	3.61	3.61	3.66	3.53	3.52
36	South Africa	ZAF	3.38	3.38	3.78	3.43	3.67
60	Egypt	EGY		2.95	3.18	2.97	2.98
103	Nigeria	NGA		2.59	2.63	2.81	2.45

Source (Ogle, 2018; LPI, 2019).

Supply chain disruptions emanating from natural and man-made catastrophes are becoming increasingly significant. First, the number of natural and man-made catastrophes, as well as their severity, is predicted to continue to rise (MunichRe, 2016; SwissRe, 2016). Several events in the past, such as the Gujarat earthquake

(2001), the tsunami in Japan (2011), the Indian Ocean earthquake, and tsunami (2004), have happened globally (Gou and Lam, 2019) causing supply chain disruptions.

The COVID-19 pandemic has compelled supply chains to adapt with extraordinary speed and agility to the changes, as have many other industries (Quiros and Alam, 2021). The logistics systems are essential in managing supply chain interruptions and recovery (Choi, 2020). In COVID-19 times, flaws in the present global supply chain were highlighted, resulting in revenue loss, demand, and supply unfulfillment (Linton and Vakil, 2020). Manufacturing disruptions in China sent shockwaves through global supply chains. Cargo was backed up at China's major container ports; this was due to a lack of truck drivers to pick up containers resulting from the travel restrictions, and ocean carriers cancelled (or blanked) sailings (Twinn et al., 2020). The lack of components from China that resulted had an influence on manufacturing activities in other countries. According to Twinn et al. (2020), the automobile, electronics, medicines, medical equipment and supplies, as well as consumer items, were among the industries affected around the world. The global pandemic has affected everything and everyone around the world in a certain way. A discussion of how the Covid 19 pandemic has affected the logistics industry using the different countries' LPI scores (presented in Table 2.3 above) as a measuring tool is provided below.

As can be seen from Table 2.3 above, Germany has maintained the number one spot for many years. Germany is also a world leader in terms of infrastructure quality and logistics technology (Research Germany, 2021). German logistics advances, particularly in telematics and navigation, are regarded as world-class. In Germany, various scientific institutes are researching on future logistics technologies, and several universities and centres of excellence offer logistics training and advanced training programmes (Murti, 2018).

According to Deller (2021), globalisation, innovative production models, consumer cost pressure, process digitalisation, and the expansion of e-commerce have all posed problems to the logistics business in recent years. More so, the industry must innovate in order to meet the needs of legislators and customers, particularly in terms of lowering the environmental impact of freight transportation (Deller, 2021).

Digitalisation, particularly through big data applications, cloud platforms, seamless monitoring, drones, route optimisation, autonomous industrial trucks, and self-controlling containers, has 33pened up a whole new potential in German supply chain management (Research Germany, 2021). The table above depicts an increase in LPI between the years 2018 and 2020, thus implying the pandemic did not have a negative effect on the German logistics sector. Chasdi (2020) states that during the COVID-19 pandemic, a number of digital platforms are streamlining supply chains in Germany's logistics landscape. In reality, new start-ups may benefit as a result of the crisis. For instance, Warehousing1, a Berlin logistics start-up, has experienced rapid growth because it provides a single point of contact for locating storage space and logistics services across several locations and managing them digitally with maximum efficiency (Chasdi, 2020).

Soh (2015) posits that Singapore has no natural resources and relies on international commerce and trading, particularly with nations in the region. Thus making Singapore completely reliant and dependent on other countries. In 1989, Singapore was the first country in the world to establish an integrated ICT logistics system, TradeNet, a single-stop online platform for trade declaration, which improved trade documentation time and cost efficiency by allowing various parties from the public and private sectors to exchange trade information electronically (Qingyu and Kaiyun, 2018). Activities that once required two to seven days can now be completed in less than a minute because of better resource management (Qingyu and Kaiyun, 2018).

Sum and Teo (1999) discovered that companies that are also the best business performers use the most advanced and expensive information technology (IT), such as warehouse management systems (WMS), automated storage and retrieval system (AS/RS), distribution requirements planning (DRP), electronic data interchange (EDI), satellite technology, and radio frequency (RF) technologies. Thus, proving that Singapore has always been forward thinking and open to technological adoption which was a huge factor in the growth of the counties' logistics sector. In 2018, the logistics sector delivered a value-add of $6.8 billion (R101,6 billion) to the Singapore economy and supported around 86,300 jobs (Enterprise Singapore, 2021). Forecasts in Singapore have now been revised in light of the global and domestic economic environments, as well as the current Covid-19 epidemic, which has lowered growth

hopes. OECD (2021) posits that Singapore's exports were down by 13% and 24% year-on-year in April and May 2020, respectively, while imports were down by 9.4%. In the face of the Covid-19 pandemic, Singapore has bolstered its position as a global logistics hub, citing competitive advantages such as network efficiency, reliability, and resilience (Trade and Industry Minister Chan Chun Sing, 2020). By enhancing the efficiency of its systems and utilising the latest technology available, Singapore is optimistic that this industry will continue to grow and provide many decent jobs for its employees as well as many good business prospects (TING, 2021). The success of upskilling workers to accept new technologies that enable more connectedness – employing big data at every stage in the supply chain for network optimisation, efficient warehousing, and automating package delivery operations – will determine the future of logistics in Singapore (Hsien, 2020).

South Africa claimed the 36th position out of 160 countries as measured by LPI scoring. Ittmann (2018) explains that in the context of Africa, South Africa has consistently been the best performing country. South Africa continues to lead other African countries, while the countries in second place, shift from survey to survey, indicating how volatile things are in the rest of Africa. Liedtke (2021) went on to say that the quality of South Africa's physical infrastructure, such as roads, rail, and ports, contributed to the country's ability to provide a wide range of logistics services. It is not surprising to learn that an entire South African logistics industry suffered a significant financial setback during the lockdown, with the rug ripped from under its feet in the aftermath of the global Covid-19 outbreak. The revelation that alcohol and tobacco sales were prohibited during levels 3, 4, and 5 of the lockdown sparked outrage among South Africans. In this scenario, the freight companies responsible for transporting these commodities across the country and across our borders were equally affected by the bans, and their businesses were severely harmed. Naidoo and Saueressig (2020) explain how the pandemic has had an impact on enterprises like Transnet, which was only able to make 60% of its expected revenue during quarter one with just 50% of its personnel working.

The existing supply chain mechanisms have been left exposed as a result of the coronavirus (COVID-19 pandemic) outbreak. Traditional supply chain disruption planning, mitigation, and recovery measures were ineffective in the face of the

COVID-19 pandemic's massive disruptions (Paul and Chowdhury, 2020). As a result, organisations have altered their strategy to survival and adaptation, as reaching or stabilising an 'old normality' is no longer conceivable because the 'old equilibrium' no longer exists (Mollenkopf, Ozanne and Stolze, 2021)

Contemporary supply chain management (SCM) trends such as supplier reduction, just-in-time inventory systems, outsourced manufacturing, and global sourcing have resulted in a highly linked global SC with fewer buffers and more risk exposure points. This increases the likelihood and severity of an SC outage (Bello and Bovell, 2012; Craighead et al., 2013; Thun and Hoenig, 2011; Tukamuhabwa et al., 2015). SC managers' primary concerns are recovery from SC interruptions. However, it appears that businesses are unprepared for a quick rebound (Deloitte, 2013). As a result, it is critical to comprehend and execute risk management techniques that make it easier to recover from supply chain interruptions (Bovell, 2012). Wong (2011) posited that collaborative recovery is a relatively new approach of reactive risk management in the field of supply chain risk management and it has yet to be well defined in the literature. During disruption recovery, SC partners enjoy a collective advantage by pooling their efforts.

These are truly trying times and in the midst of the chaos, logistics firms are turning to contemporary technology (cloud, digital, the Internet of Things, and data analytics) to acquire essential agility and a greater chance of not only surviving but prospering during these turbulent times. The Covid 19 pandemic may have accelerated these technological developments as a survival mechanism, but it did so after years of rapidly changing technology in the logistics industry. Jabbour and Khan (2020) explain how L'Oréal, Coty, and others, for example, have stepped up and converted manufacturing facilities that were previously used to make perfumes and hair products to make hand sanitizer. This approach helps keep people on the job and facilities running despite difficult economic conditions, in addition to offering a crucial resource that may save lives.

With the closure of shopping malls and high streets, many businesses realised they needed to shift from multi-channel to omni-channel distributions (Wollenburg et al., 2018; Hübner et al., 2016; Melacini et al., 2018) to a completely digital and online

trading environment by implementing digital technologies and collaborating with in-house logistics service providers to provide home deliveries. Supply chains may be made more efficient with the use of technology and data, allowing them to function more smoothly and offer more value to consumers, partners, and the organisation (Forbes, 2020). Maintaining successful supply chains necessitates technological adoption in supply chain activities. The PWC (2020) in a report mentioned that from the supply of raw materials (how and where they originate from) to the producers and end-users, technology has the ability to alleviate the lack of visibility problem in a supply chain. If properly implemented, greater inventory forecasting, staff efficiency, correct accountability, higher warehouse savings and other benefits will be realised (PWC, 2020). Organisations must also upskill supply chain employees or recruit and manage digital talent in cross-functional teams.

Bourlakis and Bourlakis (2006) state that technological integration of logistics firms' supply chain networks and distribution could aid the sector in continuing to serve the market even if there are disruptions. Letsoalo (2021) believes technology can help logistics firms to better anticipate, mitigate, and respond to disasters. For example, artificial intelligence could aid these firms in the collection and interpretation of critical data, allowing them to make more informed judgments. While certain industries have quickly accepted artificial intelligence, blockchain, cloud computing, robotics, and the Internet of Things (IoT), others, such as transportation and logistics, have been slower to absorb technology and innovation (Gono, 2013). Bizcommunity (2021) states with high-quality data analytics, increased visibility, and access to rich data generated daily, and an increasingly transparent supply chain, their firm is able to anticipate demand, plan more effectively, and track distribution in real time. To accelerate through the supply chain, they must collaborate with external partners in a larger ecosystem. The logistics technologies are discussed in more detail in Chapter 3.

2.3 THEORIES

Theory is at the heart of good research. A study must employ and build theory in order to advance beyond the pre-paradigmatic stage and be deemed mature (Kuhn, 1962). In positivism, theories are assessed on their predictability and formal refinement. As a result, the validity of a theory is determined by the accuracy of its predictions (Leplin,

1997). In a positivist paradigm, research is supported by empirical findings that confirm its predictions, and it is refuted by any deviation, no matter how small it may be (Popper, 1959). In reality, as a sole technique of theory justification, positivism relies on empirical testing (Anderson, 1983). This study used the resource-based view (RBV) and dynamic capabilities theory to explain the possible relationship between technology use and adoption and firm performance.

2.3.1 Resource-based view theory

Verbeke and Merchant (2012) posit that since the 1980s, a protracted dispute has raged around resource-based theory. They raised two basic theoretical problems that have been addressed repeatedly in international discussions: (i) How can businesses achieve competitive success, i.e. a long-term competitive advantage? and (ii) What is the purpose of businesses?

Their main questions are in fact posed from a typically strategic perspective, and more emphasis is placed on the first of the above questions. When answering the question on how businesses can achieve competitive success, contributions from industrial organisations, the strategic side of evolutionary theory (Nelson and Winter, 1982) and RBV theory, must be taken into account (Porter, 1980, 1985; Verbeke and Merchant, 2012).

The RBV theory is a strategic management theory which is also commonly used in logistics and supply chain studies. The theory identifies the resources that contribute to an organisation's competitive advantage (Mamonov and Triantoro, 2018). Verbeke and Merchant (2012) claim that the RBV theory is designed to assess a resource's capacity to deliver superior performance and, as a result, a long-term competitive advantage. The current study used the RBV theory to answer the question of how logistics firms can achieve competitive success and their performance through the use and adoption of technology. Figure 2.3 presents the key points of the RBV theory.

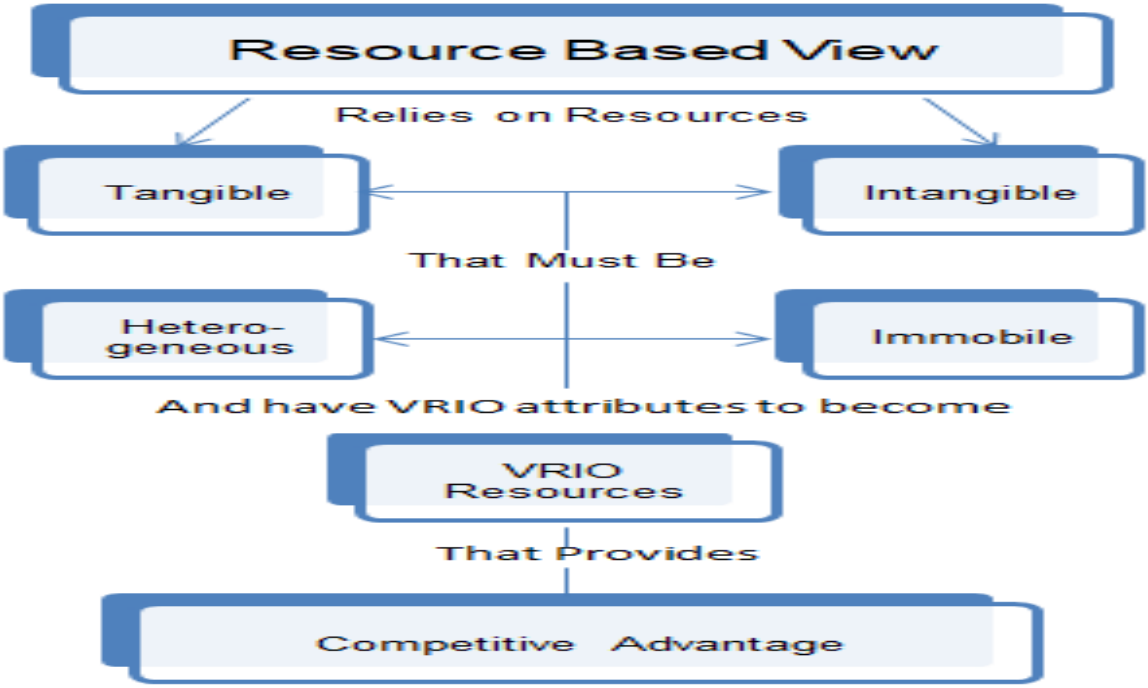

Figure 2.4: Resource-based view

Source:Jurevicius (2021)

Figure 2.4 shows that the RBV theory assumes firms to rely on both tangible and intangible resources that are heterogeneous and immobile. The theory requires the presence of value, rarity, imitability and organisation (VRIO) attributes and resources in order for firms to achieve a competitive advantage.

2.3.1.1 Tangible and intangible resources

It is critical to define the term resources before moving on to its main ideas and meanings. Resources are the assets that businesses utilise to develop and implement plans (Barney, 2001). As shown in Figure 2.4, the RBV theory classifies resources into tangible and intangible resources. According to Jurevicius (2021), tangible resources are physical assets of the firm such as land, buildings, machinery, equipment and capital. Physical resources can easily be bought in the market so they confer little advantage to the firms in the long run because rivals can soon acquire the identical assets. Furthermore, because tangible assets are frequently acquired, their worth may be determined at cost. Nordmeyer (2021) suggests some tangible assets like buildings

and machinery degrade over time and are given specific accounting treatment in order to match the asset's cost to the income it generates. Customers do not buy tangible assets. Instead, these assets are employed to run a business, producing goods or providing a service. Businesses can also utilise these assets as collateral to get loans or sell them to enhance cash flow. The market value of a firm is increased by tangible assets.

Intangible assets are everything else that has no physical presence but can still be owned by the firm (Freshbooks, 2021). Technology, patents, trademarks, and copyrights are examples of intangible assets of a firm (Nordmeyer, 2021). These and other intangible assets, such as intellectual property and goodwill, are assigned a market value based on their predicted economic benefit to a firm, or the assets expected revenue. Jurevicius (2021) posits that an asset's expenses are depreciated throughout the asset's usable or legal life. The worth of a firm's intangible assets, including its patents, brand names, customer loyalty, and copyrights, are represented by the difference between the price paid for it and the value of its tangible assets. Intangible assets are critical to a company's survival.

2.3.1.2 Heterogeneous and immobile resources

The RBV theory assumes that firm resources must be heterogeneous and immobile in order for firms to derive any cost and differential value advantages from using their resources. Pankaj (2010) explains that only when resources are heterogeneous (meaning rival firms may have different resource bundles) and immobile (meaning the inability of competing firms to obtain resources from other firms since they cannot move freely between businesses), can there be a competitive advantage. If the resources are not completely mobile (i.e. if they cannot freely move between businesses) or if a firm without such resources has a significant cost burden in creating, acquiring, or utilising them, the resources are likely to be a source of persistent competitive advantage (Madhani, 2009). The idea of resource heterogeneity and immobility are two further difficulties that separate RBV theory reasoning from other strategic management theories such as the market-based view theory (Barney, 1991).

2.3.1.3 The VRIO attributes and resources

More so, for firms to improve their performance and gain a sustainable competitive advantage, the RBV theory further requires the firm resources to possess the following attributes: Value; Rareness; Imitability; and Organisation, commonly abbreviated as VRIO. To determine whether internal resources and capabilities are potential sources of competitive advantage relative to competitors, the VRIO framework, developed by Jay Barney, one of the originators of the resource-based view, asks four questions about Value, Rarity, Imitability, and Organisation (Barney, 2002). According to Jugdev (2021), if a resource is of exclusive value to a firm, it leads to competitive parity. For a short-term competitive advantage, both value and rarity are necessary. A sustainable competitive advantage requires value, uniqueness, and inimitability, as well as an organisational emphasis on both developing and maintaining a competitive edge (Barney, 1998).

Valuable (V): Resources are valuable if they contribute to the firm's strategic goals. Pankaj (2010) claims that resources are valuable if they assist businesses in taking advantage of market opportunities or eliminating market risks. There is no use in having a resource if it does not contribute or increase the firm's value. When a resource helps a firm to design and implement methods to increase its efficiency and effectiveness, it adds value. Cardeal (2012) adds that an attribute produces value and becomes a resource if it facilitates the exploitation of opportunities and/or the neutralisation of threats, as opposed to the conventional strengths, weaknesses, opportunities, and threats (SWOT) analysis (Barney, 1991). Resources, according to Penrose (1959), are collections of prospective services.

Rare (R): Cardeal (2012) states that if the majority of competitors own the same valuable resource, they will most likely use it in similar ways, resulting in the same value creation approach. In such a case, having a valuable resource owned by most competitors will limit the ability of any of the firms to gain any competitive edge (Barney and Zajac, 1994).

Imperfect Imitability (I): Inimitability refers to a firm’s ability to safeguard its resources from being easily copied by competitors (Jugdev, 2021). According to Bates and Flynn

(1995), firms should focus on the topic of inimitability and should ask the question “do firms without a resource incur a cost disadvantage in getting or growing it?” If resources are easily replicated, an organisation's chances of achieving competitive parity are limited to value and rarity. Since nearly every resource may be imitated with enough time and money, imitation is the most difficult part of the VRIO framework to study and evaluate. As a result, it is important to estimate how long it takes for rivals to produce a duplicate of the resource during the examination of this element (Andjelkovic-Pesic, Jankovic-Milic and Andjelkovic, 2012).

Organisational focus (O): Organisational focus refers to integrated and aligned management practices, routines, and procedures, as well as managerial leadership and choices that support important assets in terms of how they are created and maintained (Jugdev, 2021). According to Cardeal (2012), firms have the opportunity to enhance their organisational procedures or routines over time (which reflects how things are done in the firm). When this path dependency effect is combined with the fact that organisational resources or routines are ambiguous (in the sense that their relationship with competitive advantage is not obvious and is often the result of the integration of various packages of resources) and socially complex, competitors find it difficult to imitate these processes/routines (Teece et al., 1997).

Firms should be able to maintain their competitive advantage even when they experience any supply chain shocks and disruptions. Sustained competitive advantage is a non-duplicatable advantage (Barney, 1991). This is supported by Lippman and Rumelt's (1982) and Rumelt's (1984) definitions, which define a persistent competitive advantage as one that persists after others' attempts to imitate it have failed (Barney, 1991). Such advantages are possible when a firm's capabilities are prioritised and when the firm concentrates on value chain reconfiguration. This is essential because it allows the firm to identify the capabilities within value chain activities that provide it a competitive advantage. Madhani (2009) posits that prolonged competitive advantage can only be achieved when resources are strategic and valued, are heterogeneously dispersed, and imperfectly mobile. Thus, a business that controls its strategic resources (those that are valuable, uncommon, difficult or costly to copy, and employed by the organisation) may achieve above average performance and a long-term competitive advantage (Verbeke and Merchant, 2012).

In the current study, the ability to adopt and use technology in a valuable, rare, difficult to imitate and in an organised manner is viewed as a firm resource that has potential to improve firm performance and ultimately create sustainable competitive advantages for logistics firms.

2.3.2 New developments to the RBV theory

Some of the key new developments informed by the RBV theory include the dynamic capabilities theory and the relational view theory.

2.3.2.1 Dynamic capabilities theory

The dynamic capability theory originated by Teece and Pisano (1994) extends from the RBV theory. Teece (2007) defines dynamic capabilities as the ability to (i) perceive and shape possibilities and threats, (ii) grasp opportunities, and (iii) maintain competitiveness by enhancing, integrating, safeguarding, and, when required, reconfiguring the commercial enterprise's resources for analytical objectives. The creation of the dynamic capabilities perspective was a reaction to the shortcomings of both the RBV and action-based view theories in the changing conditions of a knowledge and innovation economy (Mintzberg et al., 2003). In general, innovation aims for numerous novelties in various activities, such as developing items, providing services, producing new brands, installing new management systems, creating new economic or public value. Various definitions of dynamic capabilities emphasise the significance of innovation, change, and organisational learning, which are all linked to gathering, pioneering, coordinating, and deploying processes. The conception of dynamic capacities, on the other hand, is broad enough to allow for a variety of opposing interpretations of the process. Innovations may be thought of as a series of actions that include adapting to changing conditions and enhancing current goods, services, competences and business models, among others (Giniuniene and Jurksiene, 2015). Dynamic capablities are broadly categorised into sensing, seize and transform (see Figure 2.5), and these are discussed below:

- **Sensing**

Teece (2007) defines sensing capabilities as a firm's ability to continuously scan, detect, and investigate opportunities across technologies and markets. In a fast-changing industry, fresh information and knowledge can lead to new chances for innovation. Sensing necessitates a financial investment in research and development. This component of sensing entails both identifying opportunities and predicting competing dangers (Helfat and Peteraf, 2015). This can be done professionally through systematic market research, or informally, such as through staff members' self-motivated reading of industry newspapers. In this context, dynamic capability focuses more on optimising technology/information transmission across and among a firm's many components. Indeed, via the transfer of technology and know-how within an organsiation, integration enables learning, sharing of know-how, and expertise (Teece, 2014).

- **Seize**

Seizing refers to identifying and pursuing business chances that are compatible with the organisation's surroundings, strengths, and limitations (Teece, 2007), implying that market opportunities are successfully exploited and dangers avoided. Capacity begins with a plan that enables the recognition of important knowledge and connects external and internal information and knowledge. It is strongly connected inside strategic decision making, particularly with investment decisions (Kump et al., 2018). This assessment is based on past information and leads to a decision among a number of strategic choices.

- **Transform**

Transforming entails putting choices for new business models, product or process innovations into action by putting in place the necessary structures and routines, providing the necessary infrastructure, and ensuring that the workforce has the necessary skills, among other things. The actual manifestation of strategic renewal within the organisation through the reconfiguration of resources, structures, and processes is referred to as transforming (Kump et al., 2018). Teece (2007) goes on to say that transformation entails costly actions such as changing and modifying

organisational procedures, and that it is not, and should not be thought of as a set of easy and spontaneous tasks. Rather, it asks for a significant structural shift. Kindström, Kowalkowski and Sandberg (2013) and Teece (2007) suggest that transformation as a process serves the objective of preserving competitive advantage over time through continual reconfiguration.

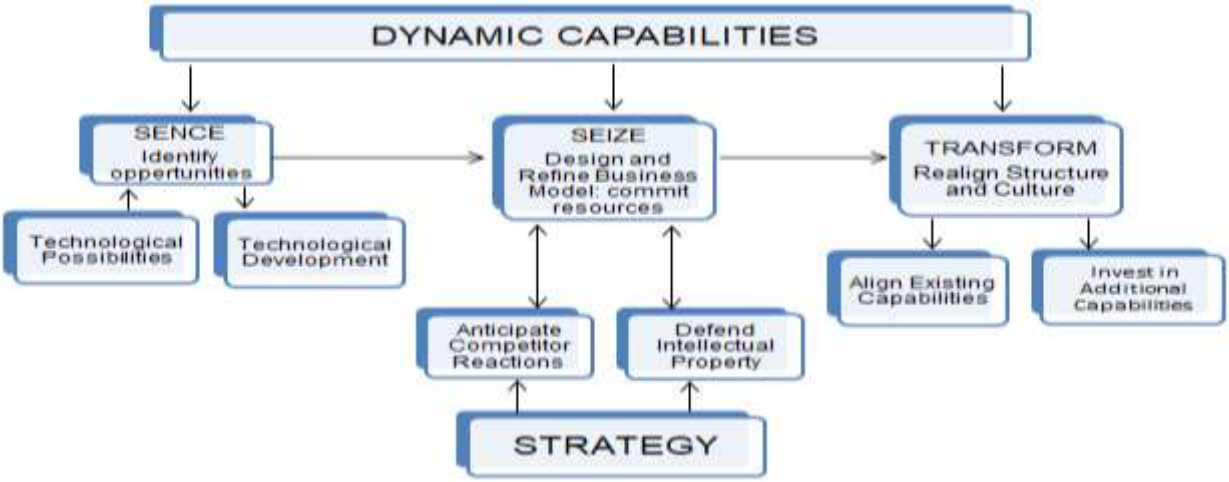

Figure 2.5: Dynamic capabilities framework

Source:Teece (2018)

Figure 2.5 depicts a simplified version of the framework that excludes feedback channels such as those between organisational design and dynamic capabilities. Interdependence is at the core of the dynamic capabilities framework, which is a multidisciplinary business model with dynamic capabilities. The combination of dynamic capabilities and strategy creates and refines a defensible business model that leads organisational change (Teece, 2018). This, in theory, should result in revenues sufficient to allow the firm to maintain and expand its capabilities and resources.

As shown in Figure 2.5, technological possibilities and development are listed as the sensing capability of a firm when identifying opportunities. The current study views technology adoption and use as a dynamic capability which can enable the firms to sense, seize, adapt and transform their business operations, which will in turn improve firm performance and generate competitive advantages for the firm.

2.3.3 Relational view theory

The relational view (RV) theory was proposed by Dyer and Singh in 1998. The vast number of papers referencing Dyer and Singh's original work is one indication of the relational view's usefulness, for instance, based on the Web of Science, there were 2359 citations of Dyer and Singh's (1998) relational view theory between 1998 and 2016 (Huemer, 2014; Li, et al., 2017). The RV theory was developed on the premise that productivity improvements in the value chain may be achieved when trading partners are ready to invest in specialised connections and combine their resources in an unrivalled manner (Wieland and Marcus, 2012).

The theory posits that a firm's vital resources may extend beyond its physical borders creating relational rents should organisations collaborate efficiently (Tescari and Brito, 2018). According to Dyer and Singh (1998), a relational rent is defined as a supernormal profit earned jointly in an exchange relationship that cannot be generated by each business in isolation and can only be formed by the unique alliance partners' joint idiosyncratic contributions. At a fundamental level, relational rents are possible when alliance partners combine, exchange, or invest in idiosyncratic assets, knowledge, and resources/capabilities, and/or they use effective governance mechanisms to reduce transaction costs or allow the realisation of rents through the synergistic combination of assets, knowledge, or capabilities (Dyer and Singh, 1998). Inter-organisational rent-generating mechanisms were studied in depth by Dyer and Singh (1998) who highlighted four sources of relational rents, namely investments in relation-specific assets, inter-firm knowledge exchange routines, the merging of complementary resources, and effective governance mechanisms. The theory holds that through these procedures, businesses may generate extraordinary revenues by cultivating a unique connection with their partners.

The relational view theory further holds that an individual firm's resources and skills are frequently insufficient to meet the difficulties posed by global competitiveness; as a result, in addition to strengthening their own core skills, businesses must seek out opportunities to collaborate with other businesses in order to form relational networks that may help them mobilise external resources. To meet the rising need for comprehensive quality control and lean operations, buyers are collaborating closely

with critical suppliers. Their collaborative efforts to improve efficiency and achieve high-quality management goals strengthened their connection, resulting in a one-of-a-kind, non-imitable interchange of resources and expertise (Biswas, 2019). This breakthrough opened up new possibilities and shifted the focus of the buyer-supplier relationship in academic writing.

Turkmen (2013) proclaims that learning, absorptive capacity, relational capital, and open innovations emerged as a result of the connection and increasing inclination to collaborate in sectors, giving further support for this trend. Most businesses, in the age of globalisation, are unable to cope with rapidly changing market competition using only their own resources and competencies. Firms should maintain long-term relationships with business partners to build relational networks for mobilising external resources, in addition to improving their own core capabilities (De Man, 2004). Meanwhile, as market opening and international division of labour gain traction, internationalising a firm's operations has become a critical strategy for pursuing long-term success and relational rents (Wong, 2011).

2.4 LEGISLATURE FRAMEWORK

The legislative framework refers to the set of laws, regulations, and policies that regulate a company or its activities (Awino and Marendi-Getuno, 2014:104). There are various legislative frameworks that govern the operations of logistics firms worldwide and in South Africa. Some of them include: the International Organization for Standardization (ISO) 28000; ISO 9001; 140001; and the National Environmental Management Act 107 of 1998.

- **ISO 28000 certification**

ISO 28000 requires that the logistics firm’s supply chain security management system be managed as an integrated business process, with its efficacy measured and enhanced on a regular basis (SGS, 2021). It can also assist the logistics firm in connecting security management to a variety of other parts of its operations.

- **ISO 9001 certification**

In the logistics industry, lack of discipline around process execution can lead to costly errors. As such a 3PL's ISO 9001 certification assures its customers that every operational aspect will adhere to stringent quality standards – whether it is in the warehouse, or on the way to a customer, or anywhere in between (Kanban Logistics, 2017).

- **ISO 14001certification**

The ISO 14001 Standard can help logistics firms to evaluate, analyse, and reduce the negative environmental effect of their logistics operations (Handa, 2019). Getting ISO 14001 certification can also help improve the logistics firms' corporate image among their clients by using effective natural resource management and waste management. This will assist them in expanding their clientele as well as identifying new cost-cutting strategies.

- **National Environmental Management Act (NEMA) 107 of 1998**

Environmental laws and regulations play a major role in firm behaviours towards green initiatives. A study by Xia et al. (2021) revealed that environmental regulations such as the command-to-control, market-based incentives and voluntary environmental regulations positively affect an enterprise's green technology adoption intentions. Likewise, the current study posits that the NEMA Act is one of the contributing factors towards the increased adoption in technologies even among logistics firms in South Africa. The Government Gazette (2005) states that the NEMA Act provides for co-operative and environmental governance by establishing principles for decision-making on matters affecting the environment. Thus, by complying with the NEMA Act, firms can improve their corporate governance and invest more in technologies to reduce their carbon footprint and promote the health of the environment.

2.5 CHAPTER SUMMARY

This chapter discussed the top logistics service providers in the world and specifically in South Africa. The logistics industry within South Africa is the backbone that keeps the country together. These companies make use of logistics technologies to remain

efficient and effective. The reviewed literature shows that the logistics sector worldwide is currently under severe pressure as movements have been restricted, placing the logistics sector on the back foot; and highlights that the adoption of logistics technologies and using resources efficiently targets the key strategies of companies' top priorities to improve business performance. Being aware of available logistics technology might impact future decisions made by logistics firms, resulting in increased capabilities. It is inevitable that technologies will be the driving force of this sector, and without the technologies currently used the logistics sector will most definitely collapse.

This study used the RBV and dynamic capabilities theories to explain the possible relationship between technology adoption and use and business performance. The study used the RBV theory to answer the question of how logistics firms can achieve competitive success and improve their performance through the use and adoption of technology. The study views technology adoption and use as a dynamic capability which can enable firms to sense, seize, adapt and transform their business operations, which will in turn improve business performance and generate competitive advantages for firms. The following chapter (Chapter 3) looks at the available technologies and how they have affected firms' business performance in South Africa, Africa, and the rest of the world.

CHAPTER 3
LOGISTICS TECHNOLOGIES' ADOPTION/USE AND FIRM PERFORMANCE

3.1 INTRODUCTION

Logistics firms need to adapt to the changing environment to ensure efficiency. This includes adopting and deploying advanced technologies in their day-to-day logistics activities. So far, the received wisdom from the industry experts and practitioners is that the strength of a supply chain is dependent on the strength of the digital technology implemented in that particular supply chain (Ivanov, 2019). Thus, for logistics firms to improve their firm performance and that of their entire supply chain, it is imperative for them to not only invest in the basic logistics technologies, but they also need to invest in the advanced technologies. This will also help them enhance their competitiveness. Over the years, the use of rapidly advancing technologies in the logistics industry has changed the way logisticians operate worldwide, yet there is scant literature on how the use and adoption of such technologies transforms the logistics industry, particularly in South Africa. The current study assessed how the adoption and use of logistics technology affects the business performance of logistics firms in Nelson Mandela Bay.

The previous chapter (Chapter 2) gave an overview of the logistics industry, and paid attention to the trends including the past, present and future innovations, from a global, African, and South African perspective. Chapter 2 also discussed the theories used to theoretically ground the relationship between technology use and adoption and firm performance. The current chapter (Chapter 3) provides a literature review of the technologies transforming the logistics industry globally and locally. The chapter also discusses the role of technology in transforming logistics firms. Literature on challenges faced when using logistics technologies among logistics firms is also reviewed. The chapter further reviews previous studies on the effect of technology adoption and use on businesses from a broader perspective as well as in the logistics industry and identifies the theoretical gap.

3.2 SUPPLY CHAIN MANAGEMENT AND TECHNOLOGY ADOPTION

The contemporary business environment is dynamic, is characterised by intense competition between supply chains, and customers who demand short product delivery times at low costs. Technology is regarded as the most potent weapon for creating and maintaining supply chain competitive advantages in such a dynamic business environment. (Saberi, Kouhizadeh, Sarkis and Shen, 2018) Deploying the right choice of technologies in supply chain activities and processes can enable numerous opportunities for supply chain member firms. Some of these opportunities include improving firm productivity and profitability which enhance the overall efficiency and effectiveness of the entire supply chain. Adam (2020), posits that technology use in supply chains has been linked to enhanced supply chain visibility because it allows supply chain member firms, such as suppliers, manufacturers, and even logistics firms, to communicate information about orders, inventory levels, and product delivery. Technology in supply chain processes and activities also improves supply chain visibility by allowing companies to track shipments and order status, communicate product design changes as they happen, reduce inventory, transportation, and warehousing costs, and check and monitor available inventory levels, among other things (Chang, Chen and Lu, 2019). Furthermore, technology adoption in supply chains facilitates profitable collaborations between member firms, improves customer service levels, lowers supply chain inventory costs, and facilitates cross-organizational cooperation on complex issues, and is a critical step for business survival as well as the development of a supply chain excellence strategy. (Saberi, Kouhizadeh, Sarkis and Shen, 2018)

Technology adoption is crucial for the success of all businesses, including those in the logistics industry and for an effective logistics technology strategy among logistics firms (Onyshchenko and Yudenko, 2019). Technology use can enable the logistics firms to discern the challenges and opportunities emanating from technological growth, enable them to be more responsive to customer demands, shorten lead times, reduce total logistics costs and provides these firms with the strategic value that enables them to achieve sustainable competitiveness (Choi and Song, 2018). Several industry trends and supply chain disruptions are constantly pushing logistics firms to implement emerging technologies in their operations (Busse and Wallenburg, 2011).

For instance, supply chain disruptions such as those emanating from the current COVID-19 pandemic, which has led to several lockdowns, and shifted most business to be online, clearly emphasise that technology adoption and use is and will remain a crucial trend even for logistics firms. Technology adoption is key for the logistics firms to improve their profitability, market share and enjoy sustainable growth in the market (Onyshchenko and Yudenko, 2019). Some of the emerging technologies discussed in this study include: artificial intelligence, advanced analytics, Internet of Things, robotic process automation, autonomous things, digital supply chain twin, immerse experience, RFID and blockchain. The next section discusses the industrial revolution.

3.3 INDUSTRIAL REVOLUTION

Roberts (2015) argues that industrial revolutions start gradually, and gain momentum over time. So far there have been four industrial revolutions, namely Industry 1.0, 2.0, 3.0 and 4.0. Skilton and Hovsepian (2018) believe that many analysts have observed a transition to systemic machine automation, powered by artificial intelligence into goods and services; living experiences; design and manufacturing capabilities; energy and transportation infrastructure; and changing social and job frontiers. The first industrial revolution with steam engines began in the 1780s, making humans more competitive. The second industrial revolution then began in the 1870s with the advent of mass manufacturing and electric power. The third industrial revolution emerged with the invention of computers and electronics, which made manufacturing more effective (Gleason, 2018). However, the fourth industrial revolution is not only about smart and wired computers and networks, but is much broader in scope. At the same time, waves of further breakthroughs are occurring in areas ranging from gene sequencing to nanotechnology, from renewables to quantum computing (Schwab, 2017). Since human beings have now established the computing capacity to store vast quantities of data, which will in effect allow machine learning, various technological developments are reported to be taking place (Gleason, 2018). Figure 3.1 presents the four industrial revolutions.

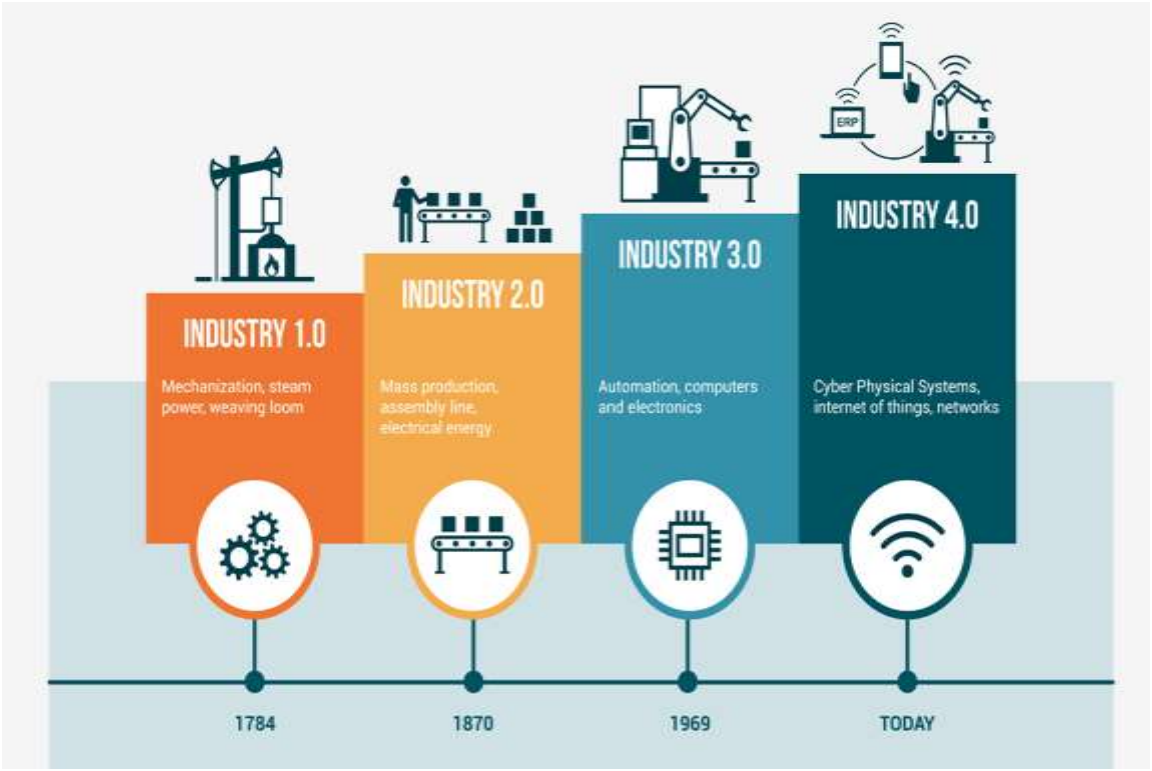

Figure 3.1: Industrial revolution

Source: Adapted from Momentum (2020)

3.3.1 Industry 1.0

Humans have been using tools and machinery since the early ages to help them hunt, plant, move, build shelter and produce products; and these basic tools and machines have historically been powered by muscle strength. As seen in Figure 3.1, the first industrial revolution occurred between 1760 to about 1840. The first industrial revolution was caused by the building of railroads and the invention of the steam engine, which led to mechanical engineering (Schwab, 2017). Agarwal and Agarwal (2020) explain that before the time of the first industrial revolution, wool was used to render cotton spinning and weaving in their home premises by individual domestic workers. But some innovators including Richard Arkwright and Samuel Crompton invented mechanised cotton spinning techniques during the time of the first industrial revolution, which took energy from water such as lakes and this practice greatly improved a worker's production and permanently transformed the textile industry (Agarwal and Agarwal, 2020). Skilton and Hovsepian (2018) argue that over

thousands of years, hydraulic motion from water, wind and fire had been used, from the sailing of a ship to the water wheel. In this era, wood and other biofuels were replaced by coal; and during the time of the first industrial revolution significant technological advances occurred in the metallurgy industry (Agarwal and Agarwal, 2020). The advantages of using coal were that coal mining needed a significantly lesser amount of labour for a certain amount of fuel than cutting wood (Agarwal and Agarwal, 2020). In the late eighteenth century, inventors like Thomas Savery and James Watt invented methods to operate water and steam driven engines, sails, and carriages; for instance, Tomas Savery designed the first steam engine in England in 1698, dubbed the Savery engine, which was used to drain extracted water from coal mines but had limited use as it used air pressure and acted against the concentrated steam vacuum to collect water (Skilton and Hovsepian, 2018).

3.3.2 Industry 2.0

After the first industrial revolution came the second industrial revolution also known as the Industry 2.0. Schwab (2017) explains that the second industrial revolution, which occurred in the late nineteenth and early twentieth century, made mass manufacturing possible, facilitated by the invention of electricity and assembly lines. Skilton and Hovsepian (2018) also point out that the second industrial revolution which was pioneered in the New World, introduced more technological advancements and led to more research into the workforce because of the newly found oil and electricity fuelled machines. The new tools, technologies and machinery electrification allowed the workers to have more technological know-how (Skilton and Hovsepian, 2018). The second industrial revolution was the era of steel which contributed to a transformation in the construction of buildings and the market for steel products (Agarwal and Agarwal, 2020). The growth of the textile industry in the time of the second industrial revolution was gradual though it was not characterised by any significant advances. Some of the key inventions were sewing machine development, the development of the Donisthrope Nip machine, the combination of the Heilmann machine and the traveller development (Agarwal and Agarwal, 2020); and these advances led to greater efficiency. Further innovations later came through the use of shoe making and enhanced product quality by using less energy (Agarwal and Agarwal, 2020).

3.3.3 Industry 3.0

The third industrial revolution also known as Industry 3.0 was described as the computer revolution that began with the production of microelectronics and semiconductors in the mid-1950s until the early 1970s (Skilton and Hovsepian, 2018). One of the first sparks of the third industrial revolution occurred in 1969 with the introduction of the Agency Network for Advanced Research Projects, which triggered Internet creation, and with it the era of transparency (Roberts, 2015). Skilton and Hovsepian (2018) claim that the this started the IT era on a global scale with IBM business software, Hewlett Packard, Microsoft, Sun Microsystems and a host of others, leading to exponential growth into digital technology and manufacturing. The third industrial revolution, driven by the advent of the Internet and which accelerated connectivity and metadata, saw a change in dependence on labour as the primary component of production because the global labour share to capital ratio had decreased dramatically since the early 1980s (Roberts, 2015). This revolution was expected to lesson labour dependence yet creating new job opportunities in the mass manufacturing markets. The completion of this revolution signalled the conclusion of a 200-year economic saga dominated by industrious entrepreneurship, competitive economies, mass labour forces and marked the beginning of a new age by collective activity, social networks and skilled and technological work forces (Rifkin, 2011). According to Rifkin (2011), the Internet which is connecting multitudes of sellers and buyers in a virtual space is almost free, and replaces all of the middlemen—from wholesalers to retailers, with a distributed virtual network of sellers and buyers and eliminating the transaction costs that are marked up at every stage in the marketing process. Roberts (2015) claims that the third industrial revolution has a major effect on the fields of ICT, information, defence, health, education, modern engineering, banking, and administration. As a result of technological developments, advances and the commercialisation of innovative goods and services, these industries began to develop very rapidly.

3.3.4 Industry 4.0

The fourth industrial revolution also known as Industry 4.0 refers to the era of automation and digitalisation, as well as data exchange in manufacturing technologies

ranging from the Internet of Things, big data and analytics to augmented reality and autonomous robots, among others (Tay et al., 2018:1379). Industry 4.0 is a term first coined in Germany at the 2011 Hannover Fair to explain how the management of multinational supply chains will be revolutionised (Schwab, 2017). According to Tay et al. (2018:1384), the Industry 4.0 refers to the "amalgamation of advanced technologies where the Internet is extensively used to support certain technologies and it combines the intelligent machines, human actors, physical objects and manufacturing lines and processes across organisational stages". It establishes smart factories by creating an environment where technological and physical production structures increasingly interact flexibly with each other, and building new types of technical data, systematic systems and high agility value chains (Schwab, 2017).

According to Skilton and Hovsepian (2018), the 4th industrial revolution brought forth new breakthroughs in research, commerce, manufacturing and most importantly, it brought new ways of resolving cross-cutting problems in public policy and social effects from these omnipresent innovations. Technologies under the fourth industrial revolution include the developments of digitisation in the Internet of Things (IoT), virtual reality (VR), augmented reality (AR), quantum computing and artificial intelligence (AI); new physical innovation of materials research in nanotechnology and 3 Dimensional (3D) printing; biological innovation of genome bioengineering, robotic surgery, prosthetics and biomedical devices all have roots that can be tracked back through time (Skilton and Hovsepian, 2018). Most of these developments were quick-tracked and then expanded worldwide with the aid of IoT that offered a new dimension of interconnectivity that had never before been seen (Momentum, 2020; Nagy et al. 2020). Under the fourth industrial revolution, not only are people aware of things that are unfolding halfway around the globe, but markets have also become so interconnected that they have become influenced (Momentum, 2020). The next section discusses Industry 4.0 in logistics.

3.4 INDUSTRY 4.0 IN LOGISTICS

Industry 4.0 is not only limited to smart manufacturing, but it spans across other industries, and logistics is not an exception to this. This is precisely because of the increasing demand for highly customised products and services, which requires firms

to adapt their inbound and outbound logistics activities to the rapidly changing environment so as to stay competitive in the market (Barreto, Amaral and Pereira, 2017). Digitalisation is one way to effectively and efficiently respond to such customer demands. Maslarić, Nikoličić and Mirčetić (2016) indicate that digitalisation has become a significant catalyst of transition in supply chains, and firms need to accelerate their businesses' modernisation to survive throughout the current setting. Skapinyecz, Illés and Bányai (2018) also report that the strategy, design and execution of intra-corporate logistics systems are profoundly influenced by the successes of the fourth industrial revolution, which allow businesses to manage customer demands and purchase orders in real time.

The adoption of Industry 4.0 technology in logistics activities and processes has led to the term Logistics 4.0. According to Barreto, Amaral and Pereira (2017:1248), Logistics 4.0 refers to the adoption and use of technologies when performing logistics activities in order to enhance flexibility, respond to the changes to the market changes, lower the prices of storage and production as well as to enable the firm to achieve higher customer service levels. Huge volumes of data and information technology are present in the logistics industry and will maximise the usage of current infrastructure. Some of the Industry 4.0 technologies deployed in the logistics industry worldwide include the transportation management system, the resource planning, warehouse management systems, intelligent transportation systems, and the use of robots, among others. There are numerous benefits that can accrue to logistics firms that adopt and deploy these technologies in their inbound and outbound logistics activities, and these include: better research, enhanced coordination, architecture, comprehension and efficiency (Maslarić, Nikoličić and Mirčetić, 2016). For instance, using the fourth industrial revolution technologies in logistics activities can significantly improve efficiency gains in logistics firms such as the freight transport and even warehousing firms. Sensors built into products ensure product tracking, fix shipping conditions and facilitate identification of goods at loading and unloading, as well as significantly reducing their time (Skapinyecz, Illés and Bányai, 2018). The next section focusses on technologies transforming the logistics industry both globally and locally.

3.5 TECHNOLOGIES TRANSFORMING THE LOGISTICS INDUSTRY GLOBALLY AND LOCALLY

Demirova (2019), argue that the introduction of emerging technology is a key element which has expanded the logistics scope, both the efficiency of their internal interactions and the efficiency of their external linkages, such as logistics information systems, are important factors and has taken logistics processes to the next level. Above all, Celik (2020) states that the Internet and information and communication technologies (ICTs) are indisputable accelerators of logistics innovation since they allow for information exchange and collaboration among all partners in a supply chain.The key benefit of adopting IoT technology in the organisation is that it enables for full virtualization and integration of supply chain management when correctly applied (Celik, 2020). These technologies promote flows of knowledge and coordination between stakeholders, and facilitate global logistics processes. The next section discusses the technologies transforming the logistics industry globally.

3.5.1 Technologies transforming the logistics industry globally

New and recent technological advancements and the expansion of e-commerce operations have been reported to play a role in transforming logistics firms and forcing them to adapt their approach to logistics. According to Erceg and Sekuloska (2019), today's competitiveness is determined not only by pricing, but also by customer service and delivery time, both of which can be influenced by the use of current logistics technologies. As such, logistics firms are seen as business partners in the global market, and the connection with a logistics service provider is regarded as a strategic partnership (Erceg and Sekuloska, 2019). This could be because of the high level of logistics costs; thus, if firms are to significantly reduce their total costs, there is need to invest in the advanced technologies.

Around 20 years ago, Harold Sirkin of the Boston Consultancy Company, noted, "as the world evolves, and as business is becoming more global, competition is no longer between individual organisations, but it is now between supply chains” (Elliff, 1996:55). Amazon.com has created a robust network of over 328 distribution centres to be able to offer a two-day free shipping service to its prime customers (MWPVL

International, 2018). The result is that nearly 100 million shoppers pay $119 a year to enrol in the prime programme, investing almost twice as much on Amazon compared to the non-prime subscribers ($1,300 vs $700) (Weise, 2018). It is evidently that many customers prefer to buy online, increasing the need for logistics be further developed in each sector, and emphasises the need for increased automation in its operations.

Kott (2021) notes that market globalisation encourages businesses to cater for the most specific needs of their clients and to give added value by, for example, improving the quality of the goods and services they supply. As a result of these actions, businesses have begun to examine their logistics customer service standards and demonstrate their relevance to employees. Logistics firms require new technologies in order to respond swiftly to client requests (Kott, 2021). As a result, in recent years, advanced technologies and systems that enable the management of these types of entities have been developed.

In recent years, China's e-commerce and logistics growth has been more coordinated, promoting the transformation and upgrading of smart logistics, with key e-commerce platforms such as Alibaba, JD, and Suning constructing smart-logistics ecological chains (Liu et al., 2020). The smart-logistics ecological chain is a structure made up of an ecological supplier group, ecological logistics operator, and ecological demand group, with a platform-based operations centre at its heart (Ji, 2008; Chen and Xu, 2011). It is supported by data sharing, credit mechanisms, and the IoT technologies (Liu et al., 2020).

On 20 October 2016, a semi-automated self-driving truck built by Uber’s Unit Otto successfully delivered 51,744 cans of Budweiser beer over a distance of 200kilometers through Colorado, avoiding the busy downtown Denver traffic (Rosenbaum, 2016). Successful distribution is the result of comprehensive work aimed at improving road safety and the capital intensity of transport technologies (Fagnant and Kockelman, 2015). Along with freight transport, vehicle travel has also substantially benefitted from automated driving (Fagnant and Kockelman, 2015). The use of automated vehicles helps enhance effective and efficient distribution of products, minimise the risk of accidents, and can reduce the lead time and delivery times, which in turn reduce the total logistics costs (Fawcett et al., 2018).

Boston Dynamics successfully developed a bipedal, humanoid robot that not only hops successively from platform to platform, but also does backflips (Simon, 2017). At a merely realistic point of view, Amazon has also made significant advances in robotics, designing machines capable of imitating human hands and collecting random objects from a supermarket bin or shelf (Garfield, 2016). The Boston Consulting Group estimates that, over the next decade, the hardware and software costs required to introduce robotics into the workplace will continue to decline (Fawcett et al., 2018). As robotic capabilities expand and costs decrease, more firms will find the integration of robotics into their logistics and supply chain operations economically attractive (Fawcett et al., 2018). However, some experts fear that the use of robots will replace workers on a massive scale, creating endemic unemployment, a potentially worse problem than an aging workforce (Manyika et al., 2017). Indeed, robotics could displace the road to industrialisation for millions of workers in less developed countries (particularly, across Africa and Asia). These concerns are possibly overblown as robotics are poorly adapted to circumstances where complicated judgment is required. More so, robots are considered a weak replacement for labour where output volumes are small (Fawcett et al., 2018). In practice, the importance of technology-driven innovation is easily found in logistics and supply chain management. For example, Walmart is well known for its high investment in IT related to real-time data collection, data storage and computerised data exchange with upstream and downstream partners. As a result, stock turnover has improved, cost competitiveness achieved and a rapid response to customer demand (Choi and Song, 2018).

3.5.2 Technologies transforming the logistics industry locally

South Africa, as one of the leading economies in the African continent, is well positioned to take the lead in lowering the carbon intensity of economic operations through implementing proper design and technology methods and to provide a precedent for other developing countries. Technological advancements impact the logistics firms' carbon emission levels in many forms. For instance, the main effect of technological innovations is that of changes made to the fuel efficiency of the freight vehicle technologies which may affect the carbon content of the used fuels. Goedhals-Gerber, Freiboth and Havenga (2018) explain how some logistics firms in South Africa are working with aerodynamic technologies to improve the fuel efficiency of their road

freight fleets. One such example is the "green Trailer" by Barloworld which uses aerodynamic panels to minimise drag and improve fuel efficiency. Diesel vehicles are growing in popularity for both passenger transport and light commercial vehicles, accounting for 29.5% of new vehicle sales in 2013 (Goedhals-Gerber, Freiboth and Havenga, 2018). According to reports from eNaTis (2020), as of March 2020, about 11 526 922 vehicles were reported on South Africa's National Traffic Information Network. Approximately 69.93% of the overall vehicles recorded were commuter vehicles (motor vehicles, minibuses, motorcycles and buses), whereas approximately 26.3% were freight vehicles comprising medium duty vehicles (LDVs) and trucks (eNaTis, 2020).

Technological advancement is also reported in South African warehouse and distribution centres. For example, the new Cilmor distribution centre of the Shoprite Group in Brackenfell, Cape Town, covers a total area of 123 000m^2 and is regarded one of the most technologically advanced distribution centres in Africa (Supermarket and Retailer, 2020). Many South African firms are investing in different warehouse technologies to strengthen their supply chains. Bhattacharya (2020) explains how South African start-up DroneScan envisages the idea of smart drones zooming up and down the aisles of the stores, accessing the more difficult-to-get shelves, refreshing the inventory and offering some relief to the human workforce. The company manufactures clever devices that can be attached to drones to scan barcodes and automatically updates the central log with the exact location of that product every time it scans a barcode (Bhattacharya, 2020). This enhances information sharing, helps reduce costs and improves customer service levels.

3.5.3 Other key technologies adopted by logistics firms in general

There are a few logistics trends making waves within the logistics industry, namely artificial intelligence, advanced analytics, Internet of Things, robotic process automation, autonomous things, digital supply chain twin, immersive experience, blockchain and RFID (Moreira, Ferreira and Zimmermann, 2018). Cloud computing, automatic identification systems, geographical info systems, distribution requirement planning and enterprise resource planning are also some recent technology adoptions (Kamali, 2018).

3.5.3.1 Artificial intelligence

Artificial intelligence is the creation of computer systems capable of carrying out tasks which require human intelligence. Habeeb (2018) mentions that AI, deep learning, machine learning, and neural networks represent incredibly exciting and efficient computer-based learning methods used to solve many real-world issues. Long (2018) argues that AI is the intelligence that redefines intelligence, the intelligence that is unnatural or simply proven by machines that give a new dimension, change perception and cause disruption. This jargon is accompanied by the ability to perform cognitive functions and simulate human activities better than them, to improve learning and problem solving (Long, 2018). Li et al. (2017) analysed the rapid development of core technologies in the new era of 'Internet plus AI', which is triggering a great change in the models, means, and ecosystems of the manufacturing industry, as well as in the development of AI. Artificial intelligence technology is what gives machines the ability to learn and develop without human help or new programming. Habeeb (2018) explains that AI is an extraordinarily powerful and fascinating technology that will only become more relevant and omnipresent, and will certainly continue to have very significant impacts on modern society.

Continuous advancement of smart cities, smart medical care, smart infrastructure, smart manufacturing, smart robotics, self-driving vehicles, smart phones, smart toys, smart neighbourhoods, and smart ecosystems, to name but a few, creates a broad market opportunity and driving force in terms of new growth of both AI technology and applications (Li et al., 2017). While a terminator-like situation is impossible sometime soon, it will definitely be very exciting to watch the advancement of artificial intelligence technologies and implementations (Habeeb, 2018). Dinesh and Kashmira (2019) claim that being a new technology, there's a large shortage of working manpower having data analytics and data science skills; those, in turn, can be deputed to urge maximum output from computing. As a result of increasing advancement of AI, businesses are reported to lack talented professionals who can match the need and work with this technology and business owners have to train their professionals to be able to leverage the advantages of this technology (Dinesh and Kashmira, 2019).

3.5.3.2 Advanced big data analytics

Big data is revolutionising many fields of business, and logistics analytics is one of them. Although the data that needs to be analysed and handled is highly complex, the initiative to embrace the technology community as advanced data analytics continue to transform a historically fragmented market is worth the effort. Naganathan (2018) argues that the huge increase in the amount of data collected and stored by organisations around the world over the past couple of decades is unquestionable and the ability to access and interpret such data is becoming increasingly important. Nowadays, firms are able to accurately evaluate the social media data and determine their customers' shopping habits, travel destinations, favourite hotels, and mode of travel using advanced information analytics (Naganathan, 2018).

Advanced analytics assists in many areas of logistics and supply chain management such as performance management, order processing, route optimisation, digitalisation of crucial operations, and many more. Operations and supply chain practitioners not only have access to data that is produced constantly from conventional tools such as POS, RFID, but also GPS to a large amount of data created by unstructured data sources such as digital clickstreams, camera and surveillance footage, photographs, social media posts, blog / wiki entries and web conversations (Sanders and Ganeshan, 2015). Currently, supply chains are strongly supported by innovative networking technology–cameras, tags, tracks and other smart devices that collect data in real-time, offering end-to-end demand and visibility of supply (Gunasekaran et al., 2017). Schoenherr and Speier-Pero (2015) claim that supply chain administrators need to handle a large amount of data in order to make recommendations that could help cut costs and increase market choice. However, the data may be incorrectly entered, so it is advisable that new capturing systems are implemented in order to receive optimum results.

- **Performance management**

Logistics firms also use advanced analytics for performance management as it enables them to monitor their level of efficiency and ensure quality in their daily activities (Hunt, 2018). Through monitoring certain indicators along the supply chain,

addressing inefficiencies and ensuring quality expectations are upheld. Quality managers transform data information into actionable results, such as resource consumption optimisation or distribution paths (Feliu, 2020).

- **Order processing capability**

Advanced data analytics can also help create order processing capability for logistics firms. Court (2015) claims that accurate, reliable data incorporation of systems unlocks increased space for new order entry. This leads to more delivered orders, which further increases demand for services within the supply chain.

- **Road planning**

The most tailored paths and times are chosen for execution due to real-time GPS data, weather data, road maintenance details and fleet, and staff schedules combined into a system that looks at past patterns ultimately improving efficiency and order-to-cycle processes. The logistics industry uses advanced data analytics to improve distribution pace and provide real-time control for consumers around orders (Litsinger et al., 2012).

- **Digitisation of critical activities**

Feliu (2020) brings forth that digital technology is used to automate processes through aggregation of rates, routing and partial load shipments. As for the customer experience, the automated front end offers a problem-free experience for consumers and increases internal operating visibility, automating manual procedures beforehand.

3.5.3.3 Internet of Things

The Internet of Things (IoT) is a term used to describe the trend of digitising and customising the delivery of goods and services by capturing, processing and acting on data collected through a network of semi-autonomous interconnected devices (Moreira, Ferreira and Zimmermann, 2018). Such devices allow semi-autonomous operations via analytics and algorithms that are then usually interconnected via the Internet or other kinds of networks such as the cloud. IoT includes electronics,

software, sensors, actuators and connectivity (Ivanov, 2019; Ravulavaru and Kumar, 2017).

Moreira, Ferreira and Zimmermann (2018) argue that there are many examples of successful IoT implementations that can be loosely grouped into the following categories: smart factory, smart home, smart cities (including power grids), and smart farming. Long (2018) indicates that the IoT has provided the rich source of information needed to power smart algorithms, AI and automation technology for about 90% of the world's data generated over the past two years. Nowadays, consumer products, vehicles, durable goods, industrial and service parts, sensors and other everyday objects are combined with Internet connectivity and powerful data analytics skills to enhance productivity (Perwej et al., 2019). The IoT system can also process workflow and transform equipment settings to improve performance (Perwej et al., 2019). With regard to the SC, IoT is ubiquitous and can be adopted to enhance productivity at any stage, from marketing and product development to manufacturing, warehousing, delivery and maintenance. In logistics, tasks such as inventory management, quality control, and routing can be automated, improving their efficiency and productivity (Moreira, Ferreira and Zimmermann, 2018). Perwej et al. (2019) explain how supply chains have been agile for a couple of years; and monitoring products while in-transit, or getting suppliers to turn stock details have been on the market for years. So while it is completely logical that the topic will get a new push with the IoT, it seems that so far its prominence remains limited. Mukhopadhyay (2014) points out that internet access is still a challenge to some parts of the world. More so, the accessibility of the Internet to individuals does not imply that the Internet is accessible to each remote corner of the world (Mukhopadhyay, 2014). Thus, to make it accessible to each and every part of the world, firms including those in the logistics industry need to make huge investments in IoT.

3.5.3.4 Robotic process automation

Over the past few years, robots have increased their level of intelligence and versatility as machine learning and AI have been implemented into the systems. Substantial improvements have been made to robots' agility, while the ability to attach robots through IoT and enhanced safety measures have also been incorporated into

robotic devices (Long, 2018). Logistics firms worldwide adopt and use robots in their logistics operations for effective high-speed picking and sorting of products, letters, parcels, and even palletised shipments in warehouses and distribution centres (Long, 2018). Sandesh (2018) claims that the potential of the interconnected supply chain of robotics remains uncertain, but it presents numerous opportunities for firms in terms of efficiency and output for businesses that require quicker movement strategies in order to remain competitive in the market. In such cases, some robots will be further combined with, for example, truck unloading, order selection, production analysis and product transporting techniques to shorten the lead time and delivery times, thus creating cost and time value advantages for the logistics firm. Despite these opportunities, Rajana (2018) claims that there are many obstacles regarding automated robots, one being that there are many different items within a warehouse, and that warehouses need to be set up to accommodate robotic functions and capabilities. More so, in a country like South Africa where unemployment levels are generally high, deploying robots in logistics firms can face serious employee resistance, due to fear of being replaced by robots.

3.5.3.5 Autonomous things

The modern logistics industry is becoming a centre for innovative robotic technologies. At first it was slow to adopt automation, but in recent years there has been a growth in use of robotic approaches to address logistics problems (Owen-Hill, 2020). Below are ten of today's most important developing applications of autonomous logistics:

- **Warehousing robots**

Owen-Hill (2020) believes that robots reduce the time that workers spend travelling around the warehouse and that having robots bring shelves to the workers instead. Wheeled robots, legged robots, humanoid robots and network sensors are just a few examples of the types of robots that are emphasised as increasingly being integrated across different industries to perform specific functions; however, they have individual behaviours and are individually controlled by a "supervisor," resulting in collaborative limitations (Burke and Ewing, 2015). Technicians have now begun designing control strategies for multi-robot systems and developing an intelligent system to enable

different types of robots to work together by communicating through a wireless network while transporting large objects around a warehouse (Burke and Ewing, 2015).

- **Autonomous picking**

Most warehousing robots these days work by bringing shelves to human workers, who then pick items by hand (Nayab et al., 2019). More and more robots are able to pick items from static shelves without human assistance. Kiva configured workstations using robots to "support picking, replenishing, finishing, value-added services, quality control, and shipping" (Kiva, 2014). This eliminates the need for workers to walk around the warehouse, climb ladders, seek inventory and then bring the inventory to a shipping station (Kiva, 2014).

- **Robotic packing**

Automation is becoming the global trend in manufacturing, and logistics firms are where the packaging process is one of the most industrially used processes. Owen-Hill (2020) states that packing is one of the most common logistics tasks, after all, everything shipped must be packed. Knoll et al. (2019) argue that robots can be used for many of the several activities in packaging industry to improve productivity and reduce total logistics costs.

- **Robot palletising**

Palletising usually involves repetitive actions and items that are too heavy for humans to lift, as such, greater efficiencies and productivity can be achieved when robots are used to perform such tasks ,Dzitac and Mazid, 2013). Owen-Hill (2020) brings forth that there are even specialised palletising robots, and these are usually robotic arms with five degrees of freedom (DoF) as well as a sixth DoF capable of rotating more than 360 degrees, so that the robot can properly orient items on pallets.

- **Robotic ports**

Robotic ports (used to load cargo onto vessels) is one of the newest robotic-logistic applications. The Chinese port is a typical example of an entirely robotised port, which

has been designed by TuSimple, a self-driving truck company that uses robotic cranes and self-driving container vehicles to execute all the tasks of a freight terminal, but without humans on the ground (Owen-Hill, 2020). Mlimbila and Mbamba (2018) posit that adopting and deploying robots helps improve port productivity and efficiency as well as reduce port congestion and waiting time, which in turn reduce total logistics costs.

- **Self-driving vehicles**

According to the World Health Organization report (2018), road accidents cause almost 1.3 million deaths and 20–50 million injuries globally every year (Asirt, 2018). Elgharbawy et al. (2019) also elaborate that automation has the potential to increase road safety, improve fuel efficiency, optimise the use of vehicles, increase productivity of drivers and reduce freight costs. Andersson and Ivehammar (2019) state that autonomous driving can help reduce fuel consumption for long-distance trucks because platooning can be established on the road, resulting in less wind resistance for the vehicles inside the platoon. Automated driving tasks are software elements that interact with the real traffic environment to support or automate human driver tasks given the high mileage and long monotonous distances of long distance trucks, multiple business cases of cooperative automated driving, such as truck platooning, are demonstrated (Elgharbawy et al., 2019). Autonomous vehicles are among the currently developed logistics technologies, and are expected to be introduced gradually (Andersson and Ivehammar, 2019).

- **Last mile drone delivery**

Schenkelberg (2016) explains how teams around the world are working on systems that allow autonomous flying delivery, systems that can bring the morning newspaper, morning coffee or products directly to a current location from a customer’s favourite store. Such drones utilise proven flying technologies, and they may have an autonomous ability to pick up a product and send it to a specific location or address (Schenkelberg, 2016). Kambire, Auti and Barge (2019) add that beginner drones usually do not have GPS, but a number of advanced drones make use of GPS receivers in their navigation and control system. Some of the decent GPS drone

navigation features include: keep spot which helps the drone to retain a hard and fast altitude and positioning location; and Return to Home, a feature which makes the drone know the position from where it was withdrawn, and immediately return to the selected spot at the click of the come back to home button (Kambire, Auti and Barge, 2019).

- **Container loading and unloading**

Container loading is like palletising, but instead of stacking goods onto a pallet, it requires items to be taken out of a shipping container. Consequently, the carrying specifications are slightly different, as the system must be able to hold products from the edge (Owen-Hill, 2020). Specific items must be marked, retrieved, delivered to a drop-off location and eventually positioned safely, thus ensuring improved performance levels and unloading times in a human-like manner (Stoyanov et al., 2016). Stoyanov et al. (2016) argue that a robotic device built to unload products from containers has to overcome many significant technical and technological problems, and such a machine has to be able to accommodate a large range of goods of different sizes, form, weight, texture and content.

- **Sorting**

Sorting is essential at many stages of logistics, but it has traditionally been challenging for robots, which require advanced sensing to differentiate between various products (Owen-Hill, 2018). Lin et al. (2019) claim that for technological advancements such as a machine vision, natural language processing, process management technology and sensor technology, the robot automated sorting device topic reaches a hotspot within the robot culture. Through the use of algorithm, when the rule becomes incorrect, robots will communicate with humans depending on the specific three-dimensional scenario details in real time, and can direct users to provide right rules by expression and after the appropriate rules are received, while robots sorts the item automatically using the programming and execution algorithm built (Lin et al., 2019).

- **Collaborative robot packing**

According to Packaging (2020), specific robotic packaging technology imitates human motions in order to eradicate the human being from the operation without losing the yield of the method. This does not reduce the need for good workers, but instead offers an incentive to eradicate the tedious, unqualified activities that many people consider stressful and unfulfilled to satisfy output needs. With the automation of robotic packaging, a software is programmed to simulate human motions by handling goods, selecting and positioning objects, packing cases and palletising which are are commonplace and secure (Packaging, 2020).

3.5.3.6 Digital supply chain twin

Digitalisation is an ongoing transition toward a digital supply chain, and is gradually changing most business processes. Ivanov et al. (2019) argue that the movement towards the implementation of digital technologies goes beyond the manufacturing sector, the manufacturer network, the consumer network and the logistics firms also need to implement the evolving digital technologies to make the whole SC versatile in non-stop delivery. For this reason, risk management for each SC actor should be the priority in case of more frequent incidents such as natural disasters or manufacturer loss (Wright, Suryanarayanan and Quigley, 2015).

The word "digital twin" has been used to describe the virtual copy. This means that during the product development stage the engineers generate an item, the digital representation of the product is then further enhanced with additional data while the actual product is being produced during its use and maintenance (Ivanov, 2019). A digital twin is a new data-driven view of SC disruption risk management that blends modelling, optimisation and data analytics (Castillo and Garg, 2013). A virtual SC twin is a model that can represent the network state at any given moment in time and allow full end-to-end SC visibility to enhance resilience and contingency planning for testing (Ivanov, 2018). Operations digitisation aims to improve development, SC capacity and versatility through real-time communication and smart, high-resolution data systems (Reddy, Singh and Hariharan, 2016).

Campos et al. (2019) claim that new business models are being established for the high-value manufacturing industries to adapt during the industrial digitalisation process; and the value-added score of the business and categorisation done based on cost and sales are highly dependent on a high value setting. Price is the critical factor in stakeholders and businesses retaining profitability to achieve value from digital twins. More so, consideration of development costs, as well as ongoing digital twins maintenance requirements would require new business and economic models as well as the advantages (Campos et al., 2019). The digital twins is also known for its complex problems.

3.5.3.7 Immersive experience

According to Moreira, Ferreira and Zimmermann (2018), virtual reality (VR) and augmented reality (AR) are two types of computer-generated worlds in the very early stages of their lifecycle. VR is a completely different virtual, immersive world such as those created by Oculus Rift (now known as Playstation) and is typified by headsets (Bardi, 2019). VR is also being introduced into training for logistics and SC employees, for example a forklift operator's VR training system was introduced by material handling equipment manufacturer Raymond Corp (Moreira, Ferreira and Zimmermann, 2018).

AR comprises the layers of digital content in the real world such as those in Google Glass, and provides firms with additional information while completing their tasks in real time. For example, virtual showrooms will allow consumers to learn and experience goods effectively, and through its functions, it gives an impression of being in a physical store, and allows fulfilment by inventory pooling, which is traditionally an online store feature.

Saunders (2020) believes that on the retail side, AR / VR allows customers to connect with items and their apps without even visiting a shop as it also offers customised environments by developing virtual fitting rooms' and virtual charts. It gives businesses the opportunity to experience their products in real time with their consumers.

3.5.3.8 Blockchain

Blockchain technology is one of the recent developments of the technological revolution. Ivanov (2019) explains that a blockchain is essentially a list of records, usually of financial transactions. More precisely, a blockchain is a distributed ledger that holds a list of records stored in a particular (usually chronological) order – these records are collected into small groups called "blocks," similar to pages in a ledger, and the blocks are classified in a linear time order or in what is called a "chain" (Ivanov, 2019). Although blockchain technology holds great promise for applications in a variety of fields, the most promising areas for this technology are disruptive-ready logistics. As a planning system for the management of resources, facilities and information flows, logistics typically involves the integration of complicated information flow, transport, warehousing and security (Liao and Wang, 2018).

Blockchains can present the potential to develop e-logistics. There are three crucial ways for blockchain technology to disrupt and change business models, and these are: (i) authentication of traded goods, (ii) disintermediation, and (iii) reduction of transaction costs (Liao and Wang, 2018). Owing to some intrinsic features, such as data integrity and decentralised operations, the blockchain technology is one of the most exciting innovations in logistics management and optimisation (Perboli, Musso and Rosano, 2018). Blockchain technology could increase the visibility over inbound processes and inventory status of the entire network of producers and warehouses. Perboli, Musso and Rosano (2018) believe that the implementation of blockchain technology in the supply chain is a positive development, ideal for all the different actors involved in the process to benefit. Long (2018) adds that by introducing the blockchain technology to the market, consumers everywhere can access the entire product source, which will satisfy the most important product information needs of the consumer.

3.5.3.9 RFID

Ivanov (2019) believes that digital technology allows for the implementation of smart factories, or dynamic (adaptive) manufacturing and logistics networks, respectively. Radio frequency identification (RFID) is a technology based on the use of tags

emitting and receiving identification in the form of a specific serial number of an object via wireless radio signals, and on readers collecting the data transmitted by the tags and transmitting it to the company's information system for further evaluation and analysis (Gale, Rajamani and Sriskandarajah, 2009). By adopting RFID technology, the logistics firms can enhance their supply chain visibility and that of their customer needs, efficient business processes, reliable and accurate order forecasts, improve productivity, reduce operating costs, improve order tracking, encourage counterfeit identification and prediction of theft (Gale, Rajamani and Sriskandarajah, 2009).

RFID includes the authentication to reduce channel volume and enhance forecasting and planning capabilities (D'Avanzo et al., 2004). Varma and Khan (2014) explain that as the latest form of artificial security tags, the RFID tags play a significant role, which can easily be integrated with existing chains. RFID helps the organisation to avoid duplication of items, since the tags are unique and authenticated, it can also reduce the chances of fraud generated by entry manipulation and customer authorisation (Varma and Khan, 2014). Bhandari (2019) points out that RFID has a significant impact on the logistics and supply chain of many industries, and some of these impacts include the following:

- RFID helps retail firms to boost their movement of goods within the supply chain and become more profitable.
- Boosts manufacturers' ability to better manage rates of inventories.
- Improves the complex Defense Operation Distribution System. Improves postal services' complex tracking and distribution operations.
- Enhances monitoring, logistics and planning activities, and helps public transport agencies to implement automatic collection of tolls on a large network of highways

3.5.3.10 Cloud computing

Kamali (2018) defines the term "cloud" as a larger network access that allows computer resources to be delivered through a network (e.g. the Internet). Cloud computing is a new information technology model that enables managers to access and analyse data with less effort by providing ubiquitous, accessible, on-demand network access to a shared pool of customisable computing resources (Mell and

Grance, 2011). In other words, cloud computing enables businesses to share information and resources, and enables them to collaborate more effectively (Wang et al., 2010). According to Ferreira and Moreira (2012), many research studies have pointed out the numerous benefits of this innovative technology.

Cloud services are becoming more important in IT and they are regarded as a method of boosting productivity, efficiency, and cost savings. Cloud-based services can improve the dependability and scalability of an organisation's systems (Cloud Computing 101: Scalability, Reliability, and Availability, 2020). Many nations, both established (the United States, the United Kingdom, Singapore, the European Union, and Japan) and emerging (Thailand and Malaysia), are embracing new technology like cloud computing to enhance productivity and customer satisfaction (Liang et al., 2017; Almarabeh et al., 2016).

In terms of complexity, the cloud computing environment gives firms the opportunity to instantaneously pool resources to meet the workload; nevertheless, for firms without technological experience and technology experts, the adoption of cloud-based services may be a difficulty (Ali et al., 2020). As a result, the complexity of cloud computing innovation solutions is essential for public organisations that are hampered by a shortage of ICT-skilled personnel and change-resistant civil workers (Ali et al., 2020).

3.5.3.11 Automatic identification systems

Automatic identification systems which comprise different devices employed as tracking systems to give precise information on particular data in warehousing have become a standard technology in logistics operations (Kamali, 2018). Examples of such technologies include the barcoding and voice recognition technology (VRT). Bar coding is an automatic product identification system that uses a scanner to identify inventory goods during storage, retrieval, pickup, inspection and dispatch (Radadiya, 2017). This technology offers a number of advantages, including minimising human error since the symbols that indicate stock information are unique, and reduces the need for paper work, shortens order processing time, and increases logistics system productivity through speed, precision, and dependability (Closs and Kefeng, 2000).

Voice recognition is a technology that uses radio frequency (RF) scanning and is based on automated identification (AutoID). It is utilised in the current warehouse management systems (WMS). The technology allows for vocal connection between the worker and the gadget in order to locate goods (Kamali, 2018).

3.5.3.12 Geographical information systems

Kamali (2018) explains that Geographical Information Systems (GIS) is a technique for visualising a specific position of any item on the planet based on data contained in geographic databases. This is done using physical maps of the earth's surface, the arrangement of the earth's inner surface, or the layout of streets or highways. GIS is essentially linked with GPS in supply chain and logistics operations for tracking and tracing of the consignment position, to the extent of providing the specific details about the road or street in a given city where the consignment is located (Bhandari, 2017).

3.5.3.13 Distribution requirement planning

Distribution requirements planning (DRP) is a logistics technique that uses IT to provide a sophisticated planning strategy for various distribution stages. According to Bhandari (2017), the system is capable of assisting in the consolidation of supplies to many sites dispersed across a large geographical region, thus decreasing freight costs. In addition, the system provides several benefits in terms of enhancing inventory visibility in the supply chain and logistics, thereby reducing inventory levels and warehousing space (Kamali, 2018).

3.5.3.14 Enterprise resource planning

According to Kamali (2018), enterprise resource planning (ERP) systems are computer-based systems used to process transactions and integrate all business activities such as finance, project management, quality control, human resources and manufacturing in the base of real time. Bhandari (2017) explains that ERP is adopted to improve the processes of logistics and inventory controls and to meet customer demands in the competitive market. In today's market, many large companies are adopting ERP as an efficient business solution specifically designed to overcome the

unique challenges in the logistics functions. The next section discusses the role of technologies in transforming logistics firms.

3.6 LOGISTICS 4.0 TECHNOLOGIES AND THEIR ROLE IN TRANSFORMING LOGISTICS FIRMS

Johnson (2020) stated that the COVID-19 crisis has posed an important problem for shippers and has made firms seek answers to the question of whether it is the time for exposure programs to stop, pause or accelerate. This question is relevant because many of the triggers for innovation in logistics technologies are coming into a clearer focus during the current pandemic. According to a new McKinsey Global Survey of executives, organisations have sped up the digitalisation of their customer and supply-chain contacts, as well as internal activities, by three to four year (McKinsey, 2020). For most essential jobs, including truck drivers and staff at pick-up and distribution sites, such as warehouses, shops or medical facilities, social distance is an obstacle. Supply chain and logistics executives should make it a priority to promote these connections as much as possible through technologies so as to avoid COVID-19 infections.

Conn (2020) advises that electronic systems tend to reduce human interaction, and that repetitive tasks such as gate check-ins and paperwork signing can transfer to the cloud with a SaaS (Software-as-a-service) system. Often, proactive alerts are a safe idea for the last-mile deliveries to end users, monitoring technology helps them to see when the package reaches their building, as well as when it arrives (Conn, 2020). COVID-19 has turned online shopping from a luxury service to a necessity worldwide. With a large increase in online sales worldwide, social movements being greatly reduced, it is prevalent that online sales will thrive even after the pandemic has passed. COVID-19 sparked a strong drive to launch robotic use and science even in logistics firms. According to Kunovjanek and Wankmüller (2021), reports have been made of firms using robots to clean areas and distribute meals to those under quarantine (Thomas, 2020). For instance, during the current COVID-19 pandemic, drones have been used to transport products to customers. This worldwide pandemic assisted greatly in the rollout of technology and it certainly proves that technology is more of an assistance than it is a threat, even in logistics firms.

The use of technology in firms' operations is facilitated by the present globalisation, increased intensity of competition, the increasing climate change concerns, and the unending customer demands. As such, customers today no longer only pay attention to time and cost, but also to the sustainability of a logistics firm; and this is compelling logistics firms to adopt and deploy technologies in their daily activities (Maslarić, Nikoličić and Mirčetić, 2020). Barreto, Amaral and Pereira (2017) identify the Logistics 4.0 technologies applied in logistics firms as: 1) Advanced transport systems, 2) Warehouse management systems, and 3) Packaging technology. These technologies play different roles in transforming the logistics firms. A study by Onyshchenko and Yudenko (2019) investigated the effect of developments on the performance of logistics companies, and found that innovations play a crucial role in delivering quality services to businesses and growing their productivity. The next sub-section discusses the logistics technologies adopted by firms.

3.6.1 Transport technology

The introduction and proliferation of driverless cars have radically changed the systemic systems, including freight transport (Skapinyecz, Illés and Bányai, 2018). Such systems play the following roles in logistics firms: they help minimise fuel consumption and reduce carbon emissions, and they eliminate the need for mandatory carriage rest periods which shortens lead times and delivery times (Skapinyecz et al., 2018). Barreto, Amaral and Pereira (2017) explain how a TMS is essential for a firm, and cite the following roles. For instance, TMS enables logistics firms to use GPS technologies, to identify their own vehicles effectively when they are on the route, track freight traffic, negotiate with carriers, combine shipments and use the advanced capabilities of the network to communicate with an Intelligent Transportation System (Barreto, Amaral and Pereira, 2017). Every year, the use of TMS technologies in logistics firms continues to grow and, most likely, more businesses will be implementing such solutions in the near future in an attempt to enhance their overall transit management and customer satisfaction (Barreto, Amaral and Pereira, 2017).

3.6.2 Warehouse technology

Barreto, Amaral and Pereira (2017) argue that adopting the philosophy of Industry 4.0 would make significant improvements in the way a warehouse works these days. Precisely, the incorporation of 'digital' management during the proper acceptance and application of WMS will facilitate warehouse operations' compliance with the Industry 4.0 model into future needs of inbound logistics (Barreto, Amaral and Pereira, 2017). Using WMS can also allow logistics firms to efficiently manage their inventories, monitor and control their warehouse activities in real time, enable tracking of material till they reach the last mile, and encourage centralisation of warehouse management activities since this systems unifies material handling equipment for reduced costs and easy use (SCjunction, 2017). Warehousing bots are also part of the technologies that play a role in transforming the logistics firms. Examples of such bots include the trailer and container parcel bot used by DHL to unload items from a container, and the goods to picker bot used to select and pick a single item (Van Rensburg and Hove-Sibanda, 2021). All these warehousing technologies play a significant role in logistics firms by reducing the total logistics costs, and improving firm competitiveness of such firms.

3.6.3 Packaging technology

The rapid increase in packaging and its value leads to the continual development of methods and ways of production. According to Wyrwa and Barska (2017), the need to modernise and enhance the quality of packaging introduced in the market with emerging developments in this area has resulted in technological innovation and intensified competition seeking to increase the versatility of packaging. Packaging also plays a vital role in shielding packaged goods from environmental factors, impacting the quality of food items, making shipping, storage and drug dispensing simpler (Wyrwa and Barska, 2017). Abdollahbeigi, Salehi and Shahidisadr (2013) claim that packaging and design sells the package, and advertising keeps up the image of the brand with the concept of a product for a customer being prejudiced by the physical interaction made with the item. Thus, efficient and successful packaging can improve sales. Modern packaging increases food products' shelf-life, and improved storage, while refrigeration chain techniques enable firms to transport goods over longer distances (Abdollahbeigi, Salehi and Shahidisadr, 2013).

There are certain standards in logistics that must be adhered to in order to maintain flow throughout the chain; these are logistics units of any type that must be recognised and monitored along the entire supply chain, defined for storage or transportation purposes (Andrzej 2016). The method of constructing a logistics unit includes: inventory selection; putting a few small objects in larger units; standardisation; grouping of products in terms of shapes and sizes; allowing the use of mechanical means of handling; and modification of the unit for stacking. Using packaging technology enables logistics firms to fulfil the primary functions of packaging, such as security, durability, efficiency, convenience / practicality and presentation / demonstration, and in particular for food, food health and prolonged shelf life. The next section focuses on the challenges of implementing technologies in logistics firms.

3.7 CHALLENGES OF IMPLEMENTING TECHNOLOGIES IN LOGISTICS FIRMS

The use of these technologies will drastically minimise the amount of labour required by humans at each stage of the supply chain. Human-operated processes and decision-making are being replaced by technology. Despite the fact that technology is a major driver in the industry, logistics companies face and are subject to facing a variety of risks. Automation, digitisation, and networking technology necessitate significant infrastructure, implementation, and maintenance costs, as investing in new technologies entails a high level of financial risk (Kodym, Kubáč and Kavka, 2020). This is because organisations are not aware of the processes that will be economically beneficial in the long run and those that will not (Kodym et al., 2020). Gunasekaran (2009) states that “the greatest challenge faced by firms when implementing technology towards achieving an integrated supply chain management strategy is the significant change in internal culture (employee mindset) that is required to make the supply chain redesign successful”. When it comes to SCM and IT integration, there are many other concerns to consider. Some of these concerns include: the utilisation of much needed IT technology, the availability of competent and skilled workers, and the time required to develop and make IT operational (Nucciarelli and Gastaldi, 2008).

According to Nibusinessinfo (2016), common problems with technology application implementation include: suppliers and partners being unwilling to compromise; staff

struggling to adjust to new processes and tools; lack of practise and training prior to implementation; communication issues both internally and externally; customers' worries, issues, and unsatisfactory experience. All of these risks can be reduced by doing a risk assessment regarding the participation of all stakeholders. Risk management is a systematic mechanism for managing an organisation's risks or threats so that it can recognise events that may have unfavourable or damaging consequences and determine the best course of action for identifying, assessing, understanding, acting on, and communicating risk issues (Heinz, 2010). The goal of the risk management process is to identify and assess risks so that they may be clearly understood and effectively managed (Kodym, Kubá and Kavka, 2020).

3.8 ASSESSMENT OF PREVIOUS LITERATURE ON THE EFFECT OF TECHNOLOGY ADOPTION/USE ON LOGISTICS FIRMS AND THE THEORETICAL GAPS

Modern technologies mean developments for the consumer companies, even though they are not unique to the supplier or industry, the reception and acceptance of innovation have been widely studied for decades, though mostly in the sense of technology, not technologies (Vaittinen, Martinsuo and Ortt, 2018). According to Ali et al. (2020), with the emergence of resource sharing concepts which include cloud computing, this notion has gradually expanded in the mainstream information and communications technology sector over the past decades. Ali et al. (2020) explain how Cloud technology leads to a transfer from locally installed applications to Internet-based services that are accessible at any time and place, offering resource scalability as needed. Cloud computing brings forth so many advantages, including keeping files backed up. With the current pandemic Cloud computing has proven to be very effective especially since many people are currently working from home or remote offices.

Maqueira-Marín, Bruque-Cámara and Minguela-Rata’s (2017) study explains that IT adoption and environmental factors affect the implementation of a technology within a society’s external agents such as the public authorities, product providers or academic institutions and internal control. Thus, if there is an appropriate critical mass of

adopters, favourable network externalities support connectivity, learning and testing processes.

Mathauer and Hofmann's (2019) study investigated the effects of different technology access modes on the integration of technological innovations among logistics service providers. Using a qualitative approach to collect data from seven logistics service providers, their findings showed that technology access modes (make, buy, and ally) prejudge the integration process's success in terms of technology acceptance, as well as process quality, speed, and integration costs. Their findings further identified factors related to technology, business, climate and relationships as the moderating factors of the relationship between technology access modes and integration of technological innovations among logistics service providers

A study by Cichosz, Wallenburg and Knemeyer (2020) researched digital transformation at logistics service providers, paying attention to barriers, success factors and leading practices. They found that the logistics service providers mainly struggled with digital transformation due to the complexity of the logistics network and lack of resources. Another study by Hao et al. (2020) investigated the factors which influence the adoption of green technology, particularly automatic warehousing systems in Chinese logistics firms. Their results from a partial least structural equation modelling analysis cited operational performance, firm size, technological turbulence and the influence of business partners as some of the key factors influencing logistics firms' adoption of automatic warehousing systems in their operations. Hao et al. (2020) further emphasise the need for decision support for firms to adopt green technologies in their operations.

Masudin et al. (2020) conducted a literature review to assess the RFID adoption in warehousing and inventory management and how it affects organisational performance. Their results reported that RFID adoption in warehousing and inventory management improves organisational performance. Their study precisely showed that the application of RFID in warehousing and inventory management increases sales, enhances quality inventory control, optimises stock turnover which in turn improves warehousing efficiency, and ultimately improves organisational performance. Onyshchenko and Yudenko (2019) point out that logistics firms require constant

development and improvement, as well as an in-depth study of all possible factors influencing the adoption of each innovation. Their study also found that adopting and applying technologies in firm operations helps to ensure sustainable growth of the company and consolidate its competitive position in the industry.

Based on the previous studies above that were assessed, many gaps can be identified. Firstly, most of the literature available focuses on first world nations such as America, China and many other foreign countries. Only a few studies done have focused on the South African situation. The current study sought to close this gap in research by assessing logistics technology adoption and use, and how it affects the business performance of logistics firms in a South African context.

3.9 CHAPTER SUMMARY

Firms are successfully realising the importance of adopting innovations and technologies in their business operations. The emergence of new technologies successfully used by logistics firms can significantly increase a firm's effectiveness. Logistics industries are changing, and the adoption of new technologies in business models cannot be overemphasised. This chapter discussed the technologies adopted by firms locally and globally. From the reviewed studies, it is evident that firms have begun embracing robotics, automatic warehousing and transport management systems, among others. The current chapter also discussed the role played by technologies adopted in logistics firms. The chapter also identified the challenges faced when implementing technologies in firm operations. Previous studies were assessed on the effect of technology adoption or use on performance of firms, and theoretical gaps were highlighted. The next chapter (Chapter 4) focuses on the research methodology of the study.

CHAPTER 4
RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

The previous chapter (Chapter 3) reviewed literature on the technologies transforming the logistics industry and their effect on business performance. The current chapter discusses the research methods used to address the research problem and objectives of this study. The chapter particularly discusses the research philosophy, design, and approach. It also discusses the sample design, clearly identifying the target population, the sampling techniques and sample size. The chapter further presents the data collection procedures and data analysis techniques used in this study. Validity and reliability are also discussed in this chapter. Finally, the chapter also discusses the ethical considerations and limitations of the study. The next section focusses on research philosophy.

4.2 RESEARCH PHILOSOPHY

Kirongo and Odoyo (2020:36) defined a research philosophy as the assumptions, beliefs and knowledge about the nature of the phenomena or reality being studied. The current study assumes that the adoption and use of technology in the activities of a logistics firm can influence its firm performance. There are various research philosophies from which a researcher can choose. The choice of a philosophy depends on the extent to which knowledge about the phenomena under investigation is available (Zukauskas, Vveinhardt and Andriukaitiene, 2018). Some of the common philosophies used include: interpretivism, pragmatism and positivism. The pragmatism research philosophy combines objective and subjective reality observed about the research phenomena under study, and provides the basis for the mixed research approaches (Creswell, 2002). A pragmatic research philosophy was not considered since the current study only required quantitative data to address the research problem and objectives. The next section focuses on the interpretivism research philosophy.

4.2.1 Interpretivism research philosophy

Interpretivism is a philosophy associated with bias, since it assumes that humans cannot be separated from their knowledge (Collins, 2010). It also assumes that the qualitative data to be collected depends on a specific context, values and viewpoints of the participants (Alharahsheh and Pius, 2020). This makes it difficult to generalise findings from qualitative data to a larger population setting. Unlike the positivism research philosophy that has absolute and universal laws generalised to every context, the interpretivism research philosophy involves conducting in-depth enquiries to gain rich insights about the specific research phenomena under investigation (Saunders, Lewis and Thornhill, 2012). Researchers that follow an interpretivism research philosophy are able to draw deep insights and conclusions from the gathered and interpreted qualitative data (Alharahsheh and Pius, 2020). This philosophy is associated with high validity since it relies on personal contributions of participants which vary from one context to another. The interpretivism research approach was not considered in the current study, since the research problem and objectives of the study required objective facts to be observed about the technology adoption and use, and how these influence firm performance of logistics firms, in a South African context.

4.2.2 Positivism research philosophy

Contrary to the interpretivism research philosophy discussed above, positivism is a philosophy that considers facts and regularities that can be measured or observed about the research phenomena being studied (Saunders et al., 2012). This philosophy works with observable reality within the society and enables the researcher to generalise research findings to a broader population (Alharahsheh and Pius, 2020). The positivism research philosophy has often been criticised for relying on the status quo and generalisations which makes it difficult for researchers to gain in-depth insights from individuals on research issues under investigation (Scotland, 2012). Despite these criticisms, a positivism research philosophy was deemed suitable for this study. This is because following a positivism research philosophy enabled the researcher to gather credible quantitative data on how technology adoption and use is currently transforming the logistics industry in the NMB. More so, following an interpretivism research philosophy enabled the researcher to test the proposed linear

relationship between technology adoption and use and firm performance. The next section focuses on the research design.

4.3 RESEARCH DESIGN

Wilson (2010:102) describes a research design as a comprehensive structure or strategy that helps guide the researcher through the research process and the researcher thus has greater chances of achieving the study objectives. It is the overall strategy to link the conceptual research problems with the actual (and achievable) empirical research, and it outlines the procedure on the data needed, along with the methods to be used to collect and evaluate this data, and how all of this can address the research questions (Grey, 2014). Robson (2002) points out that there are three possible forms of research designs, namely: exploratory, descriptive, and explanatory (also called causal), and further classifies the research structure based on the research area's intent, since each concept serves a different end intent. Figure 4.1 presents the three common research designs used in supply chain and logistics management research.

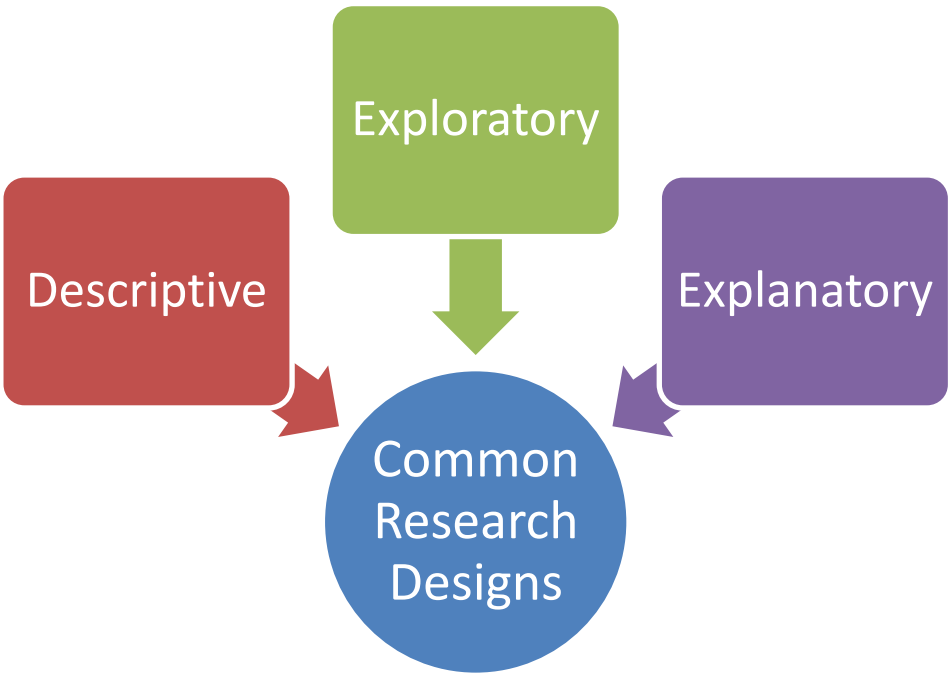

Figure 4.1: Common research designs

Source: Adapted from Robson (2002)

4.3.1 Descriptive research design

As shown in Figure 4.1, descriptive, exploratory and explanatory research designs are some of the common research designs used in primary research. Marczyk, DeMatteo and Festinger (2005) refer to descriptive research as valuable in that it can provide essential information about the typical sample member or participant. Specifically, a researcher may identify the average participant, or average performance of a participant, or that of the particular group being examined by collecting data on a large enough number of people (Marczyk, DeMatteo and Festinger, 2005). Descriptive surveys or normative surveys are often conducted as a preliminary phase to be followed by more rigorous enquiries conducted using more comprehensive research approaches such as exploratory and explanatory research designs (Singh, 2006). In this study, a descriptive research design was used to describe the sample profile, as well as help achieve objectives that sought to identify the emerging technologies currently transforming the logistics industry. This approach was also used to describe the role of technology adoption and use in the logistics industry.

4.3.2 Exploratory research design

Sekaran and Bougie (2016) explain that usually, exploratory research questions are formulated where: i) not much is known of a given phenomenon; ii) the study findings are ambiguous or have significant limitations; iii) subject matter is extremely nuanced; or iv) insufficient evidence is available to direct the construction of a theoretical framework. In support, Saunders et al. (2007) also state that exploratory research is carried out when there is not enough information about a phenomenon or where a topic has not been clearly identified. Exploratory research also uses qualitative approaches, such as informal conversations (with participants such as the customers, staff, and managers), interviews, focus groups and/or case studies to collect data (Sekaran and Bougie, 2016).

4.3.3 Explanatory research design

According to Boru (2018), that explanatory analysis searches for explanations and causes of a research phenomenon under study; and offers evidence to support or refute a hypotheses or theory. It uses quantitative data to explore, explain and

disclose those relationships between various aspects of the phenomena under review. This study used both descriptive and explanatory research designs. The descriptive research design helped to describe respondents' and surveyed logistics firms' information collected in the study. It has also been used to describe the technologies adopted and used, the main challenges as well as the role of technology adoption and use in transforming the logistics industry, within the NMB, South African context. The explanatory research design was used to explain the hypothesised effect of technology adoption and use on business performance of logistics firms surveyed in this study.

4.4 RESEARCH APPROACH

A research approach is focused on the essence of the issue being discussed in the study (Chetty, 2020). Generally, there are two fundamental research approaches, namely: qualitative and quantitative. A qualitative research approach involves conducting naturalistic, subjective and in-depth enquiries about the phenomena under study using a relatively small sample size of participants (Ahmad, et al., 2019). Malhotra (2010) adds that this approach provides in-depth and rich insights and understanding of the problem being investigated from analysing texts, words, and themes drawn from the gathered data. It is characterised by discovery, induction, exploration and generating hypothesis theory, researcher bias, and no generalisation of the findings because of the smaller sample size used (Johnson and Onwuegbuzie, 2004). A qualitative research approach helps researchers to answer the "why" of the research phenomena under investigation, and helps researchers to obtain highly valid findings (Ahmad et al., 2019).

Contrary to the qualitative research approach, a quantitative research approach is objective in nature. It makes use of numbers and hard facts to address the research problem and achieve the research objectives (Jonson and Onwuegbuzie, 2004). Using a quantitative research approach enables the researcher to generalise the research findings to a broader population (Ahmad et al., 2019). The current study followed a quantitative research approach and used a structured questionnaire, given the nature of the problem under investigation and the need for generalising its findings from logistics firms in NMB to other South African firms in the logistics industry across the

country. This also enabled the researcher to observe the effect of technology adoption and use on firm performance of logistics firms.

4.5 SAMPLING DESIGN

A sample design involves deciding on the target population, sampling frame, technique and determining the sample size (Kothari, 2004). Some sample designs are generally more reliable and simpler to implement than others. A sample design that should be correct and suitable for the research analysis must be selected / prepared by the researcher. Figure 4.2 outlines the steps to sampling design.

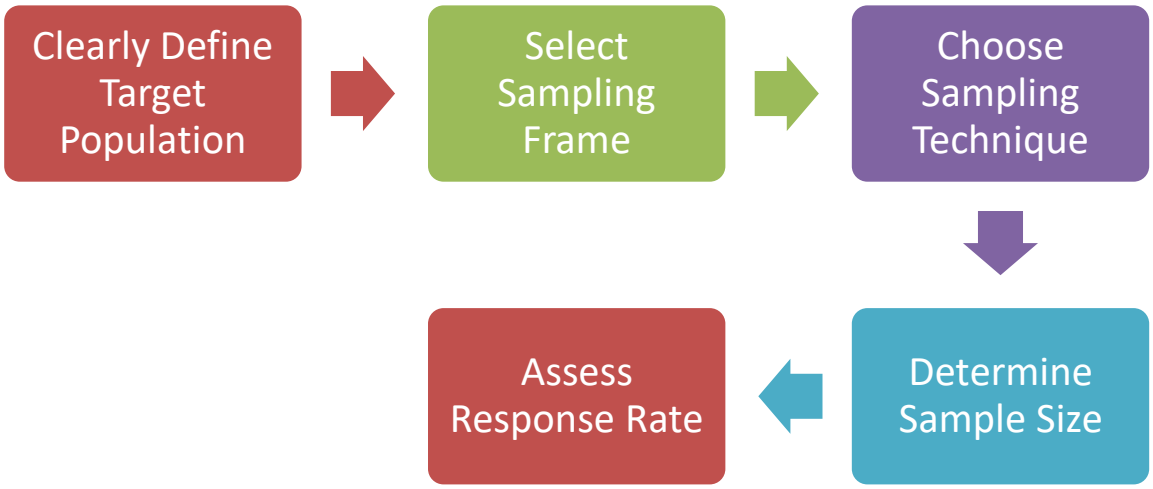

Figure 4.2: Sampling design stages

Source: Taherdoost (2016)

As shown in Figure 4.2, sampling design involves five stages. These include: clearly defining a target population, selecting an appropriate sample frame, choosing a suitable sampling technique, determining an appropriate sample size and assessing the required response rate. All these stages are crucial to ensure that the problem statement is fully addressed and that the research objectives are achieved using reliable data.

4.5.1 Target population

According to Leavy (2017), a population is a collection of elements or the total number of possible human participants in the chosen context. In some cases it is impossible to survey the entire target population due to time and cost constraints, especially where the target population is large, and where it covers a large number of geographical locations (Sekaran and Bougie, 2016). The purpose and scope of the study play a crucial role in identifying the target population (Sekaran and Bougie, 2016). In this study, the target population was comprised of all logistics firms, precisely all the transport, warehousing and packaging firms in the NMB boundary. A total of 59 transport and warehousing logistics firms were identified in the *Nelson Mandela Bay Business Chamber Directory*. A further 10 packaging logistics firms was also identified in the *Nelson Mandela Bay Local Business Directory*. As such, the total targeted logistics firms in NMB for this study were 69 (i.e. 59+10).

It should be noted that the study only gathered data from middle management, including managers involved in logistics, transport, fleet, controllers, stores, warehousing, inventory, and operations management, as the respondents of this study. These managers completed the survey regarding technologies transforming the logistics industry in NMB. This sample population was selected since these managers are likely to be better placed and more knowledgeable regarding the types of logistics technologies used, as well as the challenges, role and effects on business performance.

4.5.2 Sampling procedure

It is unlikely that a researcher should be able to gather data from all cases in order to address research questions. There is a need, therefore, to pick a sample, with the whole set of cases from which the researcher's sample is extracted being called the population (Taherdoost, 2016). Researchers apply sampling methods to reduce the number of data points since they don't have the time or funds to analyse the whole population (McCombes, 2021).

4.5.3 Select sampling frame

Kothari (2004) defines a sampling frame as the list or database from where the basic units, or a group or cluster of such units, elements, participants or respondents can be selected. Sekaran and Bougie (2016) explain how sampling frames work, and cite a telephone directory as a typical example of a sampling frame. The current study identified the transport and warehousing firms from the Nelson Mandela Bay Business chamber database. A further 10 packaging companies were found in the Local Business Directory of Nelson Mandela Bay.

4.5.4 Sampling technique

Kothari (2004) indicates that the respondents selected constitute what is technically called a 'sample' and the process of selection is called 'sampling.' Choosing the most suitable sampling methods in a quantitative sample is one of the biggest decisions. There are two broad sampling methods, namely probability and non-probability sampling (Hove, 2015). Probability sampling provides every member of the target population with a known and fair chance of being selected. Probability samples usually use simple random, stratified, systematic and cluster/area sampling (Landau and Everitt, 2004).

i. ***Simple random sampling***: This is a probability sampling technique where each item in the population has an equal chance of being included in the survey and where each respondent has a fair and known chance of being chosen in the sampling process (Bhushan and Alok, 2017).

ii. ***Stratified sampling***: In stratified sampling, the researcher divides the population into different classes called strata or into homogeneous subgroups (Nickolas, 2021). In this technique the population is devised into a number of non-overlapping subpopulations or strata, and from each stratum sample elements are picked (Bhushan and Alok, 2017).

iii. ***Systematic sampling***: This technique selects respondents using a particular system, by choosing every n^{th} respondent. According to Bhushan and Alok (2017), the most realistic way of sampling is to pick every 10^{th} name in an index, or every 15^{th} shop on one side of a street, among other things.

iv. ***Cluster sampling***: This is a multi-stage sampling technique, with pre-existing clusters being randomly chosen from the population. Second, elements are sampled in each cluster. For example, if the research population comprises all college students who engage in activism clubs, a researcher could get a list of all universities with such clubs (Leavy, 2017).

Unlike probability sampling, non-probability sampling is based on researcher judgement which leads to bias (Perla and Provos, 2012; Ormair, 2014). Non-probability sampling uses subjective methods of selecting respondents from a target population, and is generally easy, fast, and economical (Landau and Everitt, 2004; Showcat and Huma, 2017). Non-probability samples use convenience, judgmental and quota sampling techniques.

i. ***Quota sampling***: For many sub-populations, sampling is done before a fixed number of units are chosen (Etikan, 2016). There is no population list, but a quota is created, generally based on census data, and it is up to the interviewers to select how and where they will locate the respondents (Elder, 2009).

ii. ***Judgmental sampling***: This sampling technique narrows potential participants down to only including experts within a study. Judgmental sampling calls for special measures to identify and access individuals that do have the information needed (Sekaran and Bougie, 2016). In this study, a judgmental non-probability sampling technique was used to select two most senior decision-making logistics experts, particularly managers, in each of the surveyed logistics firms. Only the two most experienced managers (with a relevant qualification/ long service period) were selected.

Preference was given to the transport and/or warehouse managers (in cases where transport is sourced out, the transport company was contacted telephonically) in each company so as to ensure the gathering of accurate data related to both inbound and outbound operations, as well as the technologies that transform these logistics activities in the targeted logistics companies. The judgmental sampling technique narrows potential participants down to only including experts within a study. For this study, using a judgmental sampling technique enabled the surveying of the most senior logistics experts involved in decision making within the logistics companies

(transport, warehousing and packaging logistics companies), to ensure the collection of more accurate data. On-the-ground workers were not considered for this study as they are not decision makers, but merely follow orders from management.

4.5.5 Determine sample size

There is no single law that can be used for sample size determination (Singh, 2006). For the determination of sample size, many statistical formulas are available. This study followed Tabachnick and Fidel's (2012:7) rule for sample size, which stipulates that "…a census for a small population should be adapted, in which the entire population is regarded as the sample". Since the target population of the transport, warehousing, and packaging logistics firms in NMB is 69, which is a relatively small amount for quantitative studies, all 69 logistics firms were surveyed and used as the sample. It should be noted that the study only included data gathered from middle management, including managers involved in logistics, transport, fleet, controllers, stores, warehousing, inventory, and operations management. These managers completed the survey regarding technologies transforming the logistics industry in NMB. This sample population was selected since these managers were likely to be better placed and more knowledgeable regarding the types of logistics technologies used, as well as these technologies' challenges, roles, and effects on business performance.

Since all 69 identified logistics firms are medium to large firms, an average of two respondents per each logistics firm in NMB was considered. This number aided in confirming and improving the accuracy of the data collected in this study. Thus, the initial total sample size of this study was 138 (i.e. 69x2). In order to gain the necessary sample, the judgmental sampling technique was used to select the 138 respondents (i.e. two from each of the 69 identified logistics firms). This sampling approach helped in improving the robustness of the study's findings, and is discussed in more detail in the following paragraphs.

It is crucial that the random sample be of a sufficient size in order for it to be representative enough to make any reliable generalisations to a broader population and to also prevent sampling error biases (Taherdoost, 2016). The best approach to

determine a representative sample size is to use as big a sample as the study time and cost will allow the researcher to use (Violato, 1991). Taherdoost (2017:237) puts it bluntly, larger sample sizes minimise the sampling error at a decreasing pace. It is also more likely that a larger sample is representative of the population, and the results would likely be more reliable and consistent. It has been pointed out that the greater the sample, the less the standard error (Singh, 2006). If the sample size is sufficiently large, the researcher can assume that the nuisance variables are distributed equally among the groups, thus increasing the confidence of the researcher in the equivalence of the groups (Marczyk, DeMatteo and Festinger, 2005).

Technically, the size of the sample depends on the precision that the researcher needs at a given confidence level in estimating the population parameter (Ma, Sun and Sedransk, 2014). Increasing the sample size can also help boost the precision. However, increasing the sample size has its own drawbacks, i.e. a large size sample raises data collection costs and therefore raises the structural bias (Schäfer and Schwarz, 2019). Thus, the successful way to improve accuracy is typically to choose a better sampling design that has a lower sampling error at a given cost for a given sample size.

Marczyk, DeMatteo and Festinger (2005) believe that there are numerous threats to statistical validity; the most common include low statistical power, variability in the experimental procedures and participant characteristics, unreliability of measures and multiple comparisons and error rates.

- **Low statistical power**

The existence of low statistical power creates a low probability of detecting the difference between the conditions of experimentation and regulation even though a difference really exists (Baroudi and Orlikowski, 1989). Low statistical power is directly related to small effects and sample sizes, with both pointing to the probability of a problem in the research design of the study (Marczyk, DeMatteo and Festinger, 2005). Low statistical power can therefore lead a researcher to conclude that there are no significant findings even though there are substantial findings in reality (Rosnow and Rosenthal, 2002). Low statistical power (arising, for example, from the low sample

size of studies, small effects being studied, or both) adversely affects the probability that a statistically significant result actually represents a true effect and (if the effect is indeed real) increases the likelihood that the estimation of the magnitude of that effect will be exaggerated (also known as type M or magnitude error) or variability in the experimental procedures and participant characteristics (Gelman and Carlin, 2014).

- **Procedural and participant variability**

Another challenge to statistical validity that relates to both the participants and the procedures used in a study is variability. Marczyk, DeMatteo and Festinger (2005) argue that methodological process variability and a host of participant characteristics minimise the possibility of identifying a discrepancy between control and experimental conditions.

- **Unreliability of measures**

Another source of variability that is a challenge to statistical validity is the unreliability of measures used in a sample (Marczyk, DeMatteo and Festinger, 2005). If the measurements of the research sample are inaccurate, then the experimental design adds more random variability. This form of variability reduces statistical capacity, as with participant and procedural variability, and makes it less likely that when a difference actually occurs, statistical tests will detect a specific difference between the control and experimental conditions (Greenland et al., 2016).

- **Multiple comparisons and error rates**

The idea that the probability of finding a significant difference between the experimental and control conditions can purely by chance increase with the number of statistical analyses. Comparisons of this nature are bound to include some simplifications and accuracies, because each type of test has several different types (Greenland et al., 2016). Nevertheless, the forms have enough similar features to make the comparisons useful, even if not always fully accurate (Singh, 2006). In any grouping, the comparison of the overall care indicates that it will appear or seem to be fully balanced in relation to the other variables (Singh, 2006; Leavy, 2017).

4.6 DATA COLLECTION PROCEDURES

Once the target population, sampling frame, sampling technique and sample size have been established, the next step is to collect data. The purpose of all data collection is to capture quality information that then converts to rich data analysis and enables a compelling and reliable response to questions that have been asked to be established (Ajayi, 2020). There has to be a process of collecting and sorting data before one can present and interpret information. Regardless of the field of study or data description choice (quantitative, qualitative), accurate data collection is necessary for the quality of analysis to be maintained.

Researchers can either use qualitative or quantitative methods or a combination of the two methods to collect primary data. Marczyk, DeMatteo and Festinger (2005) state that quantitative research comprises studies that use statistical analysis to obtain their results with main characteristics including formal and systematic measurement and statistical use. Indeed, concept quantification is generally considered important to a science's development, particularly at the more advanced stages, and quantification offers greater precision and has definite advantages as a result of its statistical care (Singh, 2006). It is connected to something which can be represented in terms of quantity or something which can be counted (Bhushan and Alok, 2017). Such research involves systematic experimental analysis of the measurable phenomenon in numerical form through statistical, mathematical or computational techniques such as statistics, and percentages among others.

Qualitative research is concerned with the phenomenon of consistency, that is, consistency or variety (Creswell, 2009). Such analysis is usually subjective, and more difficult to interpret than quantitative data. Qualitative analysis means taking a more naturalistic and in-depth look at non-numerical results (Creswell, 2009). Since it is difficult to predict when theoretical saturation is reached, it is also difficult to decide how many subjects would need to be tested at the beginning of the analysis; instead, the general rule in qualitative research is that a researcher can continue to sample until no new knowledge is collected or new insights are gained (Sekaran and Bougie, 2016).

Figure 4.3 presents the various methods of data collection.

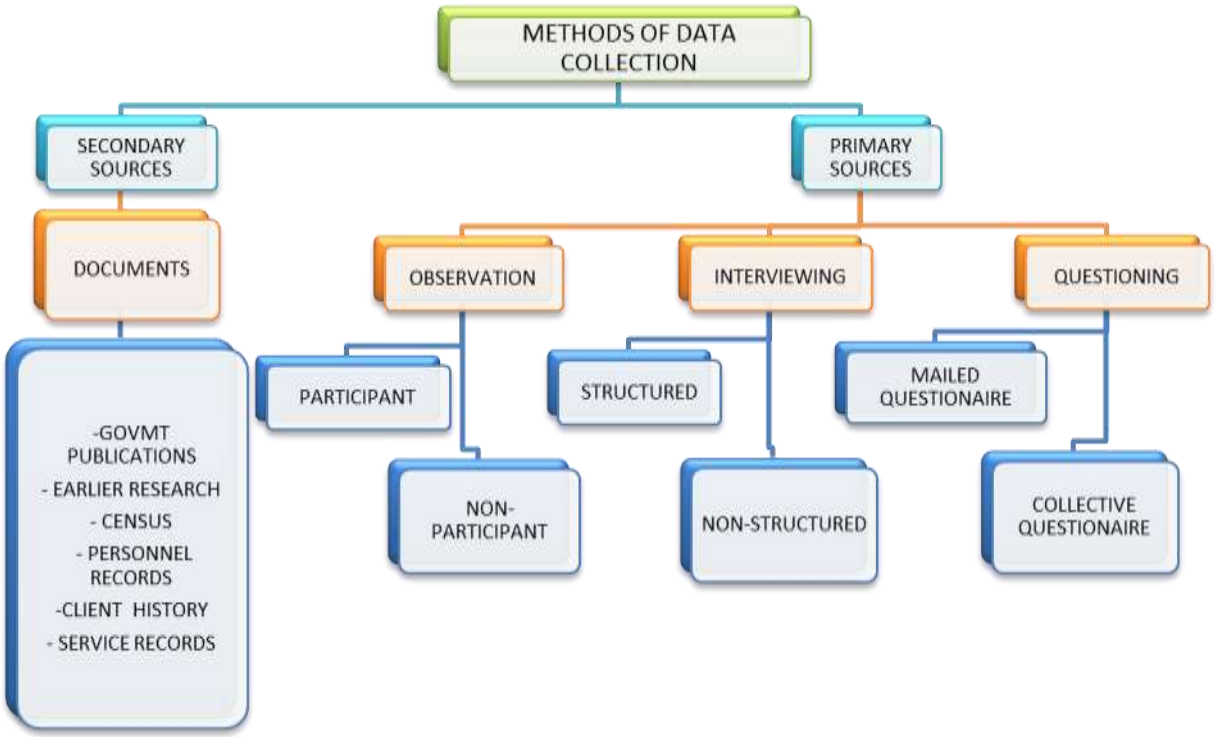

Figure 4.3: Methods of data collection

Source: Sekaran and Bougie (2016)

As shown in Figure 4.3, data can either be gathered through secondary or primary means. The next sub-section discusses secondary research.

4.6.1 Secondary research

Analysing previously collected data is one of the most successful and widely used approaches to investigating a range of issues, even in logistics and supply chain management. This is known as secondary data analysis, and it has become a more popular type of methodology for research, partially because computerised information datasets are more prevalent and the cost of gathering, storing, and retrieving data has decreased (Penson and Wei, 2006). Although many publicly accessible data sets have open access, others are limited to approved users who are allowed to use the data via the appropriate application process (Greenhoot and Dowsett, 2012). According to Kothari (2004), secondary data can be either published data or

unpublished data, and typically the published data may be available in: (a) different central publications, local governments are state publications; (b) different publications of foreign governments or international organisations and their subsidiaries; (c) scientific and commercial journals; (d) books, magazines and newspapers; (e) studies and publications by various trade and business organisations, banks, stock exchanges; (f) studies prepared in different fields by academic scholars, colleges, economists; and (g) public records and figures, historical documents and other sources of information released.

There are a variety of reasons why a researcher may prefer to conduct secondary analysis of an existing data set instead of designing a research instrument to collect original data. The most obvious rationale is that the data contain hundreds of variables of interest to developmental scientists and track individual participants over prolonged periods of time, providing unparalleled opportunities in an environment of diminishing grant funding and pressure to generate generalisable, and high-impact results to research developmental change (Greenhoot and Dowsett, 2012). Boslaugh (2007) explains that one key benefit of dealing with secondary data is economics: since the data has already been gathered by someone else, the researcher does not have to commit time to this analysis process. Even if it is appropriate to buy the secondary data set, the cost is almost certainly lower than the cost of wages, transportation, and so on, which would be needed to collect and process a comparable primary data set (Boslaugh, 2007).

4.6.2 Primary research

Primary research is research that is not found in a book, database, or journal, but obtained first hand (Lowe and Zemliansky, 2010). For instance, if an experiment is conducted by the researcher, it is that researcher who detects some objective measurements and tests to validate the truth inherent in the study hypotheses. According to Kothari (2004), primary data may be obtained by any one or more of the following methods: (i) observation (ii) interviews, and (iii) questionnaires:

(i) Observations

Observations are used to observe and measure the social world, including people's observations and other observable events; and are characterised as accurate observation and notification of phenomena as they occur with regard to cause and effect relationships in nature (Ajayi 2017). All research is concerned with the observation of a phenomena and the generalisation of these findings into certain functional relationships whose internal validity can be checked, and what is known about the social world comes from observation (Singh 2006). Kothari (2004) explains that the information gathered relates to what is actually happening and is not complicated either by the past actions or potential intentions or attitudes of respondents. This method is certainly costly and the information given by this method is therefore not appropriate for investigations involving large samples. Lowe and Zemliansky (2010) argue that while people have to volunteer to be participants in research in most situations, it is appropriate in some cases for researchers not to let participants know that they are studying them. People do not expect privacy in public areas, such as a campus food court or a shopping mall, and so observation without the permission of the participant is usually appropriate. However, participant consent should be obtained in locations that people interpret as private, which may include a church, home, classroom, or even an intimate conversation at a restaurant (Lowe and Zemliansky 2010).

(ii) Interviews

Lowe and Zemliansky (2010) describe how interviews are best used when a researcher seeks to gain specific details about a few different individuals or gain expert views. In short, to gather information from a few individuals, researchers can use interviews. Kothari (2004) states that the investigator follows a rigid protocol and seeks answers through personal interviews to a series of pre-conceived questions. This method of collecting data is typically carried out in a standardised manner where performance depends to a large extent on the interviewer's skill (Leavy, 2017). There are several distinct interview techniques, including, but not limited to, formal interviews, semi-structured interviews, in-depth interviews, interviews with focus groups, and interviews with oral history.

Researchers can also conduct interviews telephonically. This data collection method involves the researcher calling the respondents on the telephone. It is not a method that is commonly used, but it plays an important role in industrial surveys in developed regions, particularly when the survey must be carried out in a very limited period of time (Kothari, 2004). Leavy (2017) believes that telephone interviews remove the ability to communicate through gestures; however, the interviewer can still ask questions and pick up on verbal indicators.

(iii) Questionnaires

Primary data can also be collected using questionnaires. Questionnaires are either mailed through the post, physically distributed or distributed via online platforms. This is the most widely used tool in various economic and business surveys (Kothari, 2004). For questionnaires mailed through the post, the respondents are requested to complete and mail back the completed questionnaire. For physically distributed questionnaires, the researcher and the respondents come into contact with each other. For online questionnaires, potential respondents are invited to participate in the survey via emails, or social media platforms. In the same email the link to access the questionnaire is shared with the respondents. The questionnaire to be used must be prepared very carefully so that the collection of the relevant information will prove to be accurate. Questionnaires are normally less costly and time intensive than interviews and observation, but they often provide a far greater risk of non-response and non-response error (Sekaran and Bougie, 2016). Table 4.1 compares a questionnaire against an interview schedule.

Table 4.1: Questionnaire vs interview schedule

Questionnaire	Interview Schedule
• Mailed, filled in by respondent	Direct contact, filled in by researcher or enumerator
• Economical	Expensive
• High non-response	Low non-response
• Time Consuming	Time bound
• Requires literate, co-operative respondents	No such condition
• Success depends on quality of questionnaire	Success depends on quality of enumerator

Source: Adapted from Borkakati (2020)

In this study, primary data on logistics technologies transforming logistics firms in NMB was collected using a standardised questionnaire containing closed-ended questions. The questionnaire consisted of five sections (Sections A to E). Section A consisted of six questions pertaining to the biographical and logistics company information; Section B had six questions pertaining to logistics technology use and challenges. Section C contained 11 questions on technology adoption and use, while Section D contained six question on the role of logistics technologies. Section E had seven questions on the effects of technology adoption and use on firm performance. Section D and E contained questions on a further 5-point Likert-type scale where 1 = strongly disagree and 5 = strongly agree.

To allow easy electronic delivery of the questionnaire, the questionnaire was translated into a 7-12 minute questionnaire using Google Forms. The link to access the google form questionnaire was shared with the respondents via emails, LinkedIn, Facebook and Twitter. Offering the survey online also meant that respondents were more likely to engage in the survey without anyone questioning the respondent, and enabled respondents to participate in the survey out of their own free will. The online survey also helped to save on transportation and printing costs.

4.7 Assess response rate

In a survey, a response rate is the number of respondents who fully and correctly completed the returned questionnaire divided by the total number of the respondents to whom the questionnaire was sent (Taherdoost, 2016). Such cases are drawn from the original sample. In fact, a 100% response rate is never achieved by most researchers due to the following reasons: reluctance to answer, ineligibility to answer, inability to respond, or position of the respondent, but communication cannot be made by researchers (Wright, 1985). In summary, the response rate is significant since each non-response is responsible for making the final sample biased, clearly identifying the sample, using the correct sampling method, and producing a large sample (Taherdoost, 2016). In some ways, the probability of sample bias can be minimised. Table 4.2 presents the overall response rate for this study.

Table 4.2: Overall response rate

Target sample size or number of emails sent	Number of questionnaires completed in full	Percentage
138	132	95.7%

As shown in Table 4.2, the overall response rate obtained in this study is 95.7%. The total number of returned and usable questionnaires (final sample size) was 132 (all from online Google Forms), yielding a response rate of 95.7% calculated as follows: response rate = (132/138) x 100. Though the study could not achieve a 100% response rate, the current response rate of 95.7% was deemed sufficient to obtain robust results for this study. The next section discusses the data analysis procedures used in this study.

4.8 Data analysis procedures

In the social sciences, humanities, and economics, statistical methods of data analysis form the foundation of quantitative scientific study (Schwandt, 2007). Historically, in the sense of the study of (currently large) data sets from observational and experimental observations in the natural sciences, the bulk of information available in statistics has arisen from an accessible introduction to the fundamental concepts of descriptive and inferential statistics (Henk, 2019). As noted previously, the current study made use of a Social Sciences Statistical Package (SPSS) version 27 to perform both descriptive and inferential statistical analyses.

Descriptive research is valuable in that it can provide essential information about the typical community member, specifically, a researcher may identify the average participant or average performance of a participant, of the particular group being examined by collecting data on a large enough number of people (Marczyk, DeMatteo and Festinger, 2005). Kothari (2004) explains how descriptive research involves surveys and fact-finding inquiries of various sorts, with the main aim of descriptive research being to define the state of affairs as it actually exists.

In this study, descriptive analysis was performed in order to analyse the biographical and company information in Section A as well as the logistics technologies' use-related challenges in Section B, technology use and adoption in Section C and the role of technology adoption in Section D of the research questionnaire. Central

tendencies were used in this regard. Descriptive statistics define and summarise data, whereas inferential statistics are used in relation to a broader population to make inferences (Frost, 2018). Descriptive statistical analysis restricts the generalisation of any results to a particular group of individuals beyond this group, and any resemblance to those outside the group cannot be inferred (Best and Kahn, 2016).

Inferential statistical analysis often includes the sampling process and the choice of a small group believed to be similar to the population from which it is derived (Best and Kahn, 2016). Through descriptive statistics, a researcher can basically explain what the data indicates or what it is, and attempt to draw conclusions with inferential statistics that extend beyond the immediate data alone (Frost, 2018). In this study, data related to the role and effect of logistics technologies on business performance gathered from Sections C and E of the questionnaire was analysed using inferential statistics.

Inferential statistics enable the researcher to analyse causal associations in certain situations, and further, inferential statistics encourage researchers to go beyond the limits of their study sample and draw conclusions about the population from which the sample was taken (Marczyk, DeMatteo and Festinger, 2005). Singh (2006) implies that inferential statistical analysis includes the sampling process, and the selection for the evaluation of a small group which is supposed to be related to the large group from which it is derived.

In this study a standard multiple regression analysis performed in IBM SPSS version 27 was used to test the proposed research hypotheses. The study also performed an exploratory factor analysis, reliability assessment, normality, multi-collinearity, correlation and standard linear regression, to draw the conclusion of whether there was a positive or negative relationship between the variables.

4.9 Validity and reliability

For any researcher, reliability and validity are major concerns. Assessing validity and reliability is a careful process that needs to be followed to achieve quality results, from the formulation of research questions, the choice and execution of data collection methods, to the study results and interpretation of data (Heale and Twycross, 2015).

In fact, failure to evaluate the reliability and validity of the results may lead to questioning or even rejection of the research conclusions drawn (Abowitz and Toole, 2010).

4.9.1 Validity

According to Joppe (2000:1), validity refers to whether the study instrument actually tests what it was supposed to measure or how truthful the research results are. In this study, instrument reliability was tested using a pilot study. The current study tested for both convergent and discriminant validity. Convergent validity checks the degree to which questionnaire items only measure a research construct in the same direction (Hosany et al., 2015). In this study, composite reliability values of 0.6 and AVE values of 0.5 were used to test for validity. To test for discriminant validity, the square roots of AVE values were compared against the correlation coefficient values.

4.9.2 Reliability

Joppe (2000) describes reliability as the degree to which outcomes are stable over time and the research instrument is considered to be reliable if the results of a study can be replicated under a similar methodology. Kirk and Miller (1986) describe three forms of reliability referred to in quantitative analysis that relate to: (1) the degree to which a repeated measurement stays the same; (2) the stability of a measurement over time; and (3) the similarity of measurements over a given period of time.

According to Menardi and Lisi (2010), when a performance measure produces unchanging rankings over the targeted population of assets, as time varies, the maximum stability is achieved. The measure is said to be completely unstable or simply unstable when the rankings caused by a performance measure are random permutations over time. Any measure that is not unstable has some degree of stability and one of the objectives of this work is its quantification (Mehdizadeh, Arshi and Davids, 2014). Similarity is considered as the measure that establishes an absolute similarity value between two vectors, isolated from the rest of the vectors in principle and without evaluating the position within the solution space (Iglesias and Kastner, 2020).

Mikuska (2018) explains that one of the benefits of performing a pilot study is that it may provide advance notice about where the main research project could fail, where research procedures might not be followed, or if the methods or tools suggested are inadequate or too complicated. It can refer to the so-called feasibility studies that, in preparation for the main analysis, are "small-scale version, or trial run" (Polit et al., 2001: 467). To that end, a total of 14 questionnaires were distributed to NMB logistics managers for pilot testing. This approach helped the researcher to test whether or not questions asked in this study's questionnaire were internally consistent with research variables (i.e. logistics technologies adoption and use, role of logistics technologies in the logistics industry and business performance). Pre-testing allowed the researcher to also assess how well respondents understood the questionnaire's questions, the amount of time it took to complete the questionnaire, and whether there were any flaws that needed to be resolved. Emanating from the suggestions from managers involved in the pilot study, the researcher added four more items to question 14 and added question 15 to get more information on how logistics technologies affect business performance. The questionnaire was finalised after the pilot research adjustments (see Appendix A).

The study also tested for internal reliability using the Cronbach's alpha coefficients of 0.7 or more, calculated in SPSS version 27.

4.10 Delimitations

Delimitations are, in essence, the limits that the writers themselves consciously set. They are concerned with the concepts that researchers want to set as the parameters or limits of their work such that it is not difficult to achieve the goals and objectives of the analysis. In this respect, it can be argued that the researcher is in charge of delimitations (Theofanidis and Fountouk, 2018). As indicated in the previous section, this study intended to offer a better understanding of technology use and adoption and how this affects business performance of the logistics sector within the NMB context.

The focus of the study was, therefore, to assess the effect of technology adoption and use within the logistics sector; specifically, the study does not want to create the impression that logistics technology is a threat to any individual or company, but rather

to portray an overview of the changes within the logistics field due to technological advancement. According to Szłapka and Lubiński (2017), technological innovation is one of the most distinct aspects of today's environment, and Global Supply Chains and the logistics industry are significant beneficiaries of technological advancement. Logistics companies can also scale up their infrastructure spending in order to offer Logistics 4.0 (Szłapka and Lubiński, 2017). As such, the study was limited in its research scope to the logistics industry, particularly with regard to transport, warehousing, and packaging logistics service providers in NMB, as listed in the Nelson Mandela Bay Business Chamber and 2019 Local Business Directory.

4.11 Ethical considerations pertaining to the study

An ethical clearance for the data collection process was issued from the Ethical Committee of Nelson Mandela University. Brady and Jonsen (2014) stated that in terms of ethical standards to be followed during the study process, the Belmont Report regulates research. In the course of its deliberations, the Belmont Report seeks to outline the basic ethical principles defined by the Commission.

The current study sought informed participation by first issuing a respondent’s written and oral informed consent about their involvement in the survey of this study, and no respondents were pressured to be part of the study. Similarly, at any time and without sanctions, all participants had the right to withdraw from the survey. The confidentiality of the data collected was maintained and, as part of the analysis, no personal information such as company or respondent names or identification numbers was gathered. Such protocols guarantee the anonymity of the respondents. In addition, the research was autonomous, unbiased and used solely for calculating and educational purposes. No persons under 18 years of age or over 60 years of age participated in the survey for this report.

4.12 CHAPTER SUMMARY

This chapter outlined the research methodology that the researcher followed in this study which included the research philosophy, design, approach, sampling design, data collection procedures, data analysis, reliability, validity, ethical considerations, together with the delimitations. Due to the nature of the problem under investigation

and the need to generalise their findings from logistics companies in NMB to other South African companies in the logistics industry across the world, this study used a quantitative research approach. Therefore, when analysing the developments changing the logistics industry in the NMB, the analysis employed a positivist approach. In line with the research target, the selection of the research components was carried out using judgmental sampling.

The logistics sector within the NMB boundary was the target population. Only transport, warehousing and packaging firms based in NMB were considered. It should be noted that the data was collected from middle management, including logistics, transportation, fleet, controllers, warehousing, inventory, and operations management managers. The survey on logistics technologies changing the logistics industry in NMB was completed by these managers. As these managers are likely to be better positioned and more informed about the types of logistics technologies used, as well as the difficulties, functions, and effect on business performance results of these technologies, this sample population was deemed appropriate and thus chosen.

CHAPTER 5
EMPIRICAL RESULTS OF THE STUDY

5.1 INTRODUCTION

The previous chapter (Chapter 4) presented the research philosophies, research design and approach, as well as the sampling design, data collection methods and analysis methods. The current chapter discusses the analysis results and their interpretation. The chapter presents the respondent demographics and firm data, followed by the descriptive analysis results on the logistics technology adoption and use, and the challenges and the role of logistics technology adoption and use. The exploratory factor analysis, reliability, validity, normality, multi-collinearity and correlation analysis test results are also discussed in this chapter. The chapter further presents and discusses the standard regression analysis results performed in SPSS version 27, used to test and validate this study's research hypotheses. The following Hypotheses were tested:

H1: The adoption and use of logistics technology plays a significant role in logistics firms.

H2: The adoption and use of technology has a positive effect on the business performance of logistics firms.

The descriptive statistics results are discussed below:

5.2 DESCRIPTIVE ANALYSIS RESULTS

Descriptive statistics are used to explain the basic features of the data in a report, they include clear summaries about the sample and the measures along with simple graphical analysis, and they form the basis of virtually any quantitative analysis of data (Cooksey, 2020). Descriptive statistics are used to summarise data in an orderly manner and are used to define the potential connection between variables in a sample or population (Cooksey, 2020). As such, when doing research, calculating descriptive statistics is a critical initial step that should always be completed before performing inferential statistical comparisons (Kaur, Stoltzfus and Yellapu, 2018). In the current

study, descriptive statistics were provided by way of summary statistics presented in tables and graphs for better comprehension of each question response and to help define the potential link between the research variables. The next sub-section provides the demographic information of the sample respondents.

5.2.1 Demographic information

Demographics provide a generalisation of a population based on a sample of people in that geographic area (French, 2014). However, because demographics only provide an aggregate image of a group, not everyone fits a particular demographic profile (French, 2014). The sample used in this study is solely from the logistics industry and consists of 132 participants. The demographic and sample data gathered in this study includes respondents' gender, age, educational qualification, position/job title in the organisation, number of years within the logistics industry and the logistics area currently working in.

5.2.1.1 Gender classification

One of the factors that can affect technology adoption and use is the gender of management within the logistics industry. On one side of the spectrum, as outdated systems are being replaced and technological innovation is being introduced, the question raised is whether women leadership will materialise and develop itself as an independent trend, whereas on the other side, gender has always been projected as one of the main characteristics of leadership (Zaleznik, 1977). Over the years there have been shifts in the roles of women in logistics management positions in the industry. The first question in the questionnaire is aimed at gender within logistics management positions, and Figure 5.1 portrays the results.

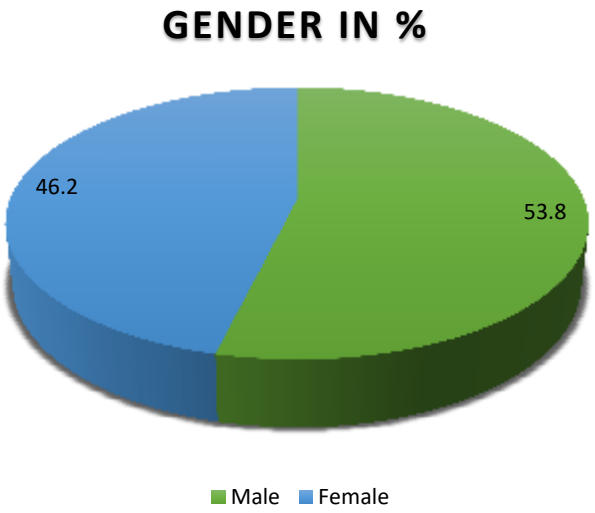

Figure 5.1: Gender

Evidently, as shown in Figure 5.1, 53.8% of the respondents were males (71), while 46.2% were females (61). The results show that in logistics management positions, women still lag behind men. Reportedly, the top logistics positions, such as logistics, warehouse, transport and inventory management positions, are occupied by a lower percentage of women. Studies have shown that male leadership is transactional leadership, i.e. focusing on achieving goals, while female leadership is transformative, i.e. encouraging team work, personal respect and innovation (Wood, 2005; Jogulu and Glenice, 2006; Werhane, 2007 as cited by Dhaigude, 2016). The next section focuses on the age of the respondents.

5.2.1.2 Age distribution

This section discusses the various age groups of the respondents within the logistics industry surveyed in this study. Figure 5.2 below illustrates this in detail.

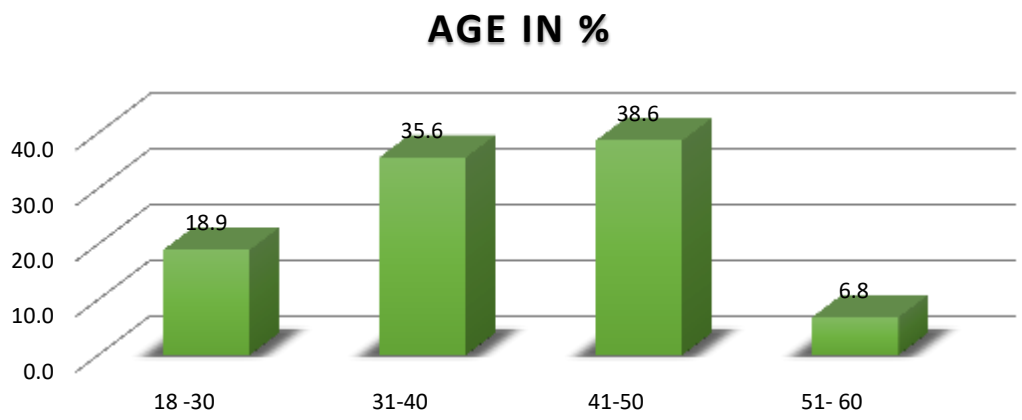

Figure 5.2: Age

Figure 5.2 highlights that 18.9% (25) of the respondents, at the time of the study, were in the age group 18 – 30, while 35.6% (47) of the respondents were between ages 31 – 40 followed by 38.6% (51) that fell in the age category 41 – 50, and lastly 6.8% (9) in the age group 51 – 60. In the next question, the level of education of the respondents is measured.

5.2.1.3 Qualification status

The level of education plays a huge role in decision making of a particular manager. Some argue that experience is better than education (Pont, Nusche and Moorman, 2011). In general, the topic of decision-making is one of the most significant and influential factors in the lives of those in leadership roles. By selecting the best alternative, a field of choice is made between more than one option to meet the goal of a decision, and so the decision-making process continues as long as there is work and operation to achieve the desired goals (Kim et al., 2018). Logistics managers also have to decide on whether or not to adopt and use technologies, and which technologies to deploy in their day-to-day logistics activities. Figure 5.3 summarises the outcome of the respondents' levels of education.

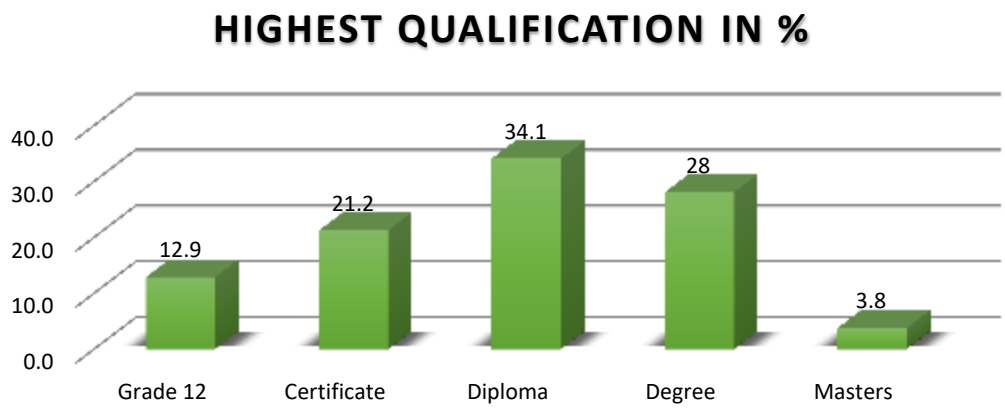

Figure 5.3: Qualification level

The results in Figure 5.3 show that 3.8% of surveyed logistics managers possess a master's degree, followed by 28% (37) who hold bachelor degrees, followed by 34.1% (45) with diplomas, 21.2% (28) with certificates and 12.9% (17) with Grade 12 only. Through behavioural and social sciences, including psychology, economics, and education – there has been interest in whether people are born to be rational decision-makers or whether rationalism can be encouraged through education (Kim et al., 2018). The assumption here is that with higher level qualifications, managers are oriented towards strategic and innovative decisions, including adopting technology for improved business performance in the long term. The next question to respondents was what their employment titles were.

5.2.1.4 Employment title

The job position held by the respondent in the logistics firm can provide them with the capacity to make decisions even those to do with technology adoption and use in the firm's day-to-day activities. Respondents in top level managerial positions participate in long-term logistics planning decisions, while the middle and lower level managers make more practical decisions that enable them to carry out the vision of the firm formulated by the top level managers. The current study's respondents comprised logistics, warehousing, transportation/fleet/shipping, procurement and inventory managers, among others, as these have the capacity to decide on the adoption and use of specific logistics technologies in their firms. Table 5.1 depicts these roles and positions.

Table 5.1: Job title

	Frequency	Percentage
Logistics Manager	31	23.5
Materials Manager	12	9.1
Transportation/Fleet/Shipping Manager	16	12.1
Procurement Manager	6	4.5
Inventory Manager	10	7.6
Warehouse Manager	33	25
Other (specify)	24	18.2
Total	132	100

The respondents were all from firms in NMB, filling the following positions listed in Table 5.1: Most of the respondents were warehousing managers (25%), followed by logistics managers (23.5%), while procurement (4.5%) and inventory (7.6%) managers were the least represented in the survey. Some respondents also chose “other” as their job positions and this accounted for 18.2% (24) of the respondents. The “other” job title category consisted of operations managers (3), logistics administrators (8), general manager (1), branch managers (6), dispatch clerks (3) and regional managers (3). At the time of the study, all the surveyed respondents fell under the logistics umbrella and either made decisions about the adoption of logistics technologies or made use of the logistics technology in some way when performing logistics activities. The next section discusses the respondents’ years of experience in the logistics industry.

5.2.1.5 Number of years in logistics industry

The surveyed respondents were also asked to provide their years of experience in the logistics industry. The assumption was that those respondents with more years in the industry will be more knowledgeable about the logistics technologies adopted and used in the firm over time, and be cognisant of the role and effect of technology adoption and use on their logistics firm’s business performance. According to Kristiawan and Lian (2019), it is expected that people with more years of experience in the same industry will have a greater capacity and ability to work and make sound decisions than those with less or without experience. Figure 5.4 presents the outcome of the respondents’ number of years within the industry.

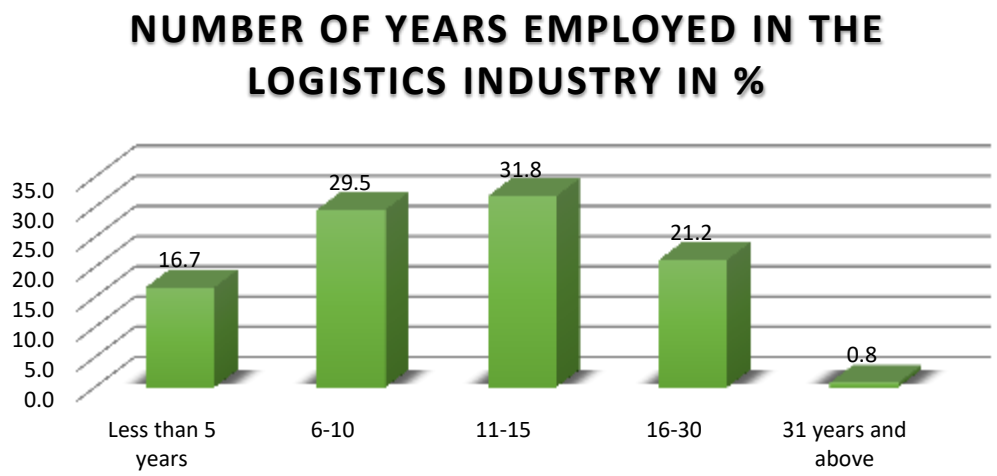

Figure 5.4: Number of years employed in the logistics industry

Figure 5.4 indicates that most (31.8%) of the surveyed respondents had between 11 to 15 years of experience in the logistics industry. This was followed by those who had between 6 to 10 years' experience who accounted for 29.5% of the respondents. Further, 21.2% of the respondents had between 16 and 30 years' experience in the logistics industry. Those who had 31 years and above accounted for only 0.8%, and made up the smallest number of respondents, after the 16.7% respondents who had less than 5 years of experience in the logistics industry. The next section discusses the type of logistics field in which the respondent is designated.

5.2.1.6 Type of logistics field

The functions of logistics include transportation/delivery, storage, packaging, freight handling, distribution processing, and information processing, and all these functions can benefit from effective and efficient use of logistics technologies. Adopting and making use of logistics technologies can enable firms in the supply chain to deliver goods from the manufacturing site or factory to the customer efficiently and on time (Introna, 1991). For this study, three areas were chosen, namely Transport, Warehousing and Packaging. Figure 5.5 portrays the distribution of respondents' type of logistics function or field.

Figure 5.5: Type of logistics business

As depicted in Figure 5.5, most (44.7%) of the surveyed respondents were under Transport, followed by Warehousing with 39.4%, Packaging with 15.2% and the lowest was “Other” at 0.75% (1) which was described as a Customs Agent. Transport tops the list as most suppliers and manufacturers have some sort of transportation in place, and will benefit from adopting logistics technologies such as those for tracking the vehicles. The next section focuses on the other descriptive statistics on technology usage in the logistics industry.

5.2.2 Other descriptive statistics

5.2.2.1 Technology usage in logistics industry

The respondents were also asked whether they use technologies in their logistics business. Table 5.2 below depicts the outcome on whether the respondents make use of logistics technology or not in their logistics activities.

Table 5.2: Do you use any technologies in your logistics business?

	Frequency	Percentage
Yes	132	100
No	0	0
Total	132	100

Table 5.2 above illustrates that the entire surveyed sample indicated that they make use of some sort of technology in their logistics activities within their logistics firms. The next section discusses the types of technologies used in surveyed logistics firms.

5.2.2.2 Technologies used by the respondents

There are various types of technologies available within the logistics industry. As earlier noted in Chapter 1, this study primarily sought to investigate whether NMB is keeping up with the current logistics technology trends and systems that are transforming logistics firms in South Africa, the African continent and the rest of the world. Secondarily, the study also sought to identify the logistics technologies transforming logistics firms. The results that helped achieve these two objectives are illustrated in Table 5.3 below.

Table 5.3: Which of the following technologies do you use in your logistics business?

	Response	Percent of Cases
Internet of Things	120	90.9%
RFID	21	15.9%
Robotic Process Automation	35	26.5%
Artificial Intelligence	1	0.8%
Autonomous things	18	13.6%
Blockchain technology	11	8.3%
Immerse experience	6	4.5%
Digital supply chain twin	33	25.0%
Advanced analytics	16	12.1%
WMS	1	0.8%
Tracking Systems	1	0.8%
Third party application	2	1.5%
Vendor managed system	23	17.4%
Collaborative Replenishment Technology	8	6.1%

Table 5.3 above reveals that, at the time of the study, 90.9% of respondents utilise the Internet of Things in their logistics operations, while others (26.5%) use robotic process automation, digital supply chain twin (25%), vendor managed system (17,4%), and RFID (15.9%). The Internet of Things is the most widely used form of technology which is at the forefront of revolutionising the ways in which logistics firms plan, source, handle, move and store cargo as well as share information with other relevant supply chain stakeholders. Using the technologies such as the Internet of Things, robotic process automation, digital supply chain twins, vendor managed

system and RFID helps firms to find new ideas and execute their logistics activities in innovative ways that promote sustainable firm growth and strengthen their market position. According to Bolton, Grewal and Levy (2007), utilising logistics technologies such as the Internet of Things may aid in the development of strong client connections, the creation of barriers to competition, the growth of customer loyalty and switching costs, and the efficiency of market operations. Table 5.4 describes the technology-related concerns to firms in NMB.

5.2.2.3 Whether technology is a growing concern in logistics firms

The most frequent measure of central tendency is the mean (average), which refers to the average value of a set of integers. According to Sykes, Gani and Vally (2021), the average or mean is calculated by adding all the data together and dividing by the number of values, the formula ΣX / N is used to compute the mean [The sum all the scores in the distribution (ΣX) divided by the total number of scores (N)]. The respondents in this study were also asked to indicate whether technology is a growing concern to logistics firms in NMB. Figure 5.6 presents the descriptive results to indicate whether technology is a growing concern in logistics firms.

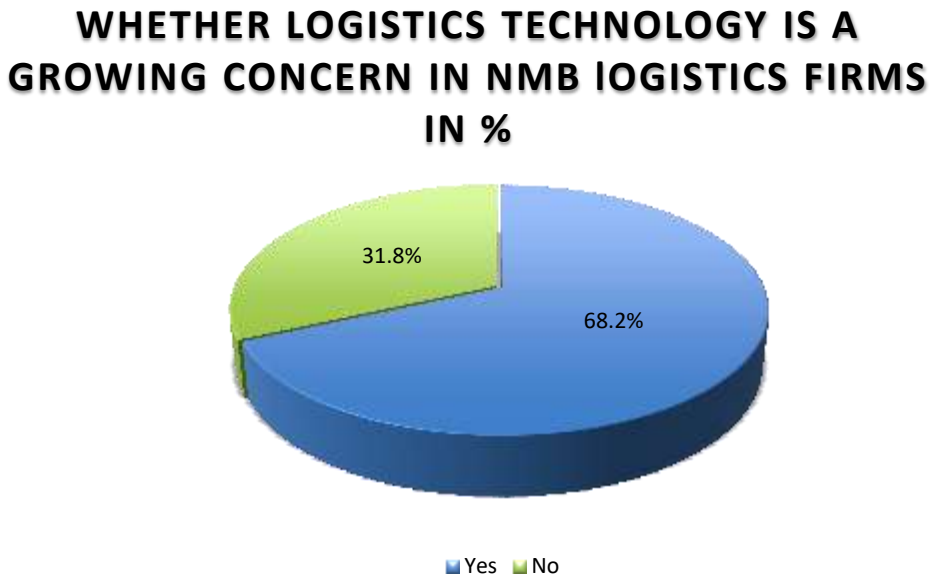

Figure 5.6: Is technology a growing concern in logistics firms in NMB?

According to the results in Figure 5.6 above, most of the respondents (68.2%) indicated that they see technology as a growing concern in logistics firms in NMB. The respondents were further asked to indicate, on a scale of 1 to 5, the extent to which technology is a growing concern in logistics firms in NMB. Table 5.4 presents the descriptive results on the extent to which technology is a growing concern in logistics firms

Table 5.4: The extent to which technology is a growing concern in logistics firms in NMB

	Frequency	Percentage	Mean	Std. Dev
Never a concern	16	12.1	2.84	1.047
Least concern	34	25.8		
Somewhat a concern	39	29.5		
It is a concern	41	31.1		
It is a big concern	2	1.5		
Total	132	100		

As shown in Table 5.4, 32.6% of the surveyed respondents indicated that technology is a growing concern, 25.8% said it is the least concern, 12.1% indicated that it was never a concern, while 29.5% were indifferent about this matter. More so, based on the mean score (M= 2.84) shown in Table 5.4 above, most respondents said they believe that technology is a concern to logistics firms in NMB. This could be because of the challenges associated with technology adoption in these firms. Mohamed and Jokonya (2021) cited high costs, security, and complexity as some of the challenges associated with technology adoption in firms. The next section and Figure 5.7 present the technological advancements within the logistics industry.

5.2.2.4 Technological advancement within logistics business

Further descriptive tests were performed to achieve the primary objective which sought to investigate whether NMB is keeping up with the current logistics technology trends and systems that are transforming logistics. These tests were also performed for the secondary objective which sought to identify the logistics technologies transforming logistics firms. The results that help achieve these two objectives are illustrated in Figure 5.7 below. The respondents were further asked to indicate any technological advancements within the logistics business. Figure 5.7 present the descriptive results.

Figure 5.7: Technological advancement within logistics business

As can be seen in Figure 5.7, firms in NMB seem to be keeping up with the current logistics technology trends and systems that are transforming the logistics industry, across the world. The results also reveal that technology use in logistics firms has advanced a lot. Most of the respondents (79.1%) revealed that technology use in logistics firms has advanced to vehicle tracking, packaging (57.4%), inventory control (55%), and communication systems (54.3%). The results also show that technology use in a few of these firms has now advanced to robotics (23.3%) and smart systems (3.1%). This could be as a result of the current COVID 19 pandemic, which has put a strain on the manual system which required more human workforce to perform logistics tasks, thus forcing such firms to seek digital solutions to remain competitive. The next section discusses the technology adoption- and use-related challenges faced by logistics firms.

5.2.2.5 Challenges faced regarding logistics technology

Technology adoption and use is also associated with challenges. This study also sought to ascertain the challenges of using logistics technologies transforming the logistics firms. The respondents in this study were asked to indicate the logistics technology adoption- and use-related challenges they face in their firms. Table 5.5 presents the results.

Table 5.5: Challenges faced regarding logistics technology

	Responses	Percent of cases
Inadequate room for logistics technology growth within logistics firms in	29	24.6%
Most of the people involved with logistics are not aware of technological advancement available	29	24.6%
There is a lack of investment towards logistics technology	47	39.8%
Other departments do not see the importance of the logistics department	53	44.9%
There are but a few new developments in NMB	30	25.4%
Technophobia (the irrational fear emanating from the side effects of using modern advanced technologies)	23	19.5%
Very high costs of investing in technology infrastructure	40	33.9%
Fear of losing jobs as people get replaced by technology such as machines and robots	65	55.1%
Absence of skilled staff in logistics technology	38	32.2%
Unwillingness of customers to pay for technology related costs	35	29.7%
High logistics costs	47	39.8%

The results in Table 5.5 above indicate that more than half of the respondents (55.1%) have cited the fear of losing jobs as people get replaced by technology such as machines and robots as the main challenge faced with regards to logistics technology. This makes sense, since job security is a main concern emanating from the high unemployment figures within Nelson Mandela Bay and South Africa as a whole. Some (39.8%, 33.9%, and 19%) cited high logistics costs, very high costs of investing in technology infrastructure and technophobia as the other logistics technology adoption and use-related challenges they face in NMB. These findings are in agreement with a study by Cichosz, Wallenburg and Knemeyer (2020) which researched digital transformation at logistics service providers, paying attention to barriers, success factors and leading practices. Their study found that the logistics service providers mainly struggled with digital transformation due to the complexity of the logistics network and lack of resources. The next section uses the central tendency measures to describe logistics technology adoption and use in logistics firms.

5.3 Central tendency measures

Central tendency is described by Manikandan (2011:140) as "the statistical metric that identifies a single value as typical of an entire distribution." It tries to give an accurate description of the complete data (Gravetter and Wallnau, 2000). It is the one number that most closely resembles/represents the data. When two or more distinct data sets

must be compared, it is common practice to condense the data for comparison. The three mostly used measures of central tendency are the mean, median, and mode.

The overall analysis of each concept in the research was conducted using central tendency measurements. To describe logistics technology adoption and utilisation in logistics firms, the following concepts were measured using a five-point Likert scale, with 1 corresponding to "Strongly disagree" and 5 corresponding to "Strongly agree."

The mean score on a five-point Likert scale is 2.5 (5/2), and any mean score below 2.5 indicates that the majority of respondents strongly disagree or disagree with the claims. The majority of responders are indifferent, as indicated with mean ratings ranging from 2.5 to 3.4. The majority of respondents likely to agree or strongly agree with the statements assessing the constructs, as indicated by the mean scores equal or above 3.5.

5.3.1 Logistics technology adoption and use

The results presented in Table 5.6 below show that the majority of respondents agreed with the statements pertaining to logistics technology adoption and use (Mean=3.97; Std.Dev=0.462). Most firms agreed (63.6% of respondents) while 28.8% strongly agreed that the adoption and use of emerging technologies, such as the Internet and extranets, have enabled them to communicate information with their stakeholders on time. According to the findings, 62.1% of respondents agreed and strongly agreed (29.5%) that the high use of technology in their logistics operations has enabled them to respond to increasing customer demand on time, while 59.1% agreed and strongly agreed (31.8%) that they use technology to create better value for their customers through their logistics activities. Furthermore, the majority of respondents (59.1%) agreed or strongly agreed (28%) that incorporating technology into their logistics operations has allowed their businesses to detect and respond to market developments quickly. Furthermore, 56.8% of respondents agreed or strongly agreed (29.5%) that adopting technology in logistics activities allows their firms to work successfully on large projects with their suppliers. Furthermore, 56.1% of respondents agreed (25%) or strongly agreed (25%) that employing technology in

their everyday logistical tasks has enabled their firms to survive any supply chain interruptions, such as the current Covid 19 epidemic.

Table 5.6: Rate the following statements on the use and adoption of logistics technology in your firm

Our management encourages the use and adoption of technology within the company.				
	Frequency	**Percentage**	**Mean**	**Std. dev**
Disagree	4	3.0	4.16	0.729
Neutral	14	10.6		
Agree	71	53.8		
Strongly agree	43	32.6		
Total	132	100		
The level of technology usage is very low within our company.				
	Frequency	**Percentage**	**Mean**	**Std. dev**
Strongly disagree	7	5.3	3.14	1.28
Disagree	53	40.2		
Neutral	12	9.1		
Agree	35	26.5		
Strongly agree	25	18.9		
Total	132	100		
Employees resist the usage of logistics technology within the company.				
	Frequency	**Percentage**	**Mean**	**Std. dev**
Strongly disagree	13	9.8	3.07	1.180
Disagree	34	25.8		
Neutral	30	22.7		
Agree	41	31.1		
Strongly agree	14	10.6		
Total	132	100		
The technology equipment within our companies is not effective for our logistics activities.				
	Frequency	**Percentage**	**Mean**	**Std. dev**
Strongly disagree	7	5.3	3.34	1.235
Disagree	37	28		
Neutral	19	14.4		
Agree	42	31.8		
Strongly agree	27	20.5		
Total	132	100		
The customers service delivery has improved since we started using logistics technologies within our company				
	Frequency	**Percentage**	**Mean**	**Std. dev**
Disagree	2	1.5	4.18	0.708
Neutral	17	12.9		
Agree	68	51.5		
Strongly agree	45	34.1		
Total	132	100		
The high use of technology in our logistics operations has enabled us to respond to increasing customer demand on time				
	Frequency	**Percentage**	**Mean**	**Std. dev**
Neutral	11	8.3	4.21	0.580
Agree	82	62.1		
Strongly agree	39	29.5		
Total	132	100		

Adopting and using technology in our logistics operations has enabled us to sense and respond to any changes in the market on time.				
	Frequency	**Percentage**	**Mean**	**Std. dev**
Disagree	2	1.5	4.14	0.663
Neutral	15	11.4		
Agree	78	59.1		
Strongly agree	37	28		
Total	132	100		
Adopting and using emerging technologies, such as the Internet and Extranets has enabled us to share information with our stakeholders on time.				
	Frequency	**Percentage**	**Mean**	**Std. dev**
Neutral	10	7.6	4.21	0.567
Agree	84	63.6		
Strongly agree	38	28.8		
Total	132	100		
We use technology to create better value for our customers through our logistics activities.				
	Frequency	**Percentage**	**Mean**	**Std. dev**
Neutral	12	9.1	4.23	0.600
Agree	78	59.1		
Strongly agree	42	31.8		
Total	132	100		
Using technology in our daily logistics activities has allowed our company to survive any form of supply chain disruptions such as the ones caused by the current COVID 19 pandemic.				
	Frequency	**Percentage**	**Mean**	**Std. dev**
Disagree	2	1.5	4.05	0.697
Neutral	23	17.4		
Agree	74	56.1		
Strongly agree	33	25		
Total	132	100		
Using technology in logistics activities has allowed our company to successfully collaborate on big projects with our suppliers.				
	Frequency	**Percentage**	**Mean**	**Std. dev**
Disagree	1	0.8	4.15	0.659
Neutral	17	12.9		
Agree	75	56.8		
Strongly agree	39	29.5		
Total	132	100		
Mean=3.97 Std. Dev=0.462				

The findings in Table 5.6 also show that the majority of respondents agreed (53.8%) and strongly agreed (32.6%) that their management encourages the use and adoption of technology within their companies, and that 51.5% agreed and strongly agreed (34.1%) that their customers' service delivery has improved since the implementation of logistics technologies within their companies. The respondents also agreed (31.8%) and strongly agreed (20.5%) that their firms' technology is ineffective for their logistical tasks. Furthermore, 31.1% of the respondents agreed that employees resist the usage of logistics technology within the company, whereas 26.5% agreed that the level of technology usage is very low within their companies.

However, while the majority of individuals agreed with the assertions about logistics technology use and acceptance, some respondents indicated they believe (40.2%) that their companies' degree of technology utilisation is low. Finally, the overall findings show that respondents are enthusiastic about the usage and acceptance of logistics technology.

5.3.2 The role of logistics technology adoption and use

The current study also sought to assess the role of logistics technologies affecting logistics firms in NMB. This section describes the role of technology adoption and use in logistics firms. Table 5.7 presents the results.

Table 5.7: Role of logistics technology adoption and use

Logistics technology is necessary for growth				
	Frequency	**Valid Percent**	**Mean**	**Std. Deviation**
Disagree	1	0.8	4.25	0.584
Neutral	7	5.3		
Agree	82	62.1		
Strongly agree	42	31.8		
Total	132	100.0		
Logistics technology plays a significant role in creating customer value advantages				
	Frequency	**Valid Percent**	**Mean**	**Std. Deviation**
Neutral	10	7.6	4.27	0.591
Agree	77	58.3		
Strongly agree	45	34.1		
Total	132	100.0		
Technology (systems robots etc.) is necessary to create cost advantages				
	Frequency	**Valid Percent**	**Mean**	**Std. Deviation**
Disagree	2	1.5	4.05	0.734
Neutral	26	19.7		
Agree	67	50.8		
Strongly agree	37	28.0		
Total	132	100.0		
Technology is necessary for on time deliveries				
	Frequency	**Valid Percent**	**Mean**	**Std. Deviation**
Disagree	4	3.0	4.11	0.748
Neutral	18	13.6		
Agree	69	52.3		
Strongly agree	41	31.1		
Total	132	100.0		
Technology is necessary to locate track and trace inventory				
	Frequency	**Valid Percent**	**Mean**	**Std. Deviation**
Neutral	16	12.1	4.17	0.624
Agree	77	58.3		
Strongly agree	39	29.5		
Total	132	100.0		

Logistics technology plays a significant role in ensuring that quality and accurate information is shared				
	Frequency	**Valid Percent**	**Mean**	**Std. Deviation**
Disagree	1	0.8	4.16	0.628
Neutral	14	10.6		
Agree	80	60.6		
Strongly agree	37	28.0		
Total	132	100.0		
Mean = 4.17 Std. Dev = 0.477				

According to the findings in Table 5.7, 62.1% of respondents agreed and strongly agreed (31.8%) that technology is required for a company to develop. Furthermore, 60.6% of respondents agreed and strongly agreed (28%) that logistics technology plays a significant role in ensuring the sharing of quality and accurate information, and 58.3% agreed and strongly agreed (34.1%) that logistics technology adoption and use play a significant role in creating customer value advantages. Furthermore, 58.3% of respondents agreed (29.5% strongly agree) that technology is required to identify, track, and trace inventories. The majority of respondents agreed with the statements about the role of logistics technology usage and adoption, based on the total mean score (Mean=4.17). Finally, the findings show that respondents had a favourable perspective regarding the use of logistics technology in businesses. The next section focuses on business performance.

5.3.3 Business performance

This section discusses the descriptive statistics results on business performance. Table 5.8 presents the results.

Table 5.8: Effect of logistics technology adoption and use on business performance

Using logistics technology have improved our firm's annual profits				
	Frequency	**Valid Percent**	**Mean**	**Std. Deviation**
Disagree	2	1.5	4.16	0.708
Neutral	18	13.6		
Agree	69	52.3		
Strongly agree	43	32.6		
Total	132	100.0		

Using logistics technology have helped us improve our customer service				
	Frequency	**Valid Percent**	**Mean**	**Std. Deviation**
Disagree	6	4.5	4.19	0.732
Neutral	7	5.3		
Agree	75	56.8		
Strongly agree	44	33.3		
Total	132	100.0		
Using logistics technology has helped us to reduce our response time to customer orders				
	Frequency	**Valid Percent**	**Mean**	**Std. Deviation**
Strongly disagree	1	0.8	4.26	0.716
Disagree	2	1.5		
Neutral	9	6.8		
Agree	70	53.0		
Strongly agree	50	37.9		
Total	132	100.0		
Using technology has helped reduce our total annual logistics costs per year				
	Frequency	**Valid Percent**	**Mean**	**Std. Deviation**
Disagree	2	1.5	4.17	0.712
Neutral	18	13.6		
Agree	68	51.5		
Strongly agree	44	33.3		
Total	132	100.0		
Logistics technology has helped us increase our market share				
	Frequency	**Valid Percent**	**Mean**	**Std. Deviation**
Disagree	2	1.5	4.20	0.704
Neutral	16	12.1		
Agree	68	51.5		
Strongly agree	46	34.8		
Total	132	100.0		
Using logistics technology has helped us to deliver our customers' orders on time				
	Frequency	**Valid Percent**	**Mean**	**Std. Deviation**
Disagree	2	1.5	4.25	0.646
Neutral	9	6.8		
Agree	75	56.8		
Strongly agree	46	34.8		
Total	132	100.0		
Using logistics technology has helped us to process customer orders on time				
	Frequency	**Valid Percent**	**Mean**	**Std. Deviation**
Strongly disagree	1	0.8	4.27	0.697
Disagree	2	1.5		
Neutral	7	5.3		
Agree	73	55.3		
Strongly agree	49	37.1		
Total	132	100.0		
Mean = 4.21 Std. Dev = 0.559				

According to the findings in Table 5.8, the majority of respondents agreed (56.8%) or strongly agreed (34.8%) that employing logistics technology has aided logistics businesses in delivering client orders on time. Furthermore, 56.8% of respondents said they believe (with 33.3% strongly agreeing) that using logistics technology has enhanced customer service in their firms. More so, 55.3% of the respondents agreed

that using logistics technology has helped their firms to process customer orders on time, whereas 53% respondents agreed and strongly agreed (37.9%) that using technology has helped firms reduce the response time to customer orders. Moreover, 52.3% of respondents agreed (with 32.6% strongly agreeing) that logistics technology has increased yearly earnings. In addition, 51.5% of respondents agreed or strongly agreed (33.3%) that technology has reduced yearly logistical expenses. Finally, the majority of respondents (51.5%) agreed or strongly agreed (34.8%) that adopting logistics technology has improved their company's market share. The next section focuses on the exploratory factor analysis results on each of the variables used in this study.

5.4 EXPLORATORY FACTOR ANALYSIS AND SAMPLING ADEQUACY

The most common exploratory factor analysis (EFA) applications among academics are the reduction of relatively large collections of variables into more manageable ones, the development and refinement of new instrument scales, and the exploration of relationships between variables to generate theory (Reio and Shuck, 2014). Researchers generally use EFA to search for the smaller collection of *k* latent factors to represent the larger set of *j* variables, which is an exploratory strategy used to build theory (Henson and Roberts, 2006). The goal of factor analysis is to break down huge amounts of data into smaller chunks, allowing the researcher to analyse the structure of variables according to theory (Reio and Shuck, 2014). In this study, EFA was used to check how the three variables in the research were structured (i.e. logistics technology adoption and use, the role of logistics technology adoption and use, as well as business performance). It also allowed the researcher to test the validity of the scales employed empirically. However, before EFA was performed, this study first confirmed the adequacy of the sample for factor analysis. To confirm that the sample is adequate for factor analysis, the Kaiser – Meyer-Olkin (KMO – see Table 5.9) measure was computed, and is discussed below.

5.4.1 Measuring of sampling adequacy

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was computed to measure and confirm whether the sample used in this study was adequate enough to

perform a factor analysis. According to Gabriel, Hoch and Cramer (2019:545), KMO is a statistic that tells a researcher how much of the variance in their research variables is due to underlying factors, and measures how suitable the study's data is for factor analysis. The test measures sampling adequacy for each variable in the model and for the complete model (Gabriel, Hoch and Cramer, 2019). A minimum threshold KMO value of 0.6 or above is recommended, and suggests that a factor analysis might be relevant for the study's data (Hair et al., 2010).

In Bartlett's test of sphericity, the identity matrix is compared to an observed correlation matrix, and the tests seek to see if there is enough redundancy between the variables to be able to summarise them with a small number of variables (Hair et al., 2010). The Bartlett's test of sphericity tests the hypothesis that a correlation matrix is an identity matrix, indicating that the research variables are unrelated and thus unsuitable for structure discovery (Pallant, 2010:199). In this study, both the KMO and the Bartlett's test of sphericity were performed in SPSS version 27, and the results are presented in Table 5.9.

Table 5.9: Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test

Kaiser-Meyer-Olkin measure of sampling adequacy		**0.797**
Bartlett's test of sphericity	Approx. Chi-Square	1443.822
	Df	276
	Sig.	0.000

Table 5.9 confirms that the sample data was suitable for factor analysis, because the KMO value of 0.797 is above the acceptable threshold value of 0.6 and the Bartlett's test of sphericity is statitistically significant (p-value=0.000) (Pallant, 2010:199). This supported the performance of EFA in this study.

5.4.2 Exploratory factor analysis

This study used the principal component with orthogonal rotation (Varimax) as the extraction method. This extraction method was chosen because it effectively collects and organises the components with high eigenvalues in order of significance. Table 5.10 shows the percentage contribution of each factor to the overall variation.

5.4.2.1 Total variance explained

Variance is a term that describes how different an item is from the average or mean (Hayes, 2021). It is determined by squaring the disparities between each number in the data set and the mean, then dividing the sum of the squares by the number of values in the data set (Hayes, 2021). A high variance suggests that the numbers in the collection are both distant from the mean and far apart. On the other hand, a smaller variation suggests the polar opposite (Howe, 1999). According to Howe (1999), a variance of zero shows that all values inside a collection of integers are the same. Every non-zero variance is a positive number. It is impossible for a variance to be negative. That is because a negative value cannot come from a square, hence it is mathematically impossible (Hayes, 2021). Table 5.10 presents the total variance explained results from the principal component analysis performed in SPSS version 27.

Table 5.10: Total variance explained

Com-ponent	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumu-lative %	Total	% of Variance	Cumu-lative %	Total	% of Variance	Cumu-lative %
1	7.103	29.596	29.596	7.103	29.596	29.596	4.599	19.161	19.161
2	2.569	10.704	40.300	2.569	10.704	40.300	3.225	13.438	32.600
3	2.243	9.345	49.646	2.243	9.345	49.646	2.604	10.851	43.450
4	1.524	6.349	55.995	1.524	6.349	55.995	1.894	7.891	51.341
5	1.159	4.831	60.826	1.159	4.831	60.826	1.755	7.314	58.655
6	1.071	4.462	65.288	1.071	4.462	65.288	1.592	6.633	65.288

Extraction Method: Principal Component Analysis.

The principal component analysis results reveal the presence of six factors with eigenvalues exceeding the recommended threshold value of 1 (see Table 5.10). As shown in Table 5.10, component factor number 1 has the highest eigenvalue (7.103) which corresponds to 29.596% of the total variance while the last component (number 6) has an eigenvalue of 1.071 which accounts for 4.462% of the total variance. The extracted factors were further rotated to ensure that the variable items were explained by the underlying factors and the results are presented in Table 5.11 below.

5.4.2.2 Rotated component matrix

Factors are rotated and rearranged to make them easier to understand. Factor rotation ensures that various items are explained or predicted by diverse underlying

factors as much as feasible, and that each factor explains more than one item, and this is referred to as simple structure (Mindrila, 2017). Although this is the intention of rotation, it is not always realised. The degree to which the simple structure is accomplished in the rotated matrix of factor loadings is one thing to look for (Jambu, 1991). The rotated factor matrix table is crucial to comprehend the study' findings. Table 5.11 presents the rotated component matrix.

Table 5.11: Rotated component matrix

	Component				
Items	**Component 1: Business performance**	**Component 2: The Role of logistics technology adoption and use**	**Component 3: Logistics technology adoption and use**	**Component 4: Logistics technology adoption and use**	**Component 5: Logistics technology adoption and use**
UA1				0.475	
UA3				0.816	
UA4				0.507	
UA5			0.664		
UA6			0.760		
UA7				0.592	
UA8			0.746		
UA9			0.547		
UA10					0.632
UA11					0.746
ROLE1		0.638			
ROLE2		0.584			
ROLE3		0.658			
ROLE4		0.747			
ROLE5		0.766			
ROLE6		0.753			
BP1	0.763				
BP2	0.722				
BP3	0.787				
BP4	0.822				
BP5	0.767				
BP6	0.723				
BP7	0.795				

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 8 iterations.

The elements associated with each component are listed in full in Table 5.11 above. The factor loadings and the number of items were used to determine the number of factors per component. When making a decision on factors, Pallant (2010:194) proposed two important considerations: (i) factor loading of above 0.3, and (ii) a component comprising more than three items should be regarded as a positive factor. Based on the results presented in Table 5.11 above, both of these considerations are

fully met. Nevertheless, there are many dynamics to consider when organising items in the components, and one of them is the theoretical structure. The current study, for example, identified three constructs, namely logistics technology adoption and use, the role of logistics technology adoption and use, and business performance.

As can be seen in Table 5.11, all the items relating to logistics technology adoption and use (UA) load in components 3, 4 and 5, but these items seem to load best in component 3. Moreso, all the items relating to the role of logistics technology adoption and use (ROLE) load best in component 2, while all the items linked to business performance (BP) load best in component 1. It is worth noting that item UA2 was removed because it was the only item that loaded to component, without any other items. The next section provides the reliability results.

5.5 RELIABILITY OF CONSTRUCTS

The degree to which a phenomenon's measurement produces steady and consistent findings is referred to as reliability (Taherdoost, 2016). The internal consistency was measured using the Cronbach's alpha coefficients of the following research variables – logistics technology adoption and use, the role of logistics technology adoption and use, and business performance. Cronbach's alpha has a cut-off value of 0.7 (Hair et al., 2014); however, 0.6 is occasionally acceptable (Malhothra et al., 2017). In the social and organisational sciences, Cronbach's alpha dependability is one of the most extensively used metrics of reliability (Cronbach, 1951). Bonett and Wright (2014) depict that the reliability of a sum (or average) of q measurements, where the q measurements may represent q raters, occasions, alternate forms, or questionnaire/test items, is described by Cronbach's alpha reliability. If the measurements are “congeneric” (Joreskog, 1971), a one-factor model with uncorrelated measurement errors can be used to represent them. However, since the measurements do not have to have equal variances or covariances among them, the congeneric assumption is more practical than the tau-equivalence assumption (Bonett and Wright, 2014). Table 5.12 presents the reliability test results.

Table 5.12: Reliability tests

Constructs	Items	Corrected item-total correlation	Cronbach's alpha	Number of items
Logistics technology adoption and use	UA1	0.384	0.783	10 (11)
	UA3	0.388		
	UA4	0.511		
	UA5	0.428		
	UA6	0.536		
	UA7	0.581		
	UA8	0.605		
	UA9	0.425		
	UA10	0.471		
	UA11	0.501		
Role of logistics technology adoption and use	ROLE1	0.524	0.823	6
	ROLE2	0.502		
	ROLE3	0.611		
	ROLE4	0.682		
	ROLE5	0.617		
	ROLE6	0.609		
Business Performance	BP1	0.712	0.904	7
	BP2	0.655		
	BP3	0.711		
	BP4	0.801		
	BP5	0.695		
	BP6	0.675		
	BP7	0.753		

The results in Table 5.12 show Cronbach's alpha coefficients ranging from 0.783, 0.823 to 0.904. All these Cronbach's alpha coefficient values are over the recommended threshold value of 0.7, thus confirming that all of the research variables used in this study are internally consistent in their measurement. The next section discusses the regression analysis results.

5.6 STANDARD MULTIPLE REGRESSION

Because the model's dependent variable is continuous, this statistical method was used (Pallant, 2010). Before performing the multiple regression test, two assumptions were considered: normality (Table 5.13) and multicollinearity (Table 5.14). Every one of these assumptions was double-checked and debated.

Normality

To ensure that the data is evenly distributed, a normality test was performed. The skewness and kurtosis values of the indicators should be less than 3 and 10, respectively (Kline, 2015). Table 5.13 presents the normality test results.

Table 5.13: Normality tests

	Skewness	Kurtosis
Logistics technology adoption and use	0.219	0.046
The role of technology adoption and use	0.185	-0.384
Business Performance	-1.009	2.199

Because the skewness and kurtosis of the constructed values fell below Kline's (2015) suggested threshold, the findings in Table 5.13 indicate that the assumption of univariate normality was fulfilled.

Assumption of multicollinearity

A multicollinearity analysis was performed to see if the independent variable, logistics technology adoption and use, had a strong correlation with this study's two dependent variables (the role of logistics technology adoption and use, and business performance). Tolerance and variance inflation factor are used to determine multicollinearity (VIF). The tolerance number should be greater than 0.1, and the VIF value should be less than 10 (Pallant, 2010). Table 5.14 presents the collinearity statistics results.

Table 5.14: Collinearity statistics

		Tolerance	VIF
1	Logistics technology adoption and use	1.000	1.000
a. Dependent Variable: The role of technology adoption and use, Business Performance			

As evidenced in Table 5.14, the tolerance value of 1.000 is greater than the recommended value of 0.1, and the VIF value of 1.000 is less than the necessary threshold value of 10. These results demonstrate that there is no multicollinearity concerns among the three research variables used in this study.

5.6.1 Correlation analysis

To determine the connections between the constructs (i.e. logistics technology adoption and use, the role of logistics technology adoption and use, and business performance), the correlation test was used. A p value less than 0.05 indicates that the association between variables is significant. At 95 or 99% confidence intervals,

values with (**), (*) indicate a substantial connection between the constructs. Table 5.15 presents the correlational results.

Table 5.15: Correlation analysis results

		Logistics technology use and adoption	The role of technology use and adoption	Business Performance
Logistics technology use and adoption	R	1		
	p-value			
The role of technology use and adoption	R	0.358**	1	
	p-value	0.000		
Business Performance	R	0.429**	0.424**	1
	p-value	0.000	0.000	

**. Correlation is significant at the 0.01 level (2-tailed).

The results in Table 5.15 show that all of the constructs have a positive and significant association with a p value less than 0.05. Also as shown in Table 5.15, there is a strong association between logistics technology adoption and use, and business performance (r= 0.429**; p=0.001), as well as between the role of logistics technology adoption and use, and business performance (r= 0.424**; p=0.001). The next section discusses the validity test results.

5.6.2 Validity tests

Table 5.16: Validity tests

Construct	Items	Factor loading	Composite Reliability	AVE	AVE Square root values
Logistics technology use and adoption	UA1	0.475	0.881	0.433	0.658
	UA3	0.816			
	UA4	0.507			
	UA5	0.664			
	UA6	0,76			
	UA7	0.592			
	UA8	0.746			
	UA9	0.547			
	UA10	0.632			
	UA11	0.746			
The role of logistics technology use and adoption	ROLE1	0.638	0.847	0.482	0.694
	ROLE2	0.584			
	ROLE3	0.658			
	ROLE4	0.747			
	ROLE5	0.766			
	ROLE6	0.753			
Business Performance	BP1	0.763	0.910	0.592	0.769
	BP2	0.722			

	BP3	0.787			
	BP4	0.822			
	BP5	0.767			
	BP6	0.723			
	BP7	0.795			

The extent to which a group of items exclusively measures one construct in the same direction is known as convergent validity (Hosany et al., 2015). For example, in the table above (Table 5.16), logistics technology adoption and use was measured with ten items, and the AVE for these items is 0.433, implying that these ten items account for 43.3% of the variations in logistics technology adoption and use. Furthermore, six factors were used to assess the role of logistics technology adoption and use, with an AVE of 0.482, implying that these six items account for 48.2% of the variations in the role of logistics technology adoption and use. Finally, seven factors were used to assess business performance, with an AVE of 0.592, implying that these seven items account for 59.2% of the variations in business performance. Since two of the research variables used in this study have AVE values less than the acceptable threshold value of 0.5, convergent validity was further assessed using composite reliability. The composite reliability values of logistics technology adoption and use (CR=0.881) and the role of logistics technology use and adoption (CR=0.847) were above the minimum acceptable composite reliability value of 0.6 (Fornell and Lacker, 1981). As a result, this study inferred that all of the questionnaire items that were kept are accurate measurements of their respective research variables, and thus confirming the presence of convergence validity for all three research variables used in the current study.

This study also checked for the presence of discriminant validity, to ensure that the questionnaire items for each variable do not explain other variables which they are not supposed to strongly correlate with (Bryman and Bell, 2011:39; Frank and Sarstedt 2018:3). Thus, following the Fornell and Lacker (1981) method of assessing discriminant, in this study, discriminant validity was measured by comparing the AVE square root values and the latent variables correlation values. Tables 5.15 and 5.16 present the results. As shown in Tables 5.15 and 5.16, the AVE square root values of 0.658, 0.694 and 0.769 for all the three latent variables (logistics technology adoption and use, role of logistics technology adoption and use, and business performance, respectively) are greater than the correlation coefficients (0.358 and 0.429

respectively) of the latent variables in this study. This corroborates that all the questionnaire items used to explain the three latent variables in the questionnaire are unique and are weakly correlated, and thus, confirming the presence of discriminant validity among this study's three research variables.

- **Model evaluation**

The effects of the predictor variable "logistics technology adoption and use" on the dependent variables (role of logistics technology adoption and use, as well as business performance) were evaluated using a standard multiple-linear regression test.

Table 5.17: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.358[a]	0.128	0.122	0.44684

a. Predictor: (Constant), Logistics technology adoption and use

Table 5.18: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	3.821	1	3.821	19.135	0.001[b]
	Residual	25.956	130	0.200		
	Total	29.777	131			

a. Dependent Variable: The role of logistics technology adoption and use

b. Predictor: (Constant), Logistics technology adoption and use

The results in Tables 5.17 and 5.18 indicate that the model predicting the role of technology is statistically significant ($F = 19.135$; $R^2 = 0.358$; $p < 0.001$). This result suggests that the predictor variable, logistics technology adoption and use explain up to 35.8% of the variance of the role of logistics technology adoption and use. Based on the results, this study concludes that the independent variable (logistics technology adoption and use) is significantly associated with the dependent variable, the role of logistics technology adoption and use.

Table 5.19: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.429[a]	0.184	0.178	0.50736

a. Predictor: (Constant), Logistics technology adoption and use

Table 5.20: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	7.535	1	7.535	29.272	0.001[b]
	Residual	33.464	130	0.257		
	Total	40.999	131			

a. Dependent Variable: Business Performance

b. Predictors: (Constant), Logistics technology adoption and use

The data in Tables 5.19 and 5.20 shows that the model for predicting business performance is statistically significant (F = 29.272; R2= 0.184; p= 0.001). This means that the adoption and use of logistics technology can account for up to 18.4% of the variance in business performance. Based on these results, the current study rejects the null hypothesis that claims that coefficients are zero, and concludes that the independent variable (logistics technology adoption and use) is significantly associated with the dependent variable, business performance.

5.7 HYPOTHESES TESTING

The current study also sought to assess the role of logistics technologies affecting logistics firms; and examine the effect of logistics technology adoption and use on business performance of logistics firms. It also sought to test the following two hypotheses:

H1: The adoption and use of logistics technology plays a significant role in logistics firms.

H2: The adoption and use of logistics technology has a positive effect on the business performance of logistics firms.

The regression results to validate these two hypotheses are presented in Table 5.21 below:

Table 5.21: Regression analysis results

Model		Standardised Coefficients Beta	T	Sig.
1	(Constant)		7.998	0.000
	Logistics technology adoption and use	0.358	4.374	0.000
a. Dependent Variable: The role of logistics technology adoption and use				
1	(Constant)		5.608	0.000
	Logistics technology adoption and use	0.429	5.410	0.000
a. Dependent Variable: Business Performance				

H1: The adoption and use of logistics technology plays a significant role in logistics firms.

The results above (Table 5.21) show that logistics technology adoption and use has a positive (β= 0.358) and statistically significant (P= 0.000 <0.05) effect on the role of logistics technology adoption and use. Therefore, Hypothesis **H1,** which claims that logistics technology adoption and use plays a significant role in logistics firms, is supported. In other words, adopting and implementing logistics technologies in the logistics activities will enhance the logistics firms' ability to locate, track and trace inventory, share accurate information on time, and even boost their firm growth. These results are in line with Onyshchenko and Yudenko's (2019) study which investigated the effect of developments on the performance of logistics companies, and found that innovations play a crucial role in delivering quality services to businesses and growing their productivity.

H2: The adoption and use of logistics technology has a positive effect on the business performance of logistics firms.

Based on the results in Table 5.21, logistics technology adoption and use has a positive (β= 0.429) and statistically significant (P= 0.000 < 0.05) effect on business performance. Therefore, **H2** is also supported. This means that adopting and implementing logistics technologies can help logistics firms to improve their annual firm profits, market share, and help them enhance their customer service levels. This also means that adopting and implementing these technologies will enable the logistics firms to reduce their total logistics costs, reduce their response time to customer orders and reduce their order processing as well as delivery times. These findings are in line with Masudin et al.'s (2020) study which found out that RFID

adoption in warehousing and inventory management increases sales, enhances quality inventory control, optimises stock turnover which in turn improves warehousing efficiency, and ultimately improves organisational performance. Onyshchenko and Yudenko’s (2019) study also adds that finding and applying technologies helps to ensure sustainable growth of the company and consolidate its competitive position in the industry.

5.8 CHAPTER SUMMARY

This chapter included the descriptive analysis (demographic) of the data collected as well as the results of the exploratory factor analysis. The results reveal that all of the constructs are internally consistent in their measurement because Cronbach's alpha values are above the required criteria. The measurement items were judged to be sufficient in terms of acceptability, making them reliable and valid. According to the study's empirical findings, respondents indicated they are excited about the use and adoption of logistics technology and have a positive outlook on the employment of technology in organisations.

The study investigated three constructs: Logistics technology usage and adoption, Logistics technology use and adoption's function, and Business performance. Both the Hypotheses (H1 and H2) have been validated and accepted through the findings. In Chapter 6, the implications of these research findings, as well as overall conclusions and recommendations, are presented.

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

This study sought to investigate whether NMB is keeping up with the current logistics technology trends and systems that are transforming logistics firms in South Africa, the African continent and the rest of the world. To achieve this primary objective, the study also sought to achieve the following sub-objectives: to identify the logistics technologies transforming logistics firms in NMB; and to assess the role of logistics technologies affecting logistics firms in NMB. The study also sought to ascertain the challenges of using logistics technologies transforming the logistics firms in NMB; and examine the effect of logistics technology adoption and use on business performance of logistics firms in NMB.

In the preceding chapter (Chapter 5), empirical findings to achieve the above stated objectives were given and discussed. The current chapter (Chapter 6) provides an overview of this research study, provides a summary of the key findings, and indicates how the research objectives of this study were met. The chapter also draws conclusions based on the empirical results, discusses the managerial implications of the results, and provides recommendations for practice, theory and further research. The next section sections summarise key research findings.

6.2 SUMMARY OF THE KEY FINDINGS

The primary goal of this study was to figure out how much logistics technology is used. The key findings from the research are discussed under the following sub-sections.

6.2.1 Key findings from literature review

The reviewed literature showed that firms across the globe make use of packaging technologies, advanced transportation management systems, warehousing management systems, ERP, RFID, the Internet of Things and robots in their logistics activities (Masudin et al., 2020). The use of such emerging technologies is currently transforming the logistics industry worldwide.

The review of previous studies also revealed that lack of resources, complexity of the logistics network, technological turbulence, the influence of business partners, employee mindsets, lack of practice and training prior to use of technology as some of the major technology adoption- and use-related challenges faced by firms (Cichosz, Wallenburg and Knemeyer, 2020; Hao et al., 2020). These challenges hinder firms' ability to realise any gains from the adoption and use of technology in their day-to-day logistics activities. Hao et al. (2020) further highlighted the need for decision support for firms to adopt technologies in their operations.

This study constituted three research variables: logistics technology adoption and use, the role of logistics technology adoption and use, and business performance. It is clear that technology adoption plays a major role in firms across the globe. This study used the RBV and dynamic capabilities theory to explain the possible relationship between logistics technology adoption and use, and business performance. The reviewed literature also showed that the use of logistics technologies such as RFID increases business performance through increased sales, enhanced inventory control, optimised stock turnover, which in turn improves organisational performance, sustainable growth and competitive advantage of firms (Masudin et al., 2020; Onyshchenko and Yudenko, 2019). The next section discusses the key findings from primary study.

6.2.2 Key findings from primary study

The primary goal of this research was to assess the logistics technologies transforming the logistics industry in NMB and the effects these have on business performance. This was accomplished by achieving the secondary objectives listed below. The key findings for each research objective are presented.

Objective 1: To investigate whether NMB is keeping up with the current logistics technology trends and systems that are transforming logistics firms

Based on the empirical results discussed in Chapter 5, the surveyed NMB logistics firms are keeping up with some of the current logistics technology trends and systems that are transforming the logistics industry world over. This objective was achieved and was presented in Chapter 5. The descriptive results in Chapter 5 also reveal that technology use in logistics firms has advanced a lot to vehicle tracking, packaging,

inventory control, and communication systems, as well as robotics. This makes sense, given the current Covid 19 pandemic which has forced firms across industries to pursue innovative and digital solutions to remain competitive and mitigate the threat placed on human resources by this pandemic.

Objective 2: To identify the logistics technologies transforming logistics firms

The study also sought to identify the logistics technologies transforming logistics firms. This objective was achieved and was presented in Chapter 5. The empirical results in Chapter 5 cited logistics technologies such as the Internet of Things, robotic process automation, digital supply chain twins, vendor managed system and RFID as some of the major technologies currently transforming the logistics firms.

Objective 3: To assess the role of logistics technologies affecting logistics firms

The current study further sought to assess the role of logistics technologies affecting logistics firms. This objective was also achieved and was presented through both the descriptive and regression results discussed in Chapter 5. The results in Chapter 5 confirm that logistics technology adoption and use play a positive and significant role in logistics firms. The regression results performed in SPSS version 27 show that adopting and implementing logistics technologies in the logistics activities can enhance the logistics firms' ability to locate, track and trace inventory, share accurate information on time, and even boost their firm growth. The results also report that adoption and use of logistics technology plays a significant role in logistics firms.

Objective 4: To ascertain the challenges of using logistics technologies transforming the logistics firms

In addition, the research aimed to ascertain the challenges of using logistics technologies transforming the logistics firms. Theoretically, the influence of technology and the challenges it faces were discussed in Chapters 2 and 3. The descriptive analysis results in Chapter 5 showed that many challenges exist with logistics technology adoption, like lack of investment towards logistics technology; the fear of losing jobs as people get replaced by technology such as machines and robots; high logistics costs due to a few challenges. Based on the above, the fourth objective of this study

was achieved. Therefore, this study concludes that NMB faces many challenges with regards to logistics technology adoption.

Objective 5: To examine the effect of logistics technology adoption and use on business performance of logistics firms

Finally, this study sought to examine the effect of logistics technology adoption and use on business performance of logistics firms. This objective was achieved and was presented in Chapter 5. The regression analysis results confirmed a positive and significant effect of logistics technology adoption and use on business performance of logistics firms. These results showed that adopting and implementing logistics technologies can help logistics firms to improve their annual firm profits, market share, and help them enhance their customer service levels. The results also confirmed that adopting and implementing these technologies will enable the logistics firms to reduce their total logistics costs, reduce their response time to customer orders and reduce their order processing as well as delivery times. Therefore, this study concludes that logistics technology is necessary to improve business performance.

6.3 CONCLUSION

The current study primarily sought to identify and assess the technologies transforming the logistics industry in NMB. The study also aimed to assess the role of technologies affecting logistics firms. Further, the research aimed to ascertain the challenges of using logistics technologies transforming the logistics firms in NMB. Finally, it also sought to examine the effect of technology adoption and use on business performance of logistics firms. Based on the empirical results discussed in Chapter 5, this study came to the following conclusions:

i. Just like other firms the world over, logistics firms in NMB keep abreast of the current logistics technological trends. Though the progress might seem to be slow, the logistics firms in NMB have commenced using advanced logistics technologies and this has advanced to vehicle tracking, packaging, inventory control, and communication systems, as well as robotics.
ii. The internet is the most commonly used kind of technology identified by the study. The study also concluded that all firms make use of the Internet. Robotic

process automation, digital supply chain twin, vendor managed system, autonomous things and RFID are some of the most commonly used logistics technologies in the NMB logistics sector. Other technology used on a smaller scale includes: Artificial intelligence, blockchain technology, immerse experience, WMS, tracking systems, third party application and collaborative replenishment technology. These advancements benefit the whole logistics industry, including trucking, warehousing, and packaging.

iii. It is crucial for logistics firms to adopt and deploy logistics technologies in their logistics activities to achieve the necessary resilience and business growth and to remain competitive, especially in this Covid 19 pandemic era. According to the role-players, logistics technology plays a significant role in creating customer value advantages and is necessary to create cost advantages to the supplier and end consumer. Technology is necessary for on time deliveries as tracking systems are necessary to locate track and trace inventory. Logistics technology plays a significant role in ensuring that quality and accurate information is shared by collaborating with other stakeholders within the supply chain.

iv. Logistics firms face major challenges when adopting and implementing logistics technologies in their activities. Some of these include the following: the concern of losing jobs as people are replaced by technology such as machines and robots; high costs; other departments do not see the importance of the logistics department; other departments do not offer the needed support in order for the logistics department to operate as efficiently and as effectively as possible. It appears that logistics firms within NMB do not have the needed capital to invest in logistics technology.

v. Logistics technology adoption and use is a key driver of business performance of logistics firms. Using logistics technology has improved logistics firms' annual profits, which resulted from improved customer service, reduced response time to customer orders and customers' orders delivered on time. Logistics technology helps increase market share by making logistics firms more competent within the sector. Improved technology has also enhanced supply chain productivity, lowering costs and reducing errors. Therefore, businesses must maximise the use of advanced technologies to remain competitive.

6.4 MANAGERIAL AND POLICY IMPLICATIONS

One of the main aims of any theoretical business research is to identify and emphasise practical implications. This study sought to make practical and theoretical implications for logistics enterprises within the constraints of NMB owners/managers and policy makers. Due to the fact that it was a business research, the current study sought to assess the logistics technologies adopted and used, assess their role in logistics firms, determine the challenges of using logistics technologies, and examine the effect of logistics technology adoption and use on the business performance of logistics firms. A variety of practical consequences are highlighted in this study. As a result, the research study aids logistics firm owners/managers in gaining a better knowledge of the advantages of incorporating new logistics technology in their businesses. It assists managers and owners in streamlining their daily operations in order to better fulfil demand.

As discussed throughout this study, the usage of technology can have a favourable effect on the business performance of logistics firms. Managers and owners are encouraged to embrace logistics technology that is appropriate for their logistics firm’s daily operations. This emphasises the importance of engaging with supply chain equivalents and other organisations in the same profession that are more technologically advanced. Constant improvement is essential to remain competitive and as effective and efficient as achievable. It is also necessary for firms to use a set of criteria to discover possible areas in need of improvement, evaluating available logistics technologies and studying the role and benefits thereof to ensure that it can strengthen their business performance and competitiveness. With the rapid advancement of modern technologies in today's business environment, logistics business owners/managers must make educated and informed judgments based on scientific study on the utilisation of such logistics technologies and the benefits they provide. The modern corporate world sees technology as the way of the future, and believes that no company can succeed without it. These business owners/managers can be assisted in assessing the benefits and costs of innovation, as more efficient processes reduce errors, reduce lead time, and save cost, to name a few of the advantages technology can provide. As a result, it is critical that these business

owners/managers have a thorough awareness of the benefits and disadvantages of technology.

The findings of the study have far-reaching implications for policymakers. The government and educational institutions in South Africa work together to devise policies and initiatives to increase academic attainment. Technology should be given more attention in secondary and postsecondary schools to ensure that future employees are physically and intellectually prepared and receptive to adopting new technology. Companies like Amazon and Alibaba have grown immensely since the emergence of technology. Technology is seen as the true driver of competitiveness, allowing for economic growth in terms of expanding GDP and tackling the ever-increasing economic challenge of unemployment.

6.5 RECOMMENDATIONS AND CONTRIBUTION

The primary objective of this study was to assess the technologies transforming the logistics industry in NMB. This research could therefore help logistics companies in the NMB decide whether or not to use logistics technologies. The findings identified the existing logistics technologies in use, the role that technologies play, and the challenges that logistics organisations face when implementing these technologies, as well as the impact on business performance. The outcomes of this study provide a platform for logistics firm owners/managers to improve their performance and make necessary changes in certain areas. The findings of the study may be useful to logistics firm owners/managers because they show that no company can progress without the right technologies in place.

The findings of this study will add to the literature on logistics technologies and business performance, and can be used in future research. This study is expected to aid logistics operators, managers, and policymakers in understanding the importance and benefits of implementing logistics technologies. NMB was chosen mainly because of its low adoption of logistics technologies. It is envisaged that NMB and South Africa as a whole might be far behind with the ever changing logistics technologies adopted by other countries. Other countries with higher levels of logistics technology adoptions might have different experiences than NMB and the larger South Africa, particularly in

terms of efficiency and effectiveness of logistics operations. The recommendations are expected to benefit the logistics industry.

According to this study, logistics technologies can help organisations function more efficiently in evolving marketplaces. It was demonstrated that suppliers can use the findings to compare themselves in order to ensure that they use their current available logistics technologies optimally and implement new technologies where necessary. The benefits of using technology include increased supply chain productivity, reduced costs and errors, better inventory control, smarter warehouse space utilisation, increased customer and supplier satisfaction, and an improved customer experience. As new technologies become available, the benefits of logistics technologies expand.

In logistics, information, communication, and automation technologies have significantly increased the speed with which data is identified, collected, processed, analysed, and transmitted, all while maintaining a high level of accuracy and reliability. The use of logistics technology can help businesses improve their competitiveness and performance. A corporation may undertake substantial strategic changes and increase operational efficiency with an automated, cost-effective logistics system. It also boosts scalability, cuts down on human error, and takes a proactive approach to client satisfaction. Every advancement in a firm is based on competition, and competitiveness is unquestionably one of the driving forces for the increased adoption of these technologies.

The outcomes of this study demonstrated that logistics firms should be guided in their quest to make better use of current technologies and adopt innovations that will benefit the firm. This study recommends the following:

i. Many firms have implemented technology, which may have had a favourable impact on current procedures. The goal is to guarantee that the firm gets the most out of its present technologies before moving on to new technologies. Following that, the firm can determine what technologies it will require to ensure that its processes run seamlessly. A firm could evaluate which technologies are available and best suited for their respective operations by conducting a study in their sector or consulting with technology specialists. Finally, businesses

should understand the advantages of this new technology and how it will affect their current operations.

ii. The most crucial issue is to analyse whether the new technology aligns with the firm's objectives and whether its adoption will result in much-needed growth within the company. Profits are the primary purpose of any organisation, and profits cannot be made without consumers; thus, the question is whether new technology can improve customer value. Customer value will undoubtedly rise as a result of more streamlined offerings and user-friendly platforms. Logistics firms need to first figure out whether the new technology will save revenue. Because technologies are costly and often necessitate large expenditures, these businesses must ensure that the cost savings realised after deployment justify the capital spent. Response time is one of the most essential criteria in business currently, as customers are more inclined to choose a service provider with a faster response time. Finally, before making any investment, the firm must decide whether the implementation will have a favourable or negative impact on their quality and accuracy.

iii. Technophobia, fear, hatred, or avoidance of new technology, could be one of the problems of incorporating new technologies. Change is unavoidable, and the adapt or die strategy is in effect. If at all possible, technophobia should be addressed or treated. Technology is costly, thus thorough research should be conducted to ensure that the new technology pays for itself and, more significantly, to assess whether the investment is justified. Employee training is critical in ensuring that they understand how the technology works and what benefits it provides. The idea is to do what we do, but to do it spending less revenue, because, as previously stated, the primary goal of a business is to generate revenue. Firms must undergo a due diligence process before obtaining financing for new technology investments since new innovations necessitate investment. Employees from the top down should be notified of any changes and how they will benefit the company if the process is successful. This will guarantee that all employees are on the same page.

iv. Technology is an important investment, but it can be entirely useless if it is not put to its intended use. Conduct a feasibility study to see whether the technology would boost earnings before making the investment. The

percentage of the whole market for a company's products and services that it controls is referred to as market share. Many firms have benefitted from technological advancements, and businesses with an online presence now have a higher market share as people gravitate toward online buying.

v. The study's findings show that technological adoption is unavoidable and that technology awareness drives and training are imperative to enlighten employees about the benefits technologies hold. The survey discovered that technology is present in every organisation, even if it is on a micro scale. According to the research, logistics companies and their employees should view technology as an opportunity rather than a threat to their operations. Governments, educational institutions, policymakers, and businesses should all be aware that technology is the way of the future. The positive advantages of technology should be emphasised more.

6.6 RESEARCH LIMITATIONS

The study addressed the research objectives as intended. The research focused on logistics firms in NMB, Eastern Cape, South Africa only. Most of the headquarters of logistics firms are based in the main centres where logistics technologies might be more common, e.g. in Gauteng and Western Cape Provinces.

The restrictions brought by the Covid-19 pandemic made it almost impossible to physically deliver questionnaires to respondents. It was difficult to get survey participants as the study focused mainly on members of logistics management. Management officials are always busy and do not have time or are not interested in the researcher’s cause. However, the use of Google survey made it easier for the participants to complete the survey, at their own convenience.

6.7 FUTURE RESEARCH

The current pandemic has brought logistics much closer, and future implementation and adoption which could have been more long term have now become a necessity in the current state we are in. Technologies are changing by the day and no current study will keep up with the change because there is always something on the forefront or in the development stage. Future studies are encouraged to look at the long-term

effects of logistics technology adoption and performance in South Africa and other African countries once technology adoption has been considered. Future studies can also investigate the long-term effects of technology use and adoption on not only business performance but also on business resilience and competitiveness.

Increased efficiency, reduced costs, higher production rates, better inventory control, intelligent warehouse space utilisation, increased customer and supplier satisfaction, and a better customer experience are all indicators of logistics success. All this can only be achieved with future research. The research could be expanded to additional cities and provinces of South Africa and in other African countries in the future. NMB was chosen for this study. Many other bigger cities in South Africa house logistics firms of a higher calibre than those in NMB.

6.8 CHAPTER SUMMARY

This chapter synthesised the key results both from previous literature reviewed and the empirical results. It was demonstrated that evaluating present and future technological needs has a favourable impact on business success. The study posits that there is a link between the use of technology and business performance. This chapter demonstrated that the study's objectives were met. It has been proven that technology adoption is required to gain market share. This study also found that there are challenges/barriers to technology adoption in NMB, but that the framework is helpful to logistics firms. This chapter also discussed the implications and made recommendations for practice, theory and research. Finally, based on the study conducted, this chapter has recommended that technology awareness drives and trainings should be presented to employees to promote the benefits of technology adoption.

One of the study's limitations was that it only looked at one metropolitan, in one province of South Africa. The majority of logistics firms' headquarters are located in major cities where logistics technology is more prevalent. Any future studies can be expanded throughout the South Africa, and beyond. Future research can look on the long-term impact of technology on business performance. Long-term testing of the technology evaluation framework should also be included in studies. Finally, the

research intended to emphasise that technology is here to stay, and that individuals and businesses should embrace it in order to reap the full benefits it brings. This chapter confirmed that the objectives had been met.

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APPENDICES

Appendix A: Cover letter

Dear Respondent

The researcher is currently busy doing an **academic research** on the research topic: "***Assessing the technologies transforming the logistics industry in NMB".*** The above-mentioned research is only for **academic purposes**. The researcher hereby undertakes to uphold the **confidentiality clause**. **No names** of respondents, businesses or departments or respondents will be identified. The respondent has the right to participate voluntarily so, and withdraw at anytime during the survey, with no consequences. 7-12 minutes of your time will be required to answer the questions of the questionnaire.

Researcher: Questionnaire: Byron Ruiters Course: Master in Logistic Management, Institution: Nelson Mandela University

Appendix B: Questionnaire

NELSON MANDELA UNIVERSITY

Researcher Questionnaire: Byron Ruiters Course: Master in Logistic Management

The researcher is currently busy doing an **academic research** on the research topic: "***Assessing the technologies transforming the logistics industry in NMB***". The above-mentioned research is only for **academic purposes**. The researcher hereby undertakes to uphold the **confidentiality clause**. **No names** of respondents, businesses or departments or respondents will be identified. The respondent has the right to participate voluntarily so, and withdraw at anytime during the survey, with no consequences. 7-12 minutes of your time will be required to answer the questions of the questionnaire.

PLEASE ASSIST BY COMPLETING THE FOLLOWING QUESTIONNAIRE

SECTION A: BIOGRAPHICAL AND COMPANY INFORMATION SECTION

Please answer question by marking with [x]

1. Gender

Male	1
Female	2

2. Age

18 -30	1
31-40	2
41-50	3
51- 60	4

3. Highest Qualification

Grade 12	1
Certificate	2
Diploma	3
Degree	4
Honours	5
Masters	6
PhD	7
Other(specify	8

NELSON MANDELA UNIVERSITY

4. What is your job title?

Logistics Manager.	1
Materials Manager.	2
Transportation/Fleet/Shipping Manager	3
Procurement Manager.	4
Inventory Manager.	5
Warehouse Manager.	6
Other (specify).....	7

5. Number of years employed in the logistics industry?

Less than 5 years	6-10	11-15	16-30	31 years and above
1	2	3	4	5

6. Type of Logistics Business

Transport	Warehousing	Packaging	Other (specify

SECTION B: USE OF LOGISTICS TECHNOLOGIES AND CHALLENGES

7. Do you use any technologies in your logistics business?

Yes	No
1	2

8. Which of the following technologies do you use in your logistics business?

Internet of Things	1
Robotic Process Automation	2
Artificial Intelligence	3

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Advanced analytics	4
Vendor Managed System	5
Collaborative replenishment technology	6
Autonomous Things	7
Digital Supply Chain Twin	8
Immerse Experience	9
RFID	10
Blockchain technology	11
Other (specify)	12

9. On a scale from 1 to 5 indicate whether technology is a growing concern to logistics firms in NMB.

Never a concern	1
Least concern	2
Somewhat a concern	3
It is a concern	4
It is a big concern	5

10. By marking with an X please, indicate in which areas have you seen these technological advancements in your company?

Inventory control	1
Vehicle tracking	2
Data exchange	3
Robotics	4

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Smart systems	5
Data protection and privacy	6
Communication systems	7
Packaging	8
Other (specify)	9

11. Do you see technology within the logistics industry as a growing concern in NMB, please mark a maximum of 2 statements you agree to with an X?

Yes	No
1	2

12. Which of the following are the main challenges you face with regards to logistics technology?

Inadequate room for logistics technology growth within logistics firms in NMB.	1
Most of the people involved with logistics are not aware of the technological advancement available.	2
Other departments do not see the importance of the logistics department.	3
There is a lack of investment towards logistics technology.	4
There are but a few new developments in NMB.	5
Technophobia (the irrational fear emanating from the side effects of using modern advanced technologies)	6
High logistics costs	7
Very high costs of investing in technology infrastructure	8
Fear of losing jobs as people get replaced by technology such as machines and robots	9
Unwillingness of customers to pay for technology related costs	10
Absence of skilled staff in logistics technology	11

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Other (specify)	12

SECTION C:

13. Please rate the following statements on the use and adoption of logistics technology in your firm.

Logistics technology use and adoption	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
13.1 Our management encourages the use and adoption of technology within the company.	1	2	3	4	5
13.2 The level of technology usage is very low within our company.	1	2	3	4	5
13.3 Employees resist the usage of logistics technology within the company	1	2	3	4	5
13.4 The technology equipment within our companies are not effective for our logistics activities.	1	2	3	4	5
13.5 The customers service delivery has improved since we started using logistics technologies within our company	1	2	3	4	5
13.6 The high use of technology in our logistics operations has enabled us to respond to increasing customer demand on time	1	2	3	4	5
13.7 Adopting and using technology in our logistics operations has enabled us to sense and respond to any changes in the market on time.	1	2	3	4	5
13.8 Adopting and using emerging technologies, such as the Internet and Extranets has enabled us to share information with our stakeholders on time.	1	2	3	4	5
13.9 We use technology to create better value for our customers through our logistics activities.	1	2	3	4	5
13.10 Using technology in our daily logistics activities	1	2	3	4	5

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has allowed our company to survive any form of supply chain disruptions such the ones caused by the current COVID 19 pandemic					
13.11 Using technology in logistics activities has allowed our company to successfully collaborate on big projects with our suppliers.	1	2	3	4	5

SECTION D: ROLE OF LOGISTICS TECHNOLOGY USE

14. Please rate the following statements on merit, what is the role of technology use in logistics firms in NMB?

The Role of logistics technology use and adoption	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
14.1. Technology is necessary for growth.	1	2	3	4	5
14.2. Logistics technology plays a significant role in creating customer value advantages.	1	2	3	4	5
14.3. Technology (systems, robots, etc.) is necessary to create cost advantages.	1	2	3	4	5
14.4. Technology is necessary for on time deliveries.	1	2	3	4	5
14.5. Technology is necessary to locate, track and trace inventory.	1	2	3	4	5
14.6. Logistics technology plays a significant role in ensuring that quality and accurate information is shared.	1	2	3	4	5
SECTION E: EFFECTS OF LOGISTICS TECHNOLOGY USE ON BUSINESS PERFORMANCE 15. Please rate the following statements on merit, what is the effect of technology on business performance of logistics firms in NMB?					
Business performance					
15.1. Using logistics technology have improved our firm's annual profits.	1	2	3	4	5
15.2. Using logistics technology have helped us improve our customer service.	1	2	3	4	5
15.3. Using logistics technology has helped us to reduce our response time to customer orders.	1	2	3	4	5
15.4. Using technology has helped reduce our total annual logistics costs per year.	1	2	3	4	5

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15.5. Using logistics technology has helped us increase our market share	1	2	3	4	5
15.6. Using logistics technology has helped us to deliver our customers' orders on time.	1	2	3	4	5
15.7 Using logistics technology has helped us to process customer orders on time	1	2	3	4	5

Thank you for your patronage

Appendix C: Letter from the language editor

Erf 9705 Agulhas Street

Ocean View, Swakopmund

Namibia

Date: 13 December 2021

Nelson Mandela University

PO Box 77000

Gqeberha

6031

Dear Sir/Madam,

Declaration of language editing

I, Jeanne Enslin, hereby declare that I have personally read through the thesis of **Byron Ruiters** and have highlighted and corrected all aspects of language errors.

Yours sincerely

Jeanne Enslin

13 December 2021

Appendix D: Ethical clearance letter

NELSON MANDELA
UNIVERSITY

PO Box 77000, Nelson Mandela University, Port Elizabeth, 6031, South Africa mandela.ac.za

Chairperson: Faculty Research Ethics Committee (Human)
Tel: +27 (0)41 504 2906

Ref: [H20-BES-LOG-018] / Approval]

5 May 2020

Prof P Hove-Sibanda
Department: Logistics

Dear Prof Hove-Sibanda,

TITLE OF STUDY: ASSESSING THE TECHNOLOGIES TRANSFORMING THE LOGISTICS INDUSTRY IN NELSON MANDELA BAY (MCOM)

PRP: Prof P Hove-Sibanda
PI: Mr B Ruiters

Your above-entitled application served at the *Faculty Ethics Committee of the Faculty of Business and Economic Science,* (*14 February 2020*) for approval. The study is classified as a negligible/low risk study. The ethics clearance reference number is **H20-BES-LOG-018** and approval is subject to the following conditions:

1. The immediate completion and return of the attached acknowledgement to Lindie@mandela.ac.za, the date of receipt of such returned acknowledgement determining the final date of approval for the study where after data collection may commence.
2. Approval for data collection is for 1 calendar year from date of receipt of above mentioned acknowledgement.
3. The submission of an annual progress report by the PRP on the data collection activities of the study (form RECH-004 to be made available shortly on Research Ethics Committee (Human) portal) by 15 December this year for studies approved/extended in the period October of the previous year up to and including September of this year, or 15 December next year for studies approved/extended after September this year.
4. In the event of a requirement to extend the period of data collection (i.e. for a period in excess of 1 calendar year from date of approval), completion of an extension request is required (form RECH-005 to be made available shortly on Research Ethics Committee (Human) portal)
5. In the event of any changes made to the study (excluding extension of the study), completion of an amendments form is required (form RECH-006 to be made available shortly on Research Ethics Committee (Human) portal).
6. Immediate submission (and possible discontinuation of the study in the case of serious events) of the relevant report to RECH (form RECH-007 to be made available shortly on Research Ethics Committee (Human) portal) in the event of any unanticipated problems, serious incidents or adverse events observed during the course of the study.
7. Immediate submission of a Study Termination Report to RECH (form RECH-008 to be made available shortly on Research Ethics Committee (Human) portal) upon unexpected closure/termination of study.
8. Immediate submission of a Study Exception Report of RECH (form RECH-009 to be made available shortly on Research Ethics Committee (Human) portal) in the event of any study deviations, violations and/or exceptions.
9. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of Research Ethics Committee (Human).

Please quote the ethics clearance reference number in all correspondence and enquiries related to the study. For speedy processing of email queries (to be directed to Lindie@mandela.ac.za), it is recommended that the ethics clearance reference number together with an indication of the query appear in the subject line of the email.

We wish you well with the study.

Yours sincerely

Prof S Mago

Cc: Department of Research Capacity Development
Faculty Research Co-ordinator: Lindie van Rensburg

ACKNOWLEDGEMENT OF CONDITIONS FOR ETHICS APPROVAL

I, **Prof P Hove-Sibanda** (PRP) of the study entitled **ASSESSING THE TECHNOLOGIES TRANSFORMING THE LOGISTICS INDUSTRY IN NELSON MANDELA BAY (MCOM) (H20-BES-LOG-018)**, do hereby agree to the following approval conditions:

1. The submission of an annual progress report by myself on the data collection activities of the study by 15 December this year for studies approved in the period October of the previous year up to and including September of this year, or 15 December next year for studies approved after September this year. It is noted that there will be no call for the submission thereof. The onus for submission of the annual report by the stipulated date rests on myself.

2. Submission of the relevant request to Faculty RECH in the event of any amendments to the study for approval by Faculty RECH prior to any partial or full implementation thereof.

3. Submission of the relevant request to Faculty RECH in the event of any extension to the study for approval by Faculty RECH prior to the implementation thereof.

4. Immediate submission of the relevant report to Faculty RECH in the event of any unanticipated problems, serious incidents or adverse events.

5. Immediate discontinuation of the study in the event of any serious unanticipated problems, serious incidents or serious adverse events.

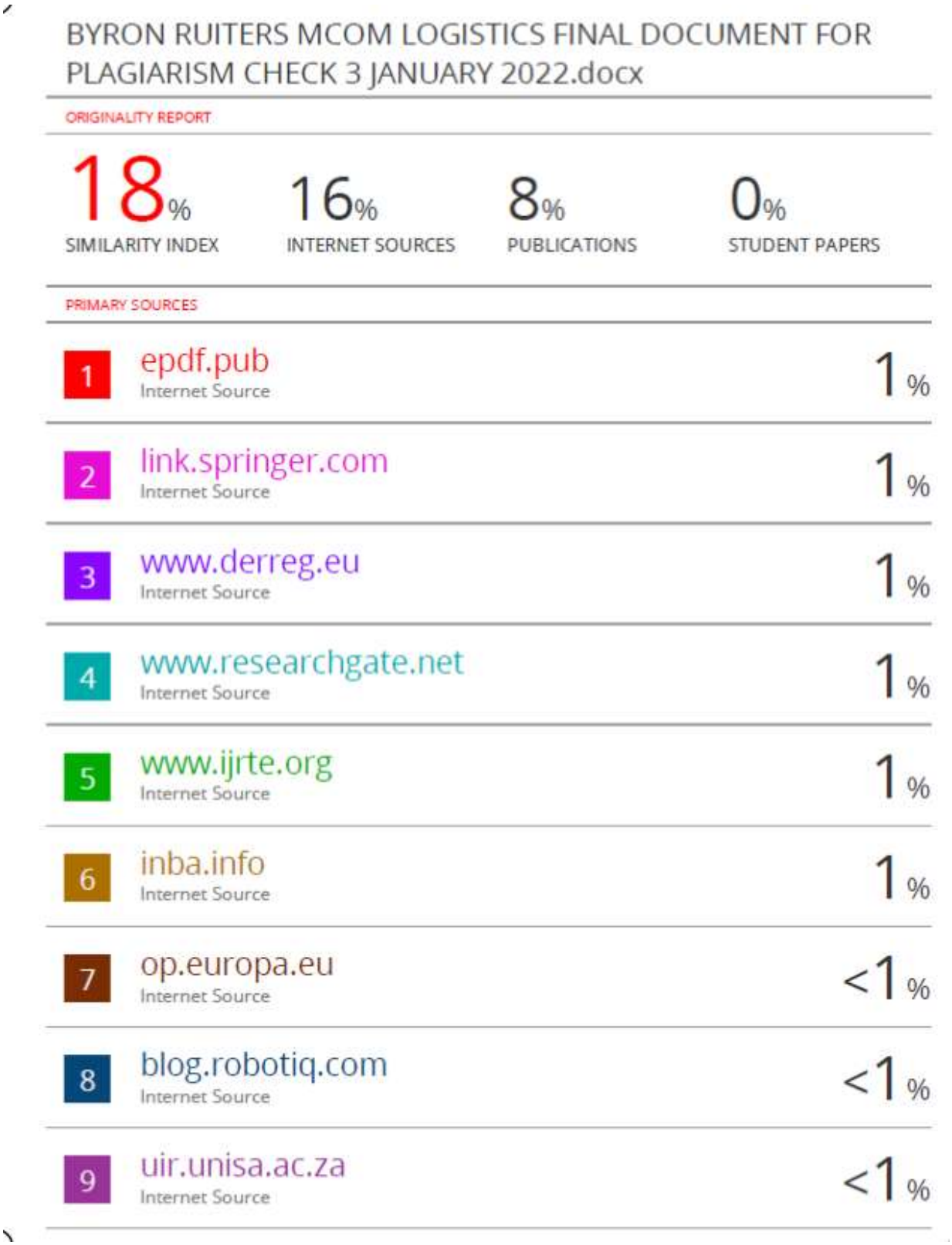
6. Immediate submission of the relevant report to Faculty RECH in the event of the unexpected closure/discontinuation of the study (for example, de-registration of the PI).

7. Immediate submission of the relevant report to Faculty RECH in the event of study deviations, violations and/or exceptions.

8. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of Faculty RECH.

Signed: _____ Date: _____

Appendix E: Turnitin results



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