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The adoption of AI in the South Africa Supply Chain Industry

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A research report submitted to the Faculty of Commerce, Law, and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in the field of Digital Business

Supervisor Professor Pias Oba

Johannesburg

2024

ABSTRACT

The adoption of Artificial intelligence (AI) in supply chain management shows great promise for the future, by identifying and removing waste, which in turn will increase efficiencies and competitiveness within the supply chain industry. The COVID-19 pandemic has fast tracked the use of technology and AI is no different to other technologies.

The significance of the research is to unpack the influence of AI adoption within one of the major industries in South Africa, the study focused on South Africa which has a unique socio-economic landscape. The study unpacks how this influences AI adoption, for example, the skills required to deploy and maintain AI, as well as the potential impact on employment (in a country with a high unemployment rate). The study evaluated the readiness for AI adoption in the country. The study analysed a company that has recently been purchased by an international conglomerate, although the company is a major player in the South African supply chain.

The researcher used interviews conducted with executives (senior roles), at a company, as well as existing literature to understand the current adoption of AI in South African supply chains. Thematic analysis of the qualitative data was employed to identify trends in the adoption of AI and understand frameworks that may have been used in the adoption.

The research found that there was a case in South Africa for the deployment of AI in the supply chain industry, although South Africa does not have the required socio-economic environment for AI to be deployed, due to the high unemployment, and low readiness for AI adoption, as well as low skills for AI adoption. The implication of the study is understanding the current view of

where AI adoption falls in the supply chain industry from a priority perspective. Is there an appetite for companies within the Supply Chain industry to adopt AI.

The research concludes that a more in-depth study is required extending the research beyond one organisation.

Keywords: supply chain, artificial Intelligence, COVID-19

DECLARATION

I, **Prenesen Naidoo,** declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in the field of Digital Business at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Name: Prenesen Naidoo

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Prenesen Naidoo
Researcher

Signature:

Signed at **Johannesburg, South Africa** on the **30th** day of **January 2023.**

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First, gratitude to my Guru and God, Shri Sathya Sai Baba, who has always been a guiding light in my life and helped thus far.

My utmost gratitude to my parents who have always supported and believed in my abilities even when I did not.

To my wife and love of my life, thank you. When my higher education journey began later than usual you gave me the confidence and support to get to this stage. The sacrifices you made - words cannot express my appreciation.

To my daughter Bhaavya, I hope this makes you proud.

In addition, I would like to thank Professor Pius Oba for his guidance throughout.

DEDICATION

I dedicate this to my wife, child, and parents to whom none of this would be possible.

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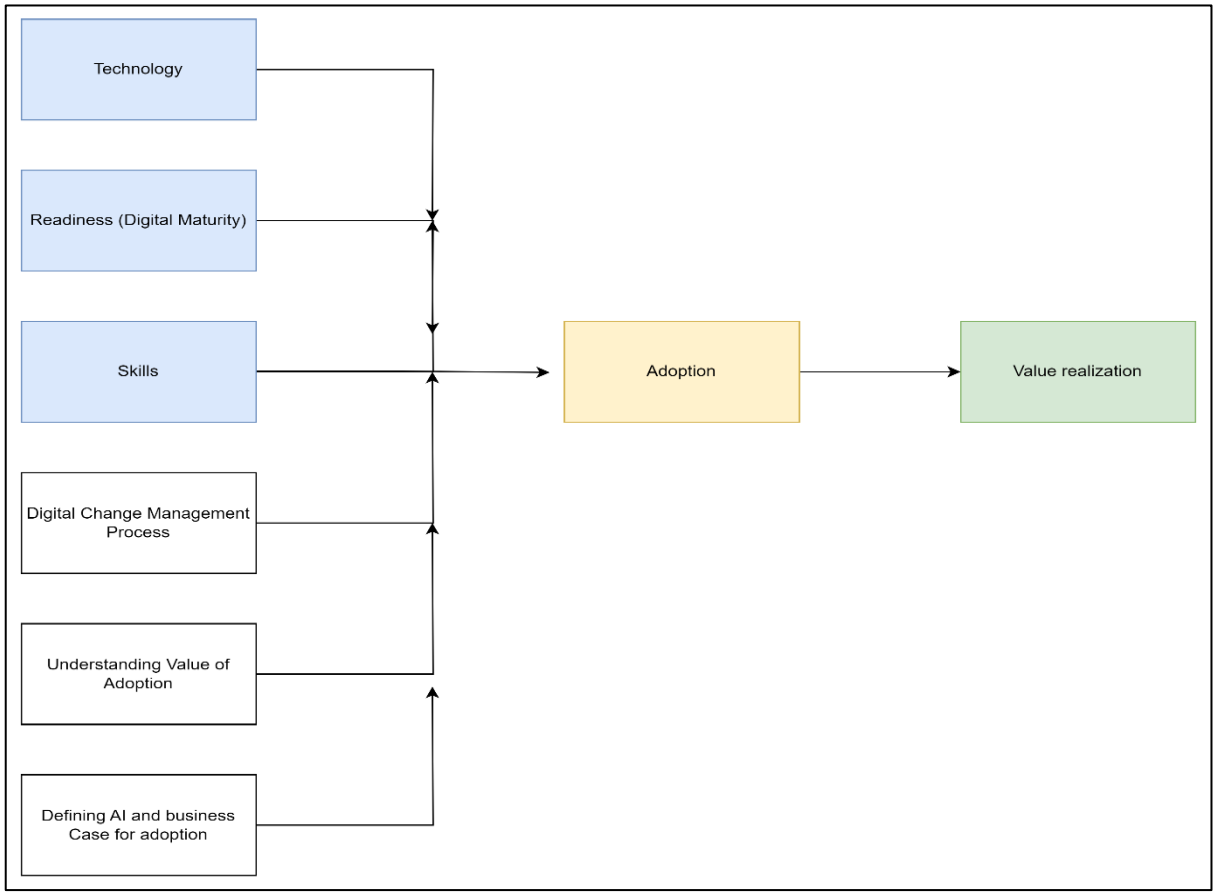


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LIST OF ACRONYMS

AI – Artificial Intelligence

SCM - Supply Chain Management

CHAPTER 1. INTRODUCTION

1.1 Purpose of the study

The purpose of this study is to determine how the adoption of AI is changing supply chains. It further investigates if and how South African supply chains are adopting AI. The study explores if there has been any adoption, the limitations, barriers and ethical considerations thereof as well as benefits.

South Africa is considered a third world country due to the high unemployment rate and low economic growth. This is driven by corruption, failing infrastructure and poor management of government entities (parastatals).(Havenga et al., 2014) A report by the GAIN Group estimated that with no solutions to Transnet (a South African parastatal) challenges, this can cost the economy up to one billion US dollars in daily revenue. This shows the importance of leveraging AI and other technologies as supply chains in South Africa play a massive role in contributing to the economy (Kruger & Luke, 2015).

1.2 Brief overview of AI and its potential impact on supply chains

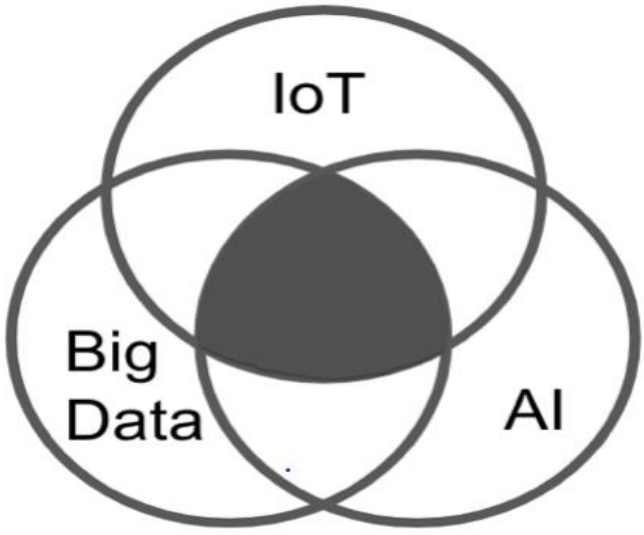
AI is a field that is large scale, essentially it is computer algorithms that can learn and change (Armstrong & Lee, 2021). Businesses in general have seen a massive uptake in adopting AI. A report by Mckendrick in 2020 reported that four out of ten enterprises now use artificial intelligence in a meaningful way. This is an increase of one-third from 2 years ago. This was based on a survey conducted of 1000 executives by RELX (global provider of information-based analytics) (Mckendrick, 2020).

From a global perspective, it is predicted that by 2030 AI will bring in 15 trillion dollars to the global economy. Businesses will also see a profitability boost of an average of 35% by 2035. In the recent Logistics Trend Radar 6.0 published by DHL, Katja Bush whom is the Chief Commercial Officer and Head of Customer Solutions and Innovations for DHL spoke about how technology is beginning to change the landscape for supply chains. Logistics was once considered one of

the back office functions however, businesses see the value of this, and combining this with technology is evolving at a rapid pace (DHL, 2022).

1.3 The current state of AI adoption in global supply chains

COVID-19 has fast tracked the use of technology in supply chains globally (Alick et al., 2020). Supply chain is the movement and flow of goods. During the pandemic it was crucial to lives that this continued, especially the movement of medical equipment and medication. As mentioned, the pandemic fast tracked the adoption of technology, and this has seen the use of automation and robotics to ensure warehouses continue to function and operate (Alick et al., 2020). A survey carried out by MHI (material handling, logistics, and supply chain industry) and Deloitte show that 67% of respondents planned to invest in automation and technology (Alick et al., 2020).



Focus of the BPF: where IoT, Big Data, AI are being used in concert.

Figure 1: Focus of the BPF: where IoT, Big Data, AI are being used in concert

Source: IGF 2019 Best Practices Forum on Internet of Things Big Data Artificial Intelligence

Supply chains have seen the use of the virtuous triangle of Internet of Things, Big Data and AI to forecast demand and optimise inventory levels, and in turn, reduce costs. This proved crucial as COVID-19 impacted demand and inventory levels. Utilising the virtous triangle this assisted in managing demand and in turn managing supply (Zamani et al., 2022).

In first world countries, the researcher has seen that these countries are able to deploy AI at scale, as there are little to no barriers to entry, from skills, low unemployment and funds availability in order to develop. (Msimangira & Tesha, 2014)

In today's fast-paced and ever-changing business environment, supply chain management plays a vital role in ensuring the efficient flow of goods and services from suppliers to customers (Toorajipour et al., 2021). To ensure meeting the ever-increasing customer demands and to stay competitive, organisations are constantly seeking ways to improve their supply chain processes. Supply chains have deployed a strategy that has gained significant traction in recent years in the integration of AI in supply chain management.

AI refers to the simulation of human intelligence in machines that are programmed to think and learn like humans (Riahi et al., 2021). AI has the potential to transform supply chain management by changing the analysis and interpretation of large datasets as well as the speed to complete this, leading to enhanced efficiency and effectiveness.

When looking at the continental view, the state of adoption varies across Africa. There are early adopters of AI in their supply chain. These countries include Nigeria, Kenya, Ghana and South Africa. (News, 2020), these countries have utilised AI mainly in the demand forecasting space within the supply chain. (Seyedan & Mafakheri, 2020)

Demand forecasting is an area of Supply Chain Management which has seen the influence of AI. Traditionally, demand forecasting has relied on historical data and

statistical models. AI algorithms has now been able to take into consideration factors such as customer behaviour, market trends, and external factors such as weather conditions to be able to provide more accurate forecasts (Seyedan & Mafakheri, 2020). By adopting AI in demand forecasting, organisations are now able to better predict changes in demand and can plan accordingly for this, which leads to removing waste and increasing efficiency of resources. This can help to reduce inventory costs, minimise stockouts or overstock situations and improve customer satisfaction. Furthermore, AI can also improve inventory management within the supply chain (Gomes & Vasconcelos, 2023). It can analyse numerous factors such as customer demand, lead times, and market trends to optimise inventory levels.

1.4 Background of the study

The supply chain industry is currently worth 9 trillion US dollars (Statista.com, 2023), and through the research it is evident that substantial investment into the supply chain gives companies a competitive edge. Supply chain technology companies raised 24.3 billion US dollars (Smith, 2021) in investment globally.

SCM history can be tracked back to two split company business practices, which eventually evolved into the concept of logistics and later led to the birth of supply chain management (Muhammad & Qamari, 2021). The pioneers in launching the first article on supply chain management were Oliver and Weber. This sparked an ongoing debate among researchers regarding its definition and complexity (Muhammad & Qamari, 2021).

The apartheid era in South Africa was a significant factor that impacted supply chain and this lasted until the early 1990s. South Africa has a diverse and rich history, and the country has undergone numerous challenges over the years (Eidelberg, 1997). Between 1948 and 1990 South Africa had endured the apartheid regime, where there was discrimination of people of colour. In this time, during apartheid, supply chains were heavily influenced by discriminatory policies and practices that spread inequality. (Eidelberg, 1997)

People of colour (African, Indians and Coloureds) were oppressed, by means of the then government implementing policies that created human rights violations. South Africa became a democratic republic in 1994, although the impact of apartheid is still felt today. Apartheid had an effect on the social, economic and political landscape in South Africa, which shapes the present of today (Kliewer et al., 2018).

South Africa's historical context of supply chain management is crucial for understanding its development and current state. The developmental years of supply chain management in South Africa faced significant challenges due to political instability and economic sanctions imposed during the apartheid era. These challenges hindered the integration of supply chains and limited access to global markets (L.Goedhals-Gerber, 2016). Following the demise of apartheid and the shift to democracy in 1994, there was a clear emphasis on effecting economic transformation and enabling inclusive growth. Supply chain management in South Africa began to adapt to the changing economic and political landscape. (L.Goedhals-Gerber, 2016).

South Africa has seen a decline in GDP over the past decade. Between 2006 and 2018, South Africa's GPD averaged at 2%, and this saw a downturn from the previous decade from 3.4% (Magwentshu et al., 2019). The reason for this can be attributed to the decrease in productivity. Productivity fell to nearly 0% in the past decade (Magwentshu et al., 2019).

South Africa has seen a decline of 43% in GDP growth rate over the period of 2006 – 2018, when compounded. Productivity has seen a drop of 83% (Magwentshu et al., 2019).

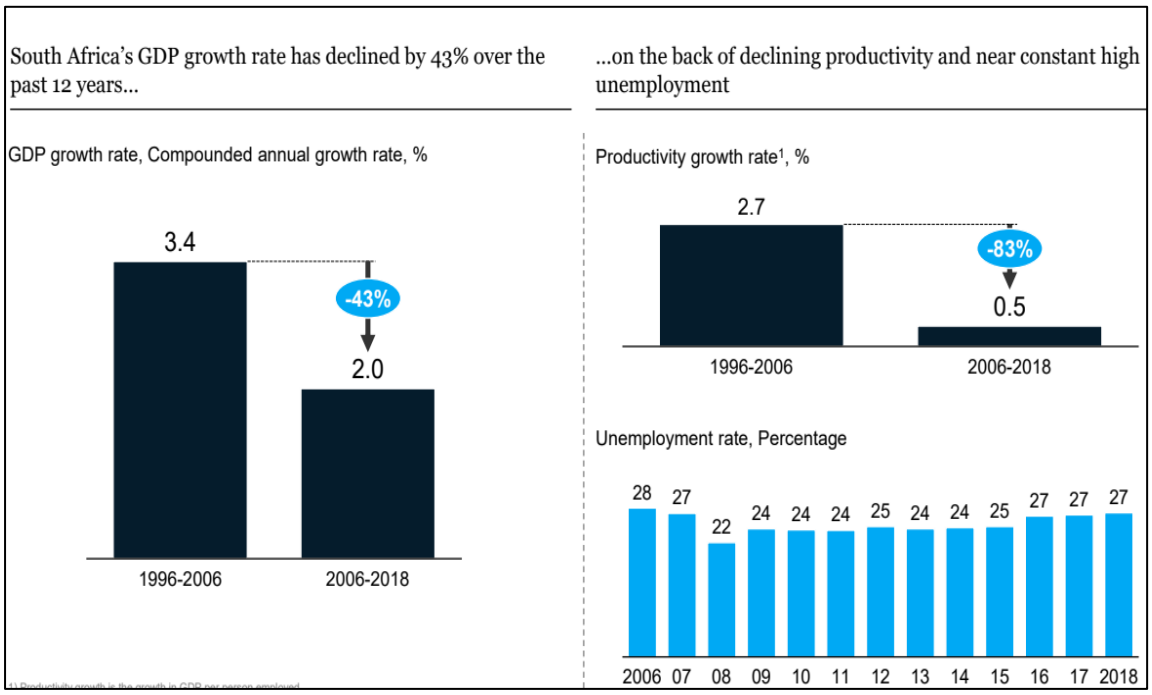


Figure 2: South Africa GDP growth, Productivity Growth rate and unemployment 1996- 2006 versus 2006 -2018

Source: Stats SA, ONET, World Bank, BLS, Oxford Economics, McKinsey Global Institute analysis (Co, 2019)

The Constitution of South Africa has significantly influenced supply chain management practices in the country (Simon Simba et al., 2017). The Constitution of the Republic of South Africa supports the public supply chain management process, aiming to address past inequitable policies and practices.

Supply chain management in South Africa has also been influenced by technological advancements. Technological enhancements have assisted in changing the supply chain management in South Africa. Supply chain companies have used advanced software and data analytics to improve efficiency, reduce costs improve decision making (Pillay & Mafini, 2017).

Another contributing factor is globalisation. This has had a huge impact on South African supply chains and due to the interconnectedness of markets, supply

chains in South Africa have had to adapt to meet increasing demands (Kruger & Luke, 2015).

This has led to South African supply chains needing to develop efficient import and export supply chains (L.Goedhals-Gerber, 2016). If South Africa wants to be a major force in global trade, its supply chains must function efficiently (L.Goedhals-Gerber, 2016). Having an efficient supply chain plays a significant role in supporting quality accessible and social economic services, by ensuring that all products and services are delivered to clients timeously. South Africa having a strong supply chain will contribute to the overall goal of ensuring good governance in South Africa (Zindi & Sibanda, 2022).

There are many drivers for AI in supply chains and along with these there are barriers to the adoption of AI. The study aims to look at both the drivers for AI and the barriers to adopting AI and the impact thereof. These will be applied to the South African climate to understand the adoption of AI.

The researcher compared the United Kingdom's (UK) unemployment levels as the UK is considered a first world country. The UK has the highest levels of AI adoption in supply chain at 68% (S. S. Department, 2023; W. B. R. Department, 2023). The UK has an unemployment level of 3% (S. S. Department, 2023). South Africa, considered a third world country, has unemployment levels of 28.77% (W. B. R. Department, 2023). As such, the researcher can clearly see that one of the glaring issues that South Africa faces in the adoption of AI in supply chain is its unemployment levels. AI will not just seek to optimise and reduce bottlenecks, but will also look at reducing labour costs, which will contribute to the already high unemployment levels in South Africa. Two of the drivers of AI adoption are resource savings and outperforming a human brain (Hangl et al., 2022). This contributes to the human and social factors.

Despite the progress that has been made in supply chain management in South Africa, there are still challenges that need to be addressed (Zindi & Sibanda, 2022). One challenge is the lack of full utilisation of supply chain management

practices in the South African public sector (Naidoo et al., 2018). The reason for this comes down to a lack of awareness and a lack of perception of the benefits of SCM (Kruger & Luke, 2015). To overcome this challenge, there is a need for increased training and capacity building programmes to improve the knowledge and skills of public sector officials in supply chain management (Msimangira & Tesha, 2014)

Another challenge is the corruption and lack of transparency in procurement processes, which undermines the effectiveness and efficiency of supply chain management (Sila & Kirwok, 2021). In order to solve this challenge, the South African government has implemented measures such as the Public Finance Management Act and the Preferential Procurement Policy Framework Act to promote clarity and accountability in procurement processes (Naidoo et al., 2018).

By implementing the frameworks and procedures, this should ensure that there are transparent and fair processes which in turn should prevent corruption. If South Africa aligns with the existing policies, then it can further enhance fairness in the procurement process. Overall, supply chain management plays a crucial role in South Africa's ability to compete globally and deliver efficient social and economic services (Oyebanjo Ogunlela et al., 2021).

It supports the goals of good governance by ensuring the delivery of quality products and services to clients in a timely manner. Furthermore, supply chain management in the South African public sector is supported by legislation and policies that aim to address past inequitable policies and practices. The use of SCM practices within the public sector is still ongoing, although this requires continuous refinement in order to solve the challenges that exist and promote good governance (Buccus, 2022).

The outbreak around the world and the spread of COVID-19 had a profound impact on supply chain operations worldwide. The pandemic has caused disruptions and challenges to international business chains and supply chain

cycles, which lead to a deconstruction and regionalisation of the trading system (Evans Mwasiaji et al., 2020).

This left the worldwide economy on the brink of recession and made it difficult for companies to recover and return to normality. One of the key takeaways in which technology has played a role in mitigating these challenges is through enhancing supply chain resilience. Companies that have invested in technology and digital infrastructure were better able to adapt and respond to the disruptions caused by COVID-19 (Nasser, 2021).

For example, JD Logistics (a logistics company in the United States of America) showed great resilience and was able to keep up their supply of 8000 orders per a day which was enabled by its utilisation of technology (Umair et al., 2021). Additionally, core technologies such as cloud computing, blockchain, and big data have played a crucial role in building more resilient supply chain management systems (Nasser, 2021). These technologies have facilitated information sharing, improved data accuracy, and enhanced visibility across the supply chain. This has helped companies to effectively track and monitor inventory levels, optimise transportation routes, and manage demand fluctuations (Oh et al., 2020).

One of the considerations for AI is that it will bring about new jobs. However, in South Africa a skills shortage in the field of AI is evident, and it will take years to the develop the skills. This will continue to leave the gap in the market for AI skills. This has been reported as per a study conducted by Accenture and GIBS (Dr Jeff Yu-Jen Chen et al., 2018). South Africa has numerous structural challenges that hurt its ability to integrate with modern technologies. South Africa has one of the more complex supply chains in the world, having to navigate a lack of infrastructure, high inflation, high crime rates, electricity shortages, and environmental challenges (of recent),while many other supply chains have managed to adopt technology to their advantage (Kruger & Luke, 2015).

Imperial Logistics, now known as DP World (after the acquisition in 2022) has many case studies on how the integration of technology has improved overall supply chain in South Africa. DP World's Fourth Party Logistics (4PL) division leverages data to identify gaps in customers processes utilising technology to improve efficiency. A solution that will enable the customer to see both short- and long-term benefits through the implementation of software to enhance visibility and provide efficiency is deployed (Desai, 2011).

There has been adoption of AI technology in South Africa. One example of this is how the University of Johannesburg is currently employing AI to predict transformer breakdowns (Kshetri, 2020). This shows how AI can be utilised in solving current challenges the country faces such as load shedding (where unreliable infrastructure causes challenges) (Lawlor, 2023). Technological advancements can clearly assist in providing a proactive solution.

1.5 Research problem

South Africa has many challenges negatively impacting the economy, from state capture to the current electricity crisis. Reports claim that state capture has cost the country 500 billion rand, although the cost may never be quantified and electricity shortages continue to negatively impact GDP (Ryan, 2022). Electricity shortages have also impacted the economy negatively contributing to a -2.1% on quarterly GDP (Lawlor, 2023). Furthermore, government debt increased to 4.3 trillion rand. The above equates to the need for businesses to become more efficient in the way they operate to circumnavigate through these challenges and technology can assist with this, specifically AI.

This study explores whether the adoption of AI has positively impacted supply chains around the world and how it could assist supply chains in South Africa. The research will explore and analyse AI with the aim of understanding barriers to entry for AI in South African supply chains. This study will further focus on South Africa's low education level and high unemployment rate and how it impacts the deployment. The research explores supply chain companies'

appetite to adopt AI and what horizon they are looking to deploy the technology in.

1.6 Research objectives

The research aims to assess the global impact of AI on Supply chains. Evaluate the current and future levels of AI adoption in South African supply chains. Identify potential benefits and barriers to AI adoption in South African Supply Chains. Assess South African supply chains adaptability and readiness for AI adoption.

1.7 Research questions

Based on the topic, the question below has been formulated:

How has the adoption of AI in supply chains in South Africa influenced the sector?

The research aims to understand the influence of AI on supply chains and will investigate how this impacts South Africa. This will be answered through specifically looking into the points below:

- What is the value of adoption of AI in supply chains?
- Do the necessary skills exist to deploy AI in supply chains?
- Are companies ready for the change to adopt AI?
- Do companies have the required technology to move forward and adopt AI?

1.8 Rational

This study aims to identify a research gap on how a third world country can adopt AI in supply chains and if and how it impacts the supply chain industry. The study will aim to understand how a country with elevated levels of unemployment can adopt technology that can add many benefits. The study will seek to understand what levels of current digital adoption the industry has embraced and how those

have impacted the industry to understand what this could mean for the adoption of AI.

1.9 Theoretical significance

- Reviewing existing literature to understand the status of AI in supply chain.
- Reviewing the literature and identifying applicable frameworks.
- Reviewing the literature to understand the positive and negative impacts of AI on supply chains.

1.10 Delimitations of the study

The study is focused on a major player in the South African supply chain industry. Interviews will be conducted with executive level employees to understand how AI has been adopted within supply chains from their company level and obtain insight into their in-depth knowledge of an industry level.

The study is limited to the South African market and uses existing literature to understand the impact on a global scale specifically understanding the impact in first world countries.

1.11 Definition of terms

The following terms are important to be defined:

Disruptive technology

This is said to be technology that fundamentally changes how industries or companies or operate (Smith, 2022).

Artificial Intelligence

This is defined as machines that can carry out tasks of human abilities, and can self-learn and correct to produce improved results (Laskowski, 2023).

Supply chain

The process of a product or service being brought from being produced until it reaches the end user. It involves all processes and organisations involved in the process that collaborate to make this possible (Professionals, 2018).

Loadshedding

This is the process of controlling the amount of electricity being supplied due to capacity constraints (Energy, 2013).

State Capture

State Capture is the term used to explain means by which individuals or groups or firms manipulate laws, and regulations for self-benefit. This can have serious ramifications on social costs. (Hellman et al., 2000)

1.12 Assumptions

In this study, the assumptions are as below:

A gap exists in the literature on the adoption of AI in Third World countries. The impact of the human element in a third world country. Unpacking Frameworks used in the adoption of AI in third world countries.

1.13 Conclusion

The study will explore how AI has been adopted within the supply chain industry in South Africa. The study will delve deeper into understanding readiness and adaptability within the industry. Barriers and potential benefits will be understood. Overall understanding of where AI adoption currently is, and the potential for where it can improve the supply chain industry. Ethical considerations are necessary when understanding the adoption of AI. The study aims to explore this.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

Supply chain is a complex process that involves the integration of key business process. This is from end user to point of origin, involves products, services and information, and adds value to the stakeholders (Felea & Albastroiu Nastase, 2013). With the impact of COVID-19 in 2019, supply chains have seen the need to become more resilient, specifically in the healthcare sector (Muhammad Umair, 2021).

AI has several definitions (Russell & Norvig, 2020). AI involves building agents, who will mimic human behaviour as well as the ability to learn and improve. AI has seen many developments and setbacks over the years (Scholten et al., 2014). AI aids in the creation of business systems and uses data to learn and obtain insights without human involvement. Organisations may identify the places of their supply chains where the use of AI can benefit efficiency and spend resources appropriately (Huang & Rust, 2018).

In recent years, businesses have experienced significant changes due to the rapid advancements in technology. In the build up to AI being deployed, deployment of other technologies has influenced the deployment of AI. For example the deployment of IOT to track materials, finished goods and assets, not just to provide visibility, but to understand utilisation of assets (Bag et al., 2023). Analytics using big data has been another example of utilising technology to manage supply chains.

Supply chain companies have seen massive benefit by effectively deploying analytics to enable competitiveness (Ittmann, 2015). AI stands out as one of the most influential. AI has drastically changed various aspects of business operations and supply chain management has also seen this. It has enabled businesses to streamline their processes, enhance efficiency and gain valuable

insights that were previously inaccessible or was labour intensive and reactive. The supply chain industry has not been exempted from this transformation.

AI has played a pivotal role in reshaping how businesses manage their supply chains. Leveraging AI businesses can optimise their supply chain processes and provide real time insights (Wang & Pan, 2022) and ultimately improve customer satisfaction. This literature review aims to explore the adoption of AI in the supply chain industry and how it is redefining business practices. From monitoring freight forwarding on a massive scale to predicting shipping needs, AI technology offers logistics firms the ability to optimise their supply chains and improve customer service (Agarwal et al., 2024).

The emergence of AI in the supply chain can be attributed to several factors. One factor is the increasing complexity of supply chain operations. Supply chains have become more complex and globalised. This means using old methods that have become ineffective. The ability to collect massive amounts of data and the advancement in technology means supply chains have had to evolve (Mishra et al., 2013). These technologies, such as big data analytics and cloud computing, have made it possible to leverage AI algorithms and machine learning techniques to derive insights and predictions from the data to help in accurate decisions being made in the supply chain. Fast tracking ,with the use of technology, to keep supply chains resilient happened when the COVID-19 pandemic started to disrupt supply chains globally (Cheng et al., 2020).

During the COVID-19 pandemic, companies faced numerous challenges in their supply chain operations. These challenges included inadequate data visibility, lack of flexibility and diversification, and reduced efficiency in supply, transport, and production (Dale, 2022). Technology has played a critical role in addressing these challenges and improving supply chain resilience. By leveraging core technologies such as cloud computing, blockchain, and big data, companies have been able to enhance information sharing and improve data accuracy.

There is certainly an appetite for supply chains to evolve and grow, due to competition, globalisation and demanding customers (Dora et al., 2021). The challenge for supply chain is to deliver high levels of customer service while ensuring they are competitive with the pricing (Smith, 2021). This means that supply chains can more effectively monitor inventory levels, transport routes and manage any demand deviations. The advancement in technologies such as AI, IoT and machine learning have helped in managing supply chain risks during the pandemic. For example, the use of IoT devices has allowed companies to collect real-time data on inventory levels, production capacity, and transportation conditions (Ilatova et al., 2022).

Through analysis of the data utilising tools like AI and machine learning algorithms, these can spot any potential bottlenecks or disruptions, and assist in making proactive decisions to possibly avoid any risks (Awan et al., 2021). Another technological intervention that has been utilised during the pandemic is blockchain technology. Technology such as Blockchain has been adopted and leveraged to improve supply chains transparency and traceability. By creating a decentralised and unchallengeable record, blockchain technology enables stakeholders in the supply chain to have a transparent view of transactions, ensuring that products are sourced ethically and verifying the authenticity of goods (Cheng et al., 2020). Additionally, blockchain technology can help in reducing instances of counterfeiting and fraud, ensuring that products reach customers safely and securely (Brun et al., 2020). Overall, the integration of technology into supply chain operations has proven to be beneficial during the COVID-19 pandemic.

This has enabled companies to be able to overcome challenges such as the COVID-19 pandemic and develop more resilient supply chain models for any future challenges that may occur (Oh et al., 2020).

2.2 AI in a supply chain context

The numerous challenges that where experienced during the COVID-19 pandemic meant the fast tracking of growth for supply chains. Some of the

challenges included lack of flexibility and diversification, and reduced efficiency in supply, transport, and production (Dale, 2022). Technology has played a critical role in addressing these challenges and improving supply chain resilience. By leveraging core technologies such as cloud computing, blockchain, and big data, companies have been able to enhance information sharing and improve data accuracy

These have enabled supply chains to have better visibility and given the ability to effectively track, monitor and maintain inventory levels. It has also enabled optimisation of transport routes while managing demand. Other technologies such as IoT along with AI and machine learning have also been key to supply chains being able to manage risks during the pandemic. An example of this is using IoT devices that is used for data collection of real time data and process this data into tangible information for supply chains to make real time decisions and avoid waste (Ilatova et al., 2022).

AI and machine learning combined has proven to be powerful in supply chains. These technologies can provide useful insights, trends and predictions which mitigates potential risks. This is crucial for supply chains as it almost gives the ability to predict the future by utilising technology (Nasser, 2021). When combining technologies these mean that supply chains can reduce more waste and become lean in operations. This in turn equals more competitive supply chains, although the challenge with this is maintenance thereof. Supply chains were previously operations driven; this has now changed into having an element of digital skills (Alick et al., 2020).

Technology has given supply chain companies the resilience required for any future challenges that are posed post the pandemic. Significant developments in AI for supply chain management have occurred over the years. One notable development is the use of AI-driven robots to optimise production and effectiveness in supply chains operations. Companies like Amazon and Alibaba have successfully implemented AI-driven robots in their warehouses to enhance the speed and accuracy of order fulfilment (Ehioghae & Idowu, 2021). These

robots use AI algorithms to optimise routes, minimise errors and improve the overall efficiency of the supply chain process. This also means a safer environment, due to the sensors (IoT) and AI, as the robots will be able to avoid collisions in the warehouse (Ehioghae & Idowu, 2021). Another significant development in AI for supply chain management is the utilisation of data collected from various systems, such as Enterprise Resource Planning, Customer Relationship Management, Manufacturing Execution Systems, Supplier Relationship Management, and Supply Chain Management systems. The data is then combined with a golden thread and is able to provide unique insights into the supply chain process (Awan et al., 2021).

AI has the potential to transform supply chain management in several ways. One of the key benefits of AI in supply chain management is its ability to analyse data from multiple sources and provide valuable insights (Dora et al., 2021). Insights like these can provide business with the necessary information required to make informed decisions minimising the risk involved (Xu et al., 2022). An example of this would be utilising AI to forecast inventory and demand to improve planning with proactive and agile decision-making (Xu et al., 2022). By leveraging AI algorithms, decision makers in supply chain can make more accurate predictions about demand patterns in order to adjust inventory levels accordingly (Xu et al., 2022). This proactive approach to inventory management can help reduce costs and minimise the risk of low stock levels or overstocking. Furthermore, AI can aid in supplier selection by predicting the reliability of suppliers (Xu et al., 2022).

This prediction capability of AI allows managers within the supply chain to be more assured of the decisions about which suppliers to engage with, considering factors such as delivery performance, product quality, and cost-effectiveness. In addition to demand forecasting and supplier selection, AI can also optimise supply chain networks (Hassan Younis et al., 2021). Hassan's paper talks about how machine learning and AI can positively influence supply chains although if an organisation does not have the necessary foundation and skills in place this can set an organisation backwards.

By analysing data on suppliers, transportation routes, and customer demand patterns, AI algorithms can identify the most efficient configurations for supply chain networks. These optimised configurations can assist in streamlining operations, reducing cost, eliminating waste and improving overall supply chain efficiency. Moreover, AI can play a significant role in warehouse management by optimising inventory placement and order picking processes. By analysing data on product demand, warehouse capacity, and order frequencies, AI algorithms can determine the most efficient placement of inventory within a warehouse (Bag et al., 2023). This can minimise travel time and improve order fulfilment rates.

2.3 How the adoption of AI in supply chains has evolved

The current use of AI and machine learning is still in its infancy, although there has already been high levels of success in the early adoption (Hassan Younis et al., 2021). AI can give supply chains the competitive advantage through reducing the bull whip effect (Hassan Younis et al., 2021).

AI has evolved in supply chains built from machine learning and big data analytics. This helped supply chains to achieve efficiency and quality improvement (Hendriksen, 2023). Mckinsey and co reported that early adopters of AI have shown to reduce their logistics costs by 15% as well as reducing inventory levels by 35% when being compared to competitors who had been slow to react (Alick et al., 2020).

One area where AI can have a significant impact is in monitoring and forecasting demand. By analysing large sets of historical data, AI algorithms can identify patterns and trends that humans might miss (Jakovlev et al., 2021). Humans will look back at historic data and try to add some predictions to model a forecast. AI can efficiently utilise historic data as well as add the component of future predications, like weather patterns or pending conflict based on being able to utilise more sources of data (Mohsen, 2021).

Another domain where AI can make contributions is in selecting suppliers by predicting reliability of suppliers. Furthermore, AI can enhance warehouse

management by optimising inventory placement and order picking processes (Mohsen, 2021).

2.4 Limitations of AI on supply chains

Despite the numerous benefits and potential of AI in supply chain management, there are also challenges and limitations that need to be considered. One of the challenges faced in the adoption of AI is the quality of data. AI algorithms require full, accurate and complete data to be able to provide tangible reliable results (Ehioghae & Idowu, 2021). Additionally, the implementation and integration of AI technologies into existing supply chain systems can be complex and require significant investment in terms of both time and resources (Hangl et al., 2023).

Figure 2.1 shows that the highest level of education across the world and looking at South Africa, the education level is not sufficient for there to be skilled workers for AI adoption. South Africa has the lowest levels of tertiary education per the study below. There is a direct correlation between low education and unemployment (Jeza et al., 2023).

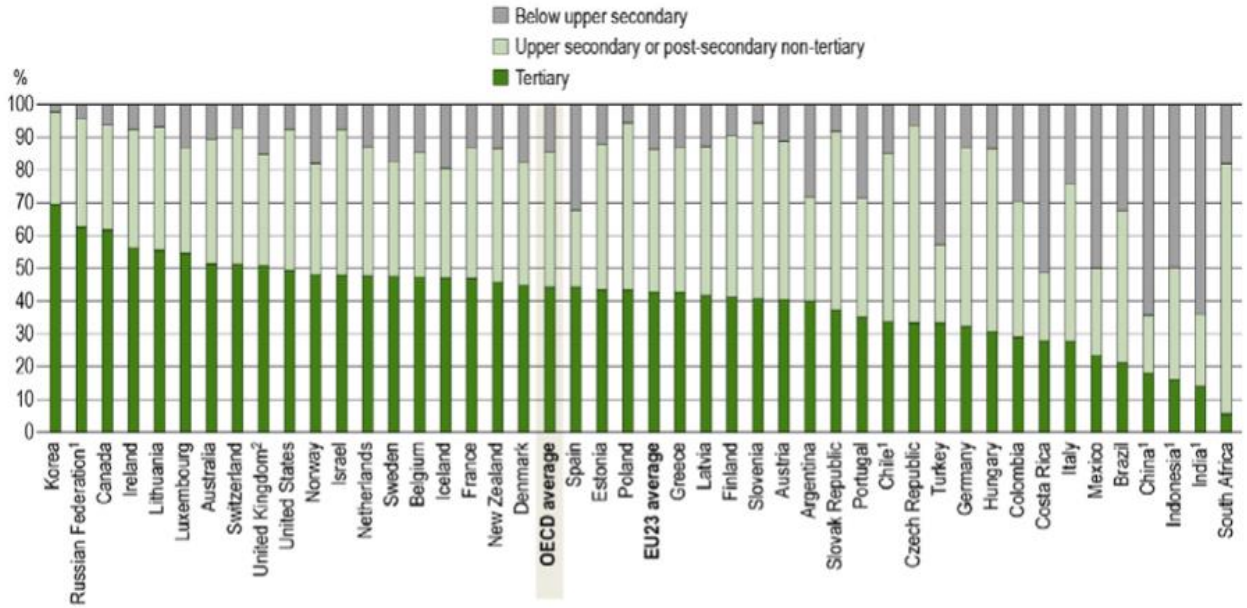


Figure 3:Educational attainment of 25-34 year-olds (2018)

Source: Education at a Glance:2019

While AI has the potential to revolutionise supply chain operations, its adoption and full integration into supply chain systems are still in the early stages (Ngetich et al., 2022). However, as more businesses recognise the benefits of AI in supply chain management, increased adoption and advancements in this field can be expected. Wang and Pan (2022) discussed the factors that drive AI adoption and the resilience that can be obtained by supply chains using AI. Three specific drivers, enterprise AI technology, supply chain collaboration, and environmental uncertainty are the three major factors affecting the adoption of AI technology. When the three factors are balanced, they had a positive impact on supply chain resilience. The research was conducted specifically on emerging markets (Wang & Pan, 2022).

Despite its potential benefits, AI faces several limitations when applied to supply chain management. One major limitation is the lack of robust and accurate data. This means data becomes part of a crucial requirement. However, in supply chain management there are challenges with data, as data can often be incomplete (this could be due to data being manually inputted), data could be of poor quality and inconsistent. The data could be found across different systems and multiple sources which makes it difficult to extract and integrate the required information (Yang & Wang, 2021). Another factor that makes adoption challenging is the dynamic nature of supply chain operations. As supply chains are dynamic and constantly changing it makes it difficult for AI systems to adapt quickly and effectively (Ehioghae & Idowu, 2021).

The three drivers explain that the market that is played in will directly impact the AI adoption. In third world countries, based on the education and skill levels, in order for AI adoption, the skills will need to be outsourced which will result in high costs and a return on investment will need to be understood and calculated to understand a cost benefit (Yang & Wang, 2021).

The supply chain industry is being disrupted through technology; in one way this is changing the skills required for supply chains (Gomes & Vasconcelos, 2023).

Another limitation is the lack of transparency and interpretability of AI algorithms (Awan et al., 2021).

While AI algorithms can analyse data, identify patterns, and provide insights, their inner workings are often seen as a "black box". This lack of transparency makes it challenging for supply chain managers to understand how the AI system arrives at its recommendations or predictions (Ngetich et al., 2022). Moreover, AI algorithms may lack the ability to handle uncertainty and unexpected events effectively. For example, AI algorithms may struggle to anticipate sudden changes in demand, supply disruptions, or unforeseen market conditions.

Additionally, AI technology may require significant investment in terms of financial resources and infrastructure (Dunayev et al., 2022). In order to adopt and implement AI, a significant amount of effort and time is required. This will be needed for training and system integration.

Lastly, ethical considerations and potential biases in AI algorithms can also present limitations in supply chain management (Jacobs et al., 2021). This is a massive challenge that still plagues adoption of AI in many instances.

A report by McKinsey and Co noted that the common challenges experienced by the participants in deploying AI included:

- 45% of respondents said that a project was not delivered on time.
- 26% said it ran over budget.

The top 3 risks identified where:

- change management (82%),
- poor process design (70%),
- missing capabilities (57%).

The above highlights a skills gap in deploying AI. A paper by Hamed Nozari identified lack of proper infrastructure and cybersecurity impacting AI in fast moving consumer goods (FMCG) environments (Nozari et al., 2022). This speaks

to the environment in which supply chain exists. In South Africa, a report by Accenture complied in 2020 noted that South Africa had the third highest number of cybercrimes worldwide (MCANYANA et al., 2020).

2.5 Polices impacting AI adoption in South Africa supply chains

South African supply chains have faced challenges in how to move both domestic and international freight efficiently and effectively (Luke & Heyns, 2019). This is due to multiple factors, which includes failing infrastructure, high logistics costs and limited operational efficiency. As of November 2023, South Africa is in the process of developing guidelines and there is still discussions for potential regulations of AI (Technologies, 2023). South Africa will need to design and leverage off experts in drafting regulations. The policies should give businesses incentive to invest in AI development as well as ensuring it is built ethically (Paul et al., 2020).

2.6 Technology infrastructure in South Africa

To move forward and build AI in supply chains, infrastructure is crucial. South Africa's current infrastructure will pose challenges in implementing AI (Gwagwa et al., 2020). South Africa has an established government agencies that can develop strategies for AI development and deployment, however there is a lack of institutional capacity (Awan et al., 2021). There is also a lack of investment in the public sector which hinders AI development (Chilunjika et al., 2022). South Africa can develop as mentioned in previous sections by designing frameworks for guidelines and policies that will both drive development and sustainability in the uptake of AI. This includes the need for high-speed internet connectivity to access advanced computing resources (Ghouati et al., 2022).

2.7 Economic impact of AI adoption in South African supply chains

The economic conditions in South Africa in specific relation to supply chain is driven by the rand/dollar exchange rate and fuel price. South Africa has seen a rise in the use of road transport, due to the failing of the parastatal, Transnet

(Kruger & Luke, 2015). The volatility in the oil price that has been impacted by the recent pandemic and the Russia/ Ukraine conflict has had a direct impact on South Africa due to higher use of road transport. Electricity shortages have been the other factor that impacts the economic conditions in South Africa. Due to failing infrastructure and corruption, this has severely impacted the South African economic environment (Barlow, 2016).

2.8 Social perceptions of AI in South African supply chains

There seems to be mixed reactions to the use of AI. There seems to be one view of the benefits to deploying AI, increasing efficiency, reducing costs, being able to identify threats and react quick enough. On the other hand, there seems to be uncertainty, around deployment and the impact of job security (Abhinav Hasija, 2022; Hasija & Esper, 2022). In a country with high unemployment and lack of skills are particularly relevant (Gwagwa et al., 2020). There is also the issue of trust, that human labour is more trustworthy than the use of AI (Venkatesh, 2021). The unexplored topic is income equality, this is interesting as there is concern around job displacement, but there should also be concern around income equality (Martens & Tolan, 2018). If AI is assisting with jobs, does this mean employee costs will be reduced?

A report released by Mckinsey and company, indicates how digitisation and automation could result in an increase of 1.2 million jobs by 2030. This was across all industries in South Africa. The report further stated that there will be demand for 1.7 million graduates specialising in technology in South Africa, which means universities and industry need to align programmes with the needs that will be required for industry (Nomfanelo Magwentshu 2019).

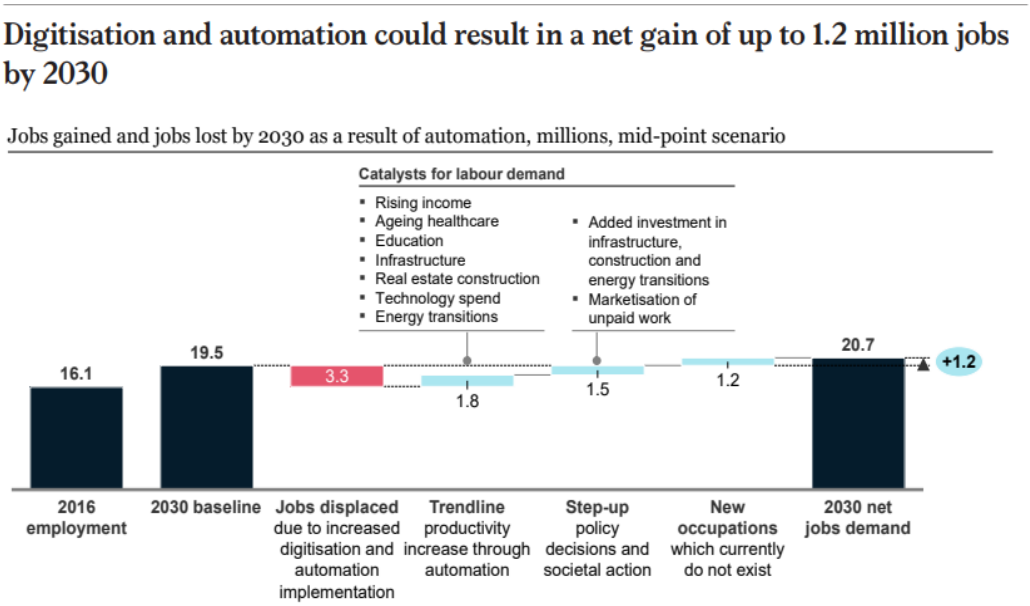


Figure 4: Jobs gained and lost through automation by 2030

Source: Stats SA, ONET, Oxford Economics, McKinsey Global Institute analysis (Co, 2019)

2.9 South African skill levels and the impact on employment

There is a direct correlation between unemployment rates and the skill levels in South Africa (Christopher, 2015). Technology advancements have meant that there is need for a new skill type. When skills become outdated more people find themselves without jobs as they do not meet the requirements (Omar et al., 2019). This will lead to higher unemployment rates (Charl & Fatima, 2011). The challenge that exacerbates the problem is that South African education organisations do not provide the necessary skills that are required (Samuel & Thakhathi, 2012). This then causes a mismatch between the skills needed in the workforce versus those that are out there (Christopher, 2015).

To tackle this mismatch, there needs to be an intervention to align the two, so that the required skills are available. This in turn will assist in lowering the unemployment rates in South Africa (Charl & Fatima, 2011). There also needs to be promotion of lifelong learning, so skills remain up to date as technology advances (Charl & Fatima, 2011). Recently, institutions have developed courses that are technology related and specifically AI related to upskill employees.

(Kiemde & Kora, 2020). A report by released by Mckinsey & Companympany highlights the requirements for South Africa to be able to take advantage of digitisation within the country (Nomfanelo Magwentshu 2019). This was disaggregated into three categories, national, business and personal. The below talks to how digitisation needs to be adopted between a collaborative approach between Government and Business.

- Government – Government needs to embrace digitisation by investing in human capital. There needs to be solutions found for the impact of automation on jobs.
- Business – Business will need to rethink strategy, as to include digitisation. The workforce will need to be upgraded by planning and upskilling the workforce. There needs to be change management to embrace the new ways of working.

From the above, it is evident that there is a need for South Africa and South African business to adapt to the disruption of technology. South Africa's high unemployment leads to higher levels of inequality (Nomfanelo Magwentshu 2019).

2.10 Successful case studies of AI in supply chains

Walmart has successfully deployed AI and machine learning into their inventory system. This is done through utilising historical data and pairing that with predictive analytics. This enables Walmart to deliver higher levels of customer satisfaction (Musani, 2023).

Parvez Musani who is the Senior Vice President E2E fulfilment at Walmart explained in an article recently how this is done.

> "*When building AI/ML (Machine Learning)frameworks for holidays, we start with a foundation of data and business constraints to create a possible universe of Machine Learning models. During model training, we fine-tune machine-learning models using historical data like past sales, as well as online searches and page views.*

We also consider 'future data' such as macro weather patterns, macroeconomic trends and local demographics to anticipate demand and potential fulfilment disruptions. With this combined data, our engines identify and correct discrepancies, inefficiencies, or inaccuracies in supply chain models. By the time our customers are ready to shop, our AI/ML data has already completed the heavy lifting to improve inventory flow."

Another case study is UPS, utilising their system called ORION (On-Road Integrated Optimisation and Navigation) to do dynamic route planning and optimisation. The system utilises advanced algorithms, AI and machine learning to optimise deliveries meaning more customers can be visited in a shorter time and provide more accurate eta's to customers (UPS, 2020).

Juan Perez, UPS chief information and engineering officer says in an article published on UPS website "*The new Dynamic Optimisation component will improve the accuracy of UPS delivery time estimates and give our customers better visibility into their shipments."* This not only provides a higher level of customer service, but saves UPS on fuel, meaning delivering higher levels of service at lower costs, thus making UPS more competitive in the market (UPS, 2020).

2.11 Unsuccessful case studies of AI in supply chains

Most papers reviewed talk about the positive impacts of AI in supply chains, from the below case study we see the negatives if there is no foundation and readiness for the adoption it can create major issues.

Nike is a notable example of an unsuccessful case study of an AI implementation. Nike deployed their i2 ERP solution back in 2004 and felt the effects of deploying new technology due to a glitch. The glitch cost over 100 million US dollars due to the system over stocking on low-selling items and low stocking on high selling items (Koch, 2004). The strategic failure was that Nike deployed software that would use historic data to compile predictive analytics, this could enable them to

tell into the future. The glitch that occurred was the machine learning was setup incorrectly which resulted in the above.

Nike did not understand the software and the implications of deploying this. The lesson learnt from this is evaluating the needs and understanding the advantages and disadvantages before blindly deploying. Technology should be deployed with caution, understanding the failures and having back-up plans to ensure continuity.

The construction industry in India provides another example of the challenges with deploying AI. The challenges include physical, behavioural and logistical issues (Singh et al., 2023). The main challenge is due to the lack of infrastructure and remote areas that construction takes place. This causes issues in adopting AI and machine learning. The fact that most of the construction work is project based also causes challenges (Singh et al., 2023).

2.12 AI as a strategy in supply chain

Looking at the literature, AI is becoming a focal point of supply chains. DHL is one of the leading supply chain companies in the world. This is shown in the Logistics Radar report released by DHL. The report looks at the trends in the logistics industry and a large part of the trends are now looking at technology (DHL, 2022). One of the concepts to understand if organisations are ready to take on technology is Digital Maturity. This essentially is the measure of an organisations ability to obtain specific strategic and operational organisational results within the use of technological change. Therefore, it measures where an organisation is on the digital transformation journey (Armstrong & Lee, 2021). Organisations need to understand this to factor in where on the journey they are. This will give companies the opportunity to benchmark where they are and where they intend to be, to bridge the gap. One of the models used to understand this is Westerman's 'Leading Digital' Model.

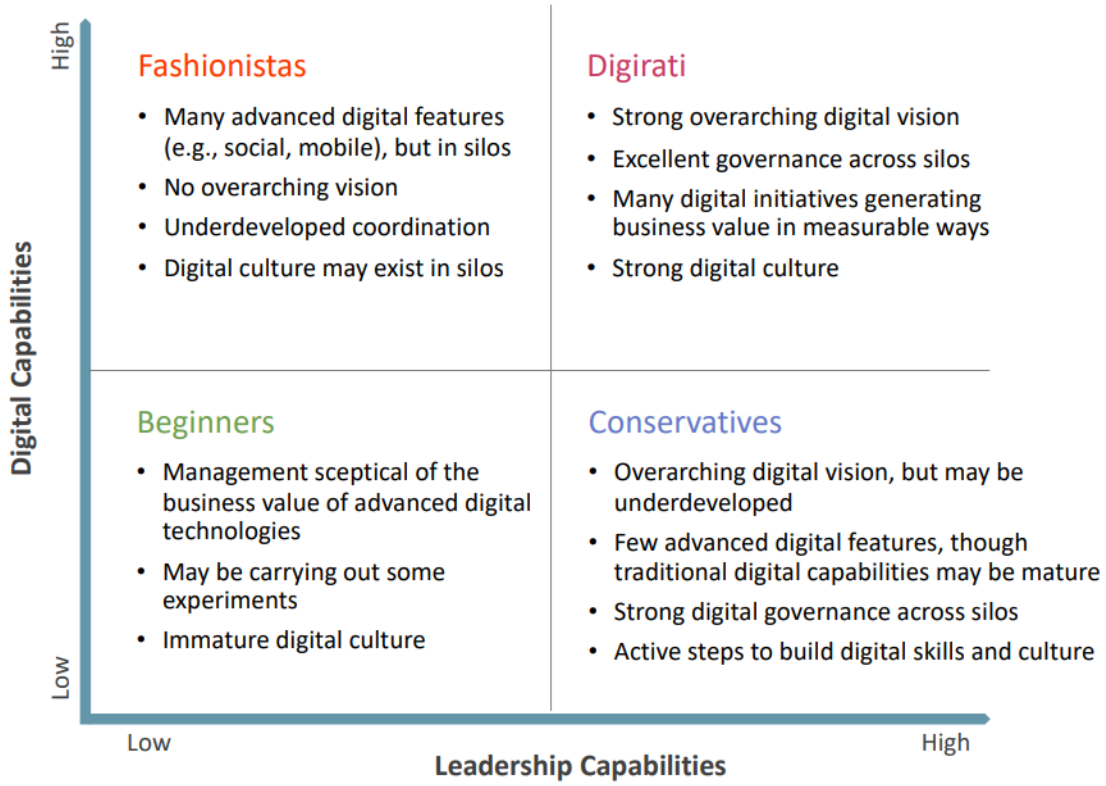


Figure 5:Westerman representation of Digital Maturity

Source: Westerman 2014

Westerman representation shows both digital capabilities and leadership capabilities and then ranks where on the graph companies are based on characteristics. Westerman's model also comments that there is a correlation between higher levels of maturity and organisation performance, between revenue and profitability (Westerman et al., 2014). The model speaks to the different journeys that organisations find themselves in. In the lower left-hand side, there are beginners, still in the infancy of adoption. The top left-hand side, where the organisations have advanced digital skills, although there is lack of cohesion. The bottom right-hand side of the quadrant, where the strategy is strong, with strong governance across the organisations for the adoption of technology, although the technology is still in the infancy. The top right-hand side speaks to the digirati, organisations who have strong technological skills coupled with a strong vision and governance.

Another model worth noting is Evans Digital Business model. Evans talks about how leading organisations have been launching digital interruptions within their markets. Evans proposed that there are four key areas for digital transformations, as noted below. (Evans, 2017a, 2017b)

1. **Strategy and vision**

   This involves re-designing the organisations strategy from the inside out with the customer at the centre of the design. It also involves setting targets so that the organisation re-designs strategy and business processes to achieve digital command.

2. **People and culture**

   This component speaks to leadership, culture and digital skills. Leadership plays a vital role in driving the change through the business to align to a digital business. To enable this there needs to be collaboration and innovation. As digital transformation involves the deployment of technology, this requires a set of skills to deploy. The organisation must have a strong set of skills throughout to transform it. This may even mean having a new set of tools and techniques to transform the organisation.

3. **Process and governance**

   For the framework to work, the organisation will require change management as well as innovation management. There will need to be formal programmes that have digital transformations across the organisation to achieve the objectives. This will enable the organisation to focus on executing the ideas. This will align strategy and operations.

4. **Technology and capabilities**

   This pillar emphasises the importance of companies having the necessary experience and skills to attain digital transformation. To attain these there needs to be a digital services mastery. The six key capabilities of digital services mastery are:

1. Agile
2. DevOps
3. As-a-service infrastructure
4. Intelligent automation
5. Personas and context
6. Digital service management

Supply chain companies will need to use a hybrid model as there is a need for operations and automation can only happen in a few tasks.

It is important for organisations to adopt the correct framework. As mentioned by Evans, the researcher can see the importance of the below:

- Skills
- Readiness (Digital maturity and digital change management)
- Technology

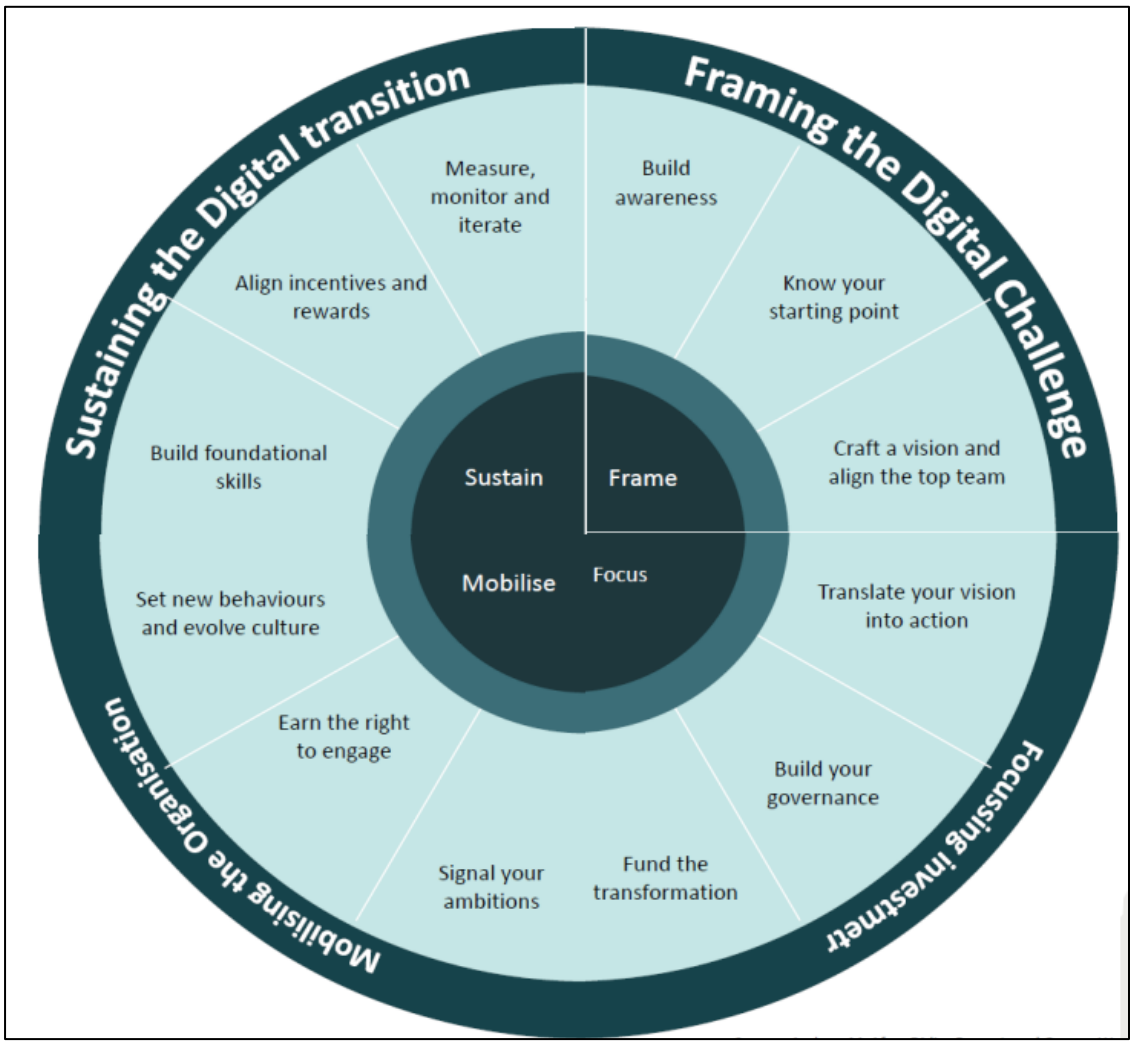


Figure 6: Digital Transformation Compass

Source: Westerman et. al (2014)

If organisations find themselves in a position where they need to implement a digital change management process, then Westerman suggests a digital transformation compass. This is based on four pillars.

1. Framing the digital challenge
    a. Building awareness - This involves building awareness in understanding both the potential threats and opportunities that come from digital technologies.
    b. Identify a starting point – A starting point is needed as this will assess the digital maturity of the organisation.

c. Shared vision – a shared vision needs to be established across the organisation.

2. Focusing the investment
    a. Translate vision – This will ensure there is a plan in place to obtain the goals.
    b. Build governance – Building the required governance to drive the digital transformation.
    c. Funding the transformation – The last step is to fund the investment.

3. Mobilising the organisation
    a. Signal – This involves leadership driving the message across the business and clearly communicating the ambitions and timelines.
    b. Earning the right to engage – This involves building an environment where employees can come up with solutions. This will set the environment up for more innovation.
    c. Setting new behaviours – This will mean changing the thinking of the organisation.

4. Sustaining the digital transition
    a. Build foundation – This is a process where the organisation needs to build the strong fundamentals, with capabilities for digital technology.
    b. Align reward structures – Organisations need to align rewards structures that will align with the objectives.
    c. Measure monitor and iterate – this will mean obtaining a process that will measure success and identify failures to improve.

2.13 Current trends on AI in supply chain

AI adoption in supply chain has seen great traction (as mentioned, this was accelerated due to the pandemic) (Hangl et al., 2022). AI adoption has seen many barriers both organisational and developmental (Dora et al., 2021). To

implement AI and be successful there is a requirement for good organisation and development. In addition to this, some supply chain industries have been slow to adopt AI (Riahi et al., 2021). Environmental and technological barriers are other factors impacting the decision to deploy of AI (Hassan Younis et al., 2021). The advancements in supply chain software over the past years has made it easier for the adoption of other technologies (Awan Usama & Ajantha, 2021). Supply chains will see the need to evolve and will eventually find ways to overcome these barriers, although in the current state it is still in its infancy.

2.14 Future trends on AI in supply chain

In the future, it is anticipated that AI will continue to play a pivotal role in supply chain management. AI has the potential to optimise many of the current supply chain processes such as demand forecasting, inventory management and logistics optimisation, these will also grow further. AI is still a growing technology, there are advancements in natural language processing capabilities and machine learning, this will then enable AI to better understand but also interpret unstructured data such as customer reviews, social media sentiments, and market trends (Kamble et al., 2021).

AI is transforming the supply chain management landscape by improving planning and decision-making processes, enhancing inventory forecasting and demand prediction accuracy. Furthermore, AI has the potential to enable end-to-end visibility across the supply chain, facilitating real-time tracking and monitoring of goods and shipments. AI is expected to take off in supply chain, with enhanced capabilities for demand forecasting, inventory management and understanding unstructured data.

AI will not just benefit from the optimisation and efficiency that AI will bring to the supply chain industry, but it will change the landscape of competitiveness (Bag et al., 2023). A survey done on healthcare supply chain executives showed that AI's impact will be on significantly improving the operational efficiencies in the supply chain (Bag et al., 2023). South African supply chains will become more cost effective and will have many opportunities for value creation. This in turn will

put South Africa in a better standing on the global stage. This will enable South Africa to be more competitive (Tzachor et al., 2014).

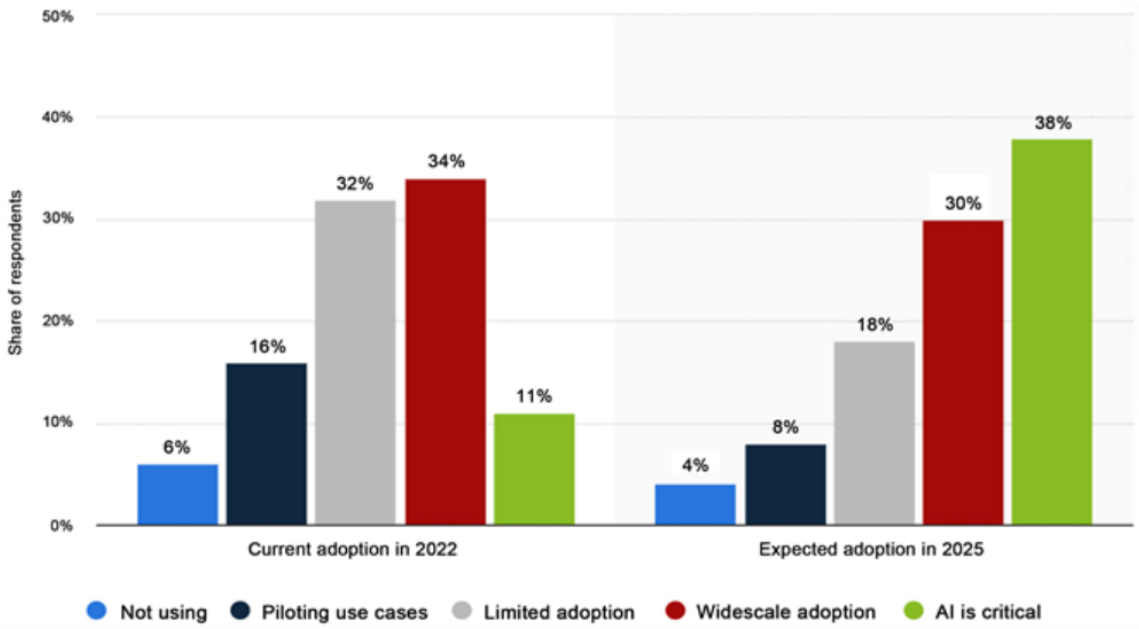


Figure 7: Global AI adoption rate in supply chain and manufacturing businesses (2022 and 2025)

Source: Statista (2022)

Figure 3 shows the rate of AI adoption in supply chain and manufacturing. The data shows that AI will become critical in the coming years - an increase of 27% in 3 years where AI will be critical. Widescale adoption decreases although that can be accounted for by the increase in AI and this is critical.

The below figure from a McKinsey and Co report shows how the future landscape of supply chain could look with the assistance of AI. This will result in more proactive decision making for supply chains, as AI will enable integrated solutions (Alick et al., 2020).

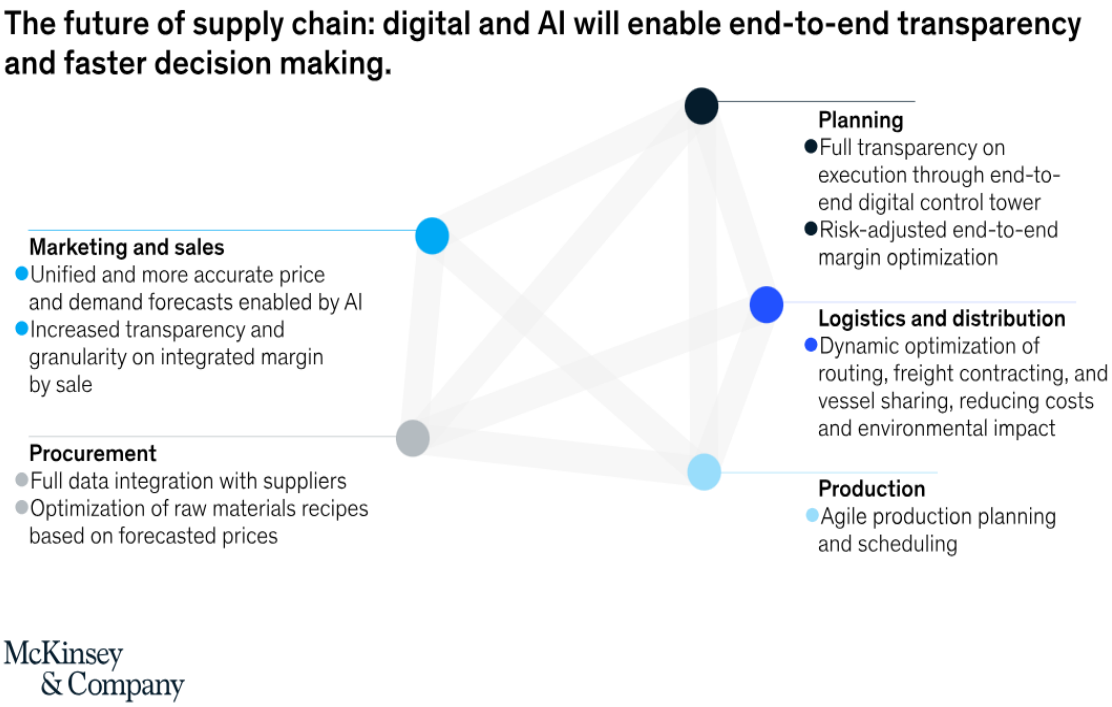


Figure 8: The future of supply chain

Source: Mckinsey and Company 2022

Based on the logistics trend radar report 6.0 (a report released by DHL every 2 years), the below shows that Interactive AI will see realisation in the next 5 years and will have a high impact. DHL is a global player in the logistics industry and one of the top supply chain companies in the world (DHL, 2022).

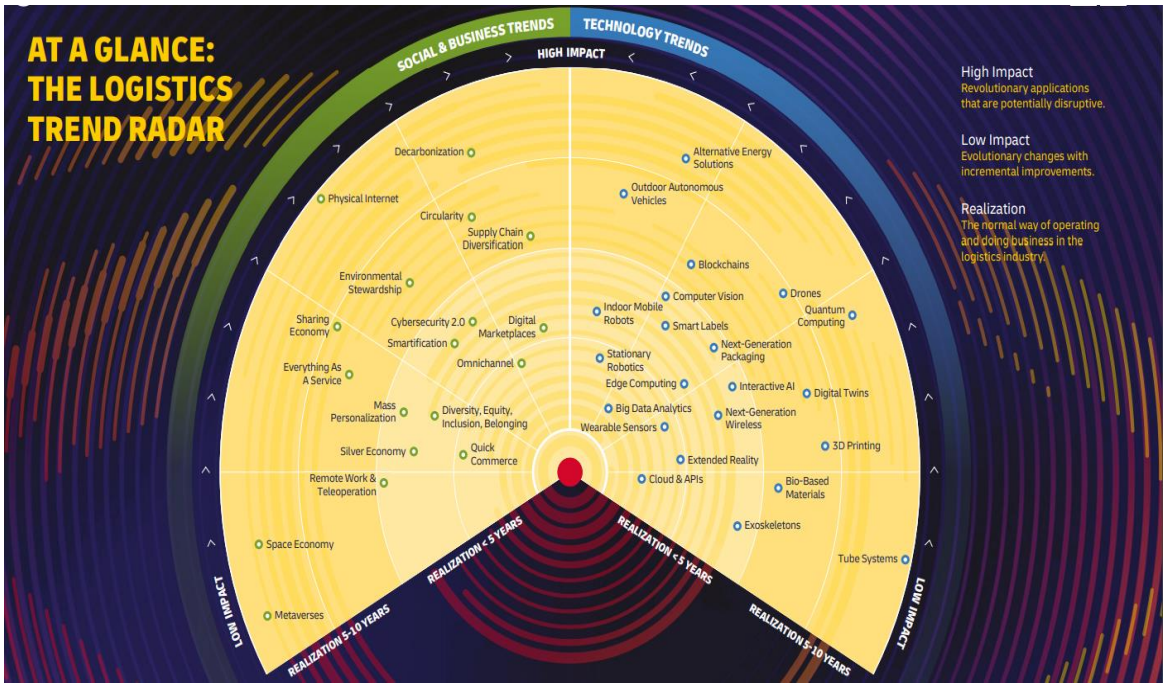


Figure 9: The Logistics Trend Radar

Source: DHL The Logistics Trend Radar Report 6.0

DP World another world leading supply chain company, sees AI as a crucial part of its company. Pradeep Desai who is the Chief Technology Officer at DP World spoke on his blog as to how DP World uses AI in their terminals. The software does rostering of staff to streamlining customer inspections (which use to be a long intensive process), the AI-driven software creates and then applies solutions (that are practical) for the terminal to operate (Desai, 2023). This shows how supply chain companies are embracing AI and how it is becoming fundamentally important to give higher levels of customer satisfaction.

2.15 Recommendations

Continuous research to track the evolution of AI adoption and the impact of AI in supply chains is recommended. It is important that the impact on the economy and skills development is noted. An annual study would be able to provide the necessary data. Skills development is another focus area, to ensure that there are programmes in place to bridge the skills gap for AI implementation in supply chains.

Policy frameworks- government will need to put extra focus in fast tracking designing and implementation of these frameworks. Understanding the necessary Digital Transformation Change frameworks and Digital Maturity of an organisation will be crucial for AI adoption. This will enable developing a road map as well as measuring progress. The policies will need to ensure it caters for ethical AI development. Lastly there will need to be a collaboration, by engaging with businesses, policymakers and academia. This could include workshops, conferences and forums.

2.16 Theories

Various theories have been looked at in identifying the most applicable theory to apply to the adoption of AI in supply chain.

Technology Acceptance Model (TAM) was the first model evaluated. The TAM model looks at how users accept the use of technology (Marangunić & Granić, 2014). The model looks at when a technology is deployed there are several factors (variables) that influence the decision to use it. The variables include:

Perceived usefulness – this specifically looks at what the person perceives that the technology is useful for, what they want to do (Marangunić & Granić, 2014).

Perceived ease of use – this looks at how easy the technology is to use, the easier to use, the ease of adoption (Marangunić & Granić, 2014).

There are other factors such as social influence that need to be considered.

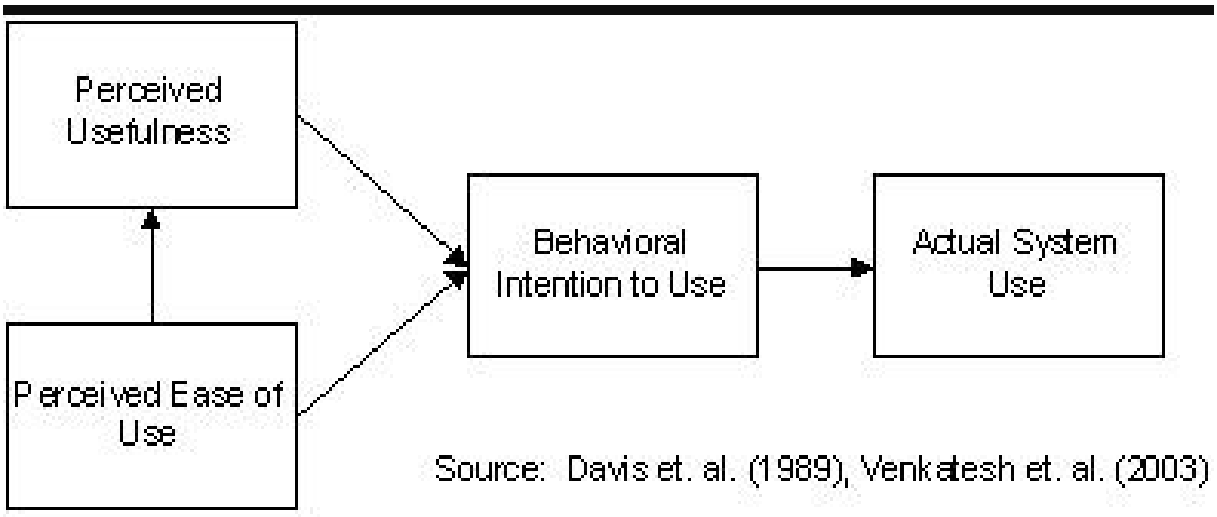


Figure 10: TAM Model

Source: (Davis, 1989; Viswanath Venkatesh et al., 2003)

TAM's limitation is this model focuses on user adoption, where as supply chain adoption has multiple stakeholders that influence adoption which has more than just the user involved in the adoption. TAM is solely user orientated while supply chain adoption has other complexities that are not unaccounted for, such as cost benefit analysis, and infrastructure readiness. TAM does not account for external factors that are required for supply chain AI adoption such as government policies, economic conditions, market trends which help in designing AI adoption strategies (Viswanath Venkatesh et al., 2003).

TAM does not account for the dynamic nature of technology like AI. TAM focuses on user acceptance at a point in time while AI is ever evolving which TAM cannot account for. This ruled out the use of TAM.

The second framework explored is the unified theory of acceptance and use of technology (UTAUT). This framework is an expansion on TAM. The UTAUT looks at four factors to determine the behaviour and user intention. The four factors are performance expectancy, effort expectancy, social influence and facilitating conditions. Gender, age, experience and voluntariness are influencers to the four factors (Venkatesh, 2021).

After evaluation, the challenges posed with this framework only focuses on the four factors - performance expectancy, effort expectancy, social influence and facilitating conditions to determine technology adoption. AI will have many more factors that can influence adoption like industry challenges and governance. Like TAM, UTAUT focuses on users' perceptions of adoption. In supply chain there are many stakeholders who will influence adoption. For these reasons UTAUT will not be applicable to the study.

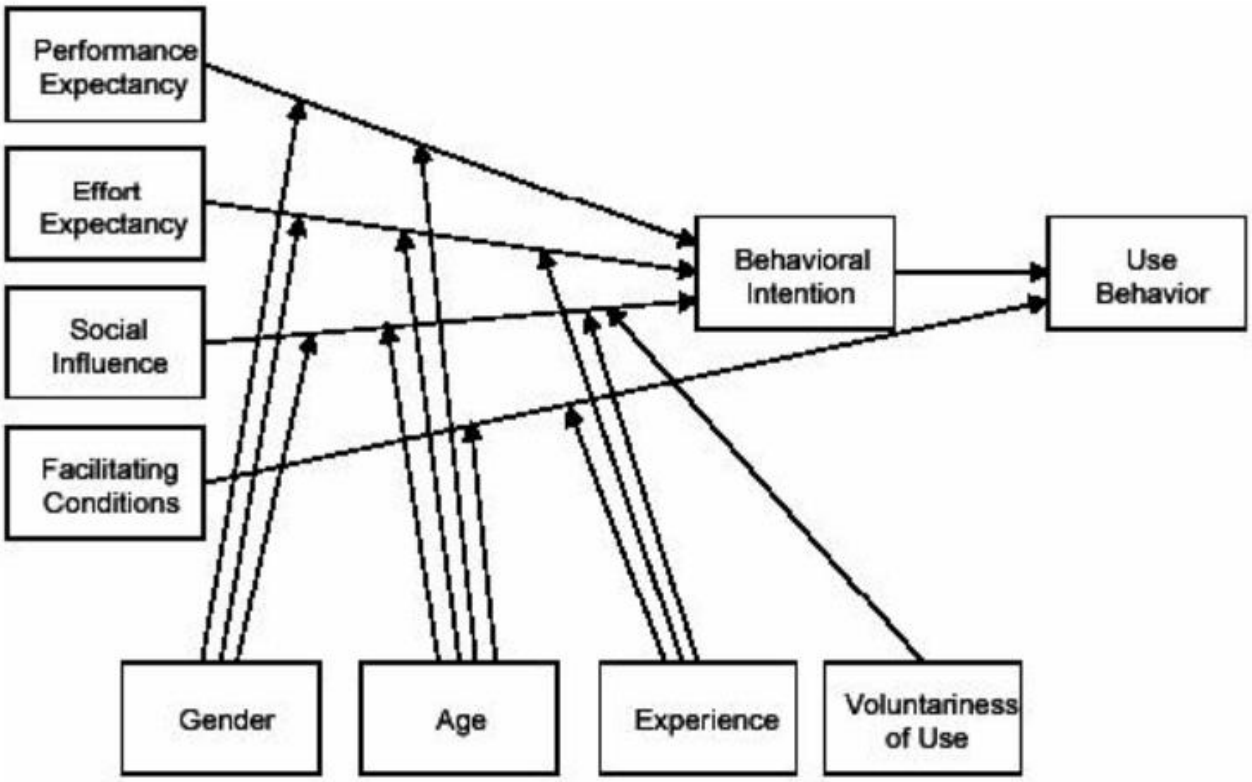


Figure 11: UTAUT Model

Source: Venkatesh et al. (2003)

2.17 Conclusion

Overall, the impact of AI on supply chain management is significant and wide-ranging. AI algorithms can analyse data from multiple sources and identify patterns that may be missed by traditional methods (Ghouati et al., 2022). Supply chain companies, though the adoption of AI, not just benefit from cost savings

and efficiencies, they also benefit from improved customer service, thus retaining existing customers and growing the customer base. AI can improve the sub services for example, demand forecasting, logistics processes, early adopters have seen the above the benefits of taking the risk to ensure the maximise any potential.

AI also has the potential to improve the environmental performance of supply chains. Through eliminating waste and by analysing the Co2 emissions and greenhouse gases, supply chains can identify where they will need to where to place the largest amount of time and energy to reduce carbon footprint. An example of this is where AI is used to provide route optimisation on delivery vehicles. These enable optimisation to ensure the routes with the least kms are driven, less fuel is used and empty legs are reduced (Ngetich et al., 2022).

There are a number of ways AI has the potential to greatly enhance the effectiveness of supply chain management (Mohsen, 2021). AI can be used to estimate future demand and manage inventory levels in accordance with the demand. AI may be used to evaluate vast volumes of data from many different sources, including sensor data, predictions, and social media. AI can be used to increase efficiency by optimising logistics, including transport routes, manufacturing schedules, reducing costs and optimising delivery schedules. AI may be used to anticipate equipment failures and plan maintenance appropriately, cutting down on costs and downtime (Kshetri, 2020).

Natural catastrophes, a lack of supplies, political unrest, and other possible risks to the supply chain may be identified and mitigated using this method. AI may be used to keep an eye on and examine goods as they are being produced and transported, guaranteeing delivery of services and goods. A study by Awan Usama confirms the AI technology when deployed correctly can have a positive impact on supply chain resilience (Awan Usama & Ajantha, 2021).

When looked at, the landscape for third world countries to deploy AI is complicated by many factors based on the environment. The two barriers to entry

are the skills gap, which in third world countries is highlighted by the high unemployment rates. The second barrier is quality of data. There are positive and negative implications to implementing AI, some of the gaps in the literature, are as follows:

- Understanding how readiness can influence adoption.
- Understanding the gap in skills can influence adoption.

This then poses the question - has AI been adopted in South African supply chains effectively?

CHAPTER 3. METHODOLOGY

The research has shown the impact the adoption of AI has on supply chains. The literature review has identified gaps in the existing research that speaks to the adoption of AI in third world supply chains. Has AI been adopted, what are the barriers to entry for AI in these markets? The literature review provided the positive impacts of the adoption of AI in supply chains and identified some limitations, although it does not look at the environment and how that can influence supply chains and how AI can be deployed in supply chains.

The methodology chapter builds on the literature review , where theories were identified although be used to research the gaps identified. This will involve the research strategy which will be used to research the gaps identified, the sample selection, and sources. The methodology chapter will inform the methods deployed to investigate the adoption of AI on supply chains in South Africa, from the view of senior executives and decision makers within the supply chain sector in South Africa. This will assist in covering the gaps identified in the literature.

3.1 Research approach

There are various strategies that can be deployed, however in this research a set of scholarly assumptions are applied for the study. Three frameworks were analysed to identify which theoretical framework would be the most suitable, part of this was done in the literature review.

The process by which a firm adopts and implements technological innovations is influenced by the technological context, the organisational context, and the environmental context (Depietro et al., 1990). The technological context includes the internal and external technologies that are relevant to the firm. This will give context to organisations ,if they are adopting AI and to what extent ie is the organisation ready for AI? The organisational context refers to the characteristics and resources of the firm, including the firm’s size, degree of centralisation, degree of formalisation, managerial structure, human resources, number of slack

resources, and linkages among employees. This focuses on the perceived positive or negative impact by organisations and how will this impact resources, do organisations have the required skill to embrace AI? The environmental context includes the size and structure of the industry, the firm's competitors, the macroeconomic context, and the regulatory environment. How does unemployment play a factor in this? How does the South African environment influence adoption? (Depietro et al., 1990). The TOE framework has been effective in understanding the adoption of Generic AI in the retail industry adoption. Overall, the TOES framework unpacks and understands how the adoption of new technology and the various factors that impact the adoption. Technology-Organisation-Environment Framework (TOE) will be adopted to understand the adoption of AI in supply chains.

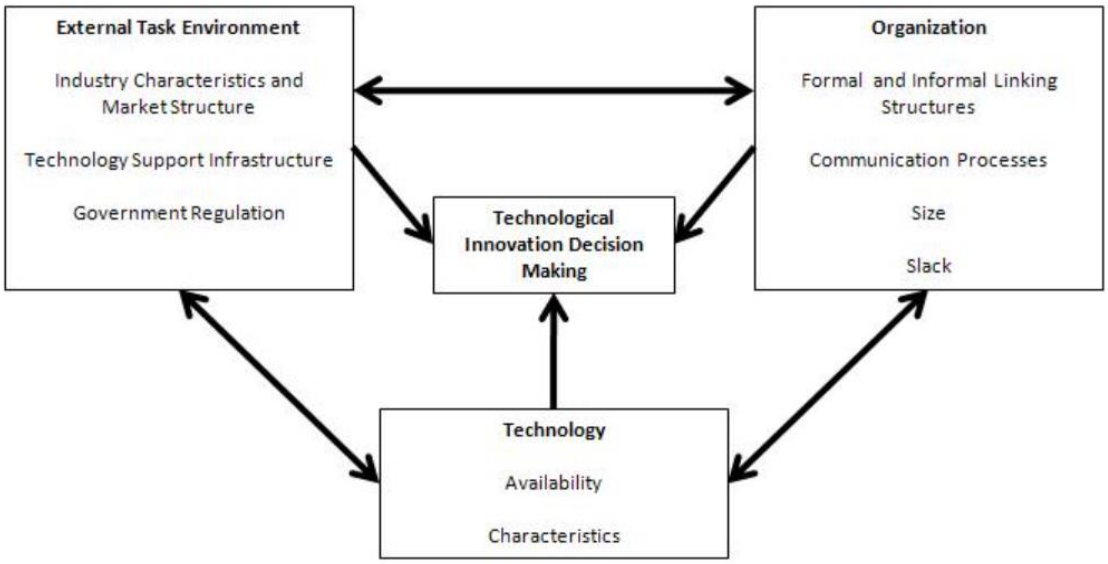


Figure 12:TOES Framework

Source: Adapted from (Baker, 2012)

The constructivist approach will be taken, as this approach focuses on understanding and interpreting the meanings held about the subject. The conceptual framework will look at the variables that have an influence on adoption.

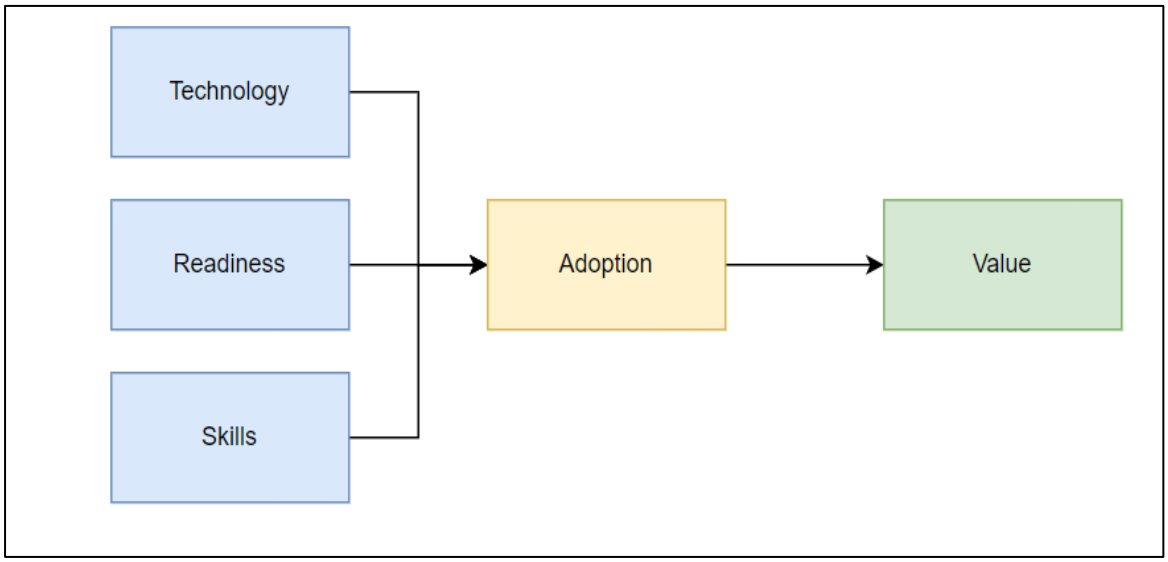


Figure 13: Conceptual Framework

The framework looks at the value generated by adopting AI technology across supply chains, while understanding the variables that influence adoption. These variables include:

- Skills
- Readiness (Digital Maturity and Digital Change Management)
- Technology

Did the organisation have the required skills?
Was the organisation ready for adoption?
Did the organisation have the required technology for adoption?

Utilising this framework will determine how the variables influenced the adoption of AI on supply chains at the various levels.

The framework was assessed by interviews of 8 senior executives within the supply chain field from one organisation. The company provides supply chain services. The company that the executives work for, is a major player in the supply chain field, act as technology providers to enable supply chain solutions in South Africa and have several years of experience. The participants have provided real life experience on how technology has changed the landscape, and more specifically on the adoption of AI in the supply chain industry. The study will be conducted on one company and senior executives will be interviewed.

3.2 Research design

Based on the literature review, the research question is: What has been the adoption of AI in South Africa supply chains. The literature review conducted has shown both positive impacts and limitations to AI being adopted in supply chain. Although the gap exists, this talks to the impact on the human element on which supply chain is heavily reliant (Supply chain employs +- 450 million people (Kippenberg, 2020). The adoption of AI can be divided into two categories under employment. These two categories are unemployment and employment opportunities.

There were variables that needed to be considered, and this study aimed to understand the variables and how the variables influenced the adoption of AI in supply chains.

3.3 Data collection methods

This research aimed to collect data and understand the external factors that impact the adopting of AI. The primary method of data collections is interviews and a minimum 8 senior executives from a supply chain organisation. The executives are in high levels of leadership within a supply chain company that has a global footprint. The company operates in South Africa. The reason for utilising South Africa is to understand the adoption of AI in a third world country.

The interviews were conducted over Microsoft Teams (a cloud-based remote working and videoconferencing solution). The duration of the interviews were scheduled for 60 mins. The interviews were conducted in English.

The aim of the study is to understand the adoption of AI in supply chain in South Africa.

3.4 Data analysis and interpretation

The analysis of the data was completed utilising thematic analysis. Transcripts from the interviews were reviewed several times to unpack “common patterns and themes” (Cho, 2014). The key phrases in the interviews were identified. The coding categories were then overlaid with the framework to identify relationships (Skjott Linneberg & Korsgaard, 2019).

Construct A	Sub-Construct	Code	Organsational/Industry	Interview Question
Adoption Factors	Barriers	BE	Orgnisational	External factors influencing AI adoption (competitors, micro-economic, skills market [labour])
		BE	Industry	Do you believe there are any limitations to deploying AI?
	Change Management	CM	Industry	How do you think this will impact employment within the Supply Chain Sector in South Africa?
		Sk	Orgnisational	Do the necessary skills to deploy exist in your organisation or will it need to be sourced?
	Skills	Sk	Industry	Do you believe South Africa has the necessary skills to deploy AI at scale throughout Supply Chains?
Skills Development		RD	Orgnisational	Following on from the previous question, will you look to employ labour to implement the use of AI and maintain AI? Or will you outsource this function?
	Readiness	RD	Industry	Have you seen examples of use cases of positive adoption of AI within the Supply Chain sector.
		CM	Orgnisational	In your opinion is your organisation ready for AI? Please elaborate on your answer.
		RD	Industry	where do you see the future impact of AI within Supply chain ?
		TC	Orgnisational	Have you seen a significant demand from clients to utilize technology to •Reduce cost, •Increase efficiency and •Deliver higher levels of customer service •Competitive advantage
Technology Solutions	Technology	TC	Industry	What do you believe will be the value of adopting AI?
	Strategy	ST	Industry	Does AI form part of a long-term strategy for your organisation/industry with investment being budgeted for this
		ST	Orgnisational	is there willingness in your organisation to explore the use of AI?
		TC	Orgnisational	If and how does your organization utilise AI currently? If not is there a strategy to explore the use of AI

Figure 14:Questionaire and Themes

3.5 Population and sampling

3.5.1 Population

The research is based on one supply chain company that has a global footprint. The company specialises in supply chain services and leveraging technology to provide best in class supply chain solutions.

3.5.2 Sample and sampling method

Different sampling methods was investigated, through investigation the researcher found that random sampling would not be applicable to the study as the study required interviewing participants with specific knowledge, experience and skills. For this reason, selective sampling was chosen.

Selective sampling was used and nonprobability (non-random) sampling was applied. Based on the investigation it was important to select individuals who play a strategic senior role in the organisation to understand what current industry trends are versus the business outlook on employing AI. These individuals will understand the strategic aspirations to include AI. The table is the targeted audience (Appendix A).

‘

These individuals will have expert industry knowledge (Palinkas et al., 2015). The disadvantage of this type of sampling is it can not be applied to the general population, although for this study it is required that this only applicable to an industry. The sample size is 8 participants, the reason for this sample size being used is it is accessible to individuals who have the necessary skill, experience and knowledge within the organization to provide insights.

3.5.3 The research instrument

Interviews were used as primary data, although secondary data supplemented the data collection.

3.5.4 Procedure for data collection

Data was gathered directly from the interviews. The interviews had open ended questions.

3.5.5 Reliability

Reliability for this study means reflecting on the consistency and accuracy of the data collected. Did the data collected accurately reflect the concepts and variables under investigation. The data collected was from interviews with senior-level executives’ views with in-depth industry knowledge on the adoption of AI in supply chain. To ensure reliability the researcher kept a standardised

questionnaire. The researcher ensured the interviews were recorded and transcribed for consistency. Codebook development was done to ensure the consistency.

3.5.6 Demographics

The demographics of the data is 75%/25% split in gender (6 male and 2 female). 37.5% of candidates are transformational candidates (3 African/Indian and 5 white). The selection criteria were Senior Executives. Details are presented in the interview participant guide. (Appendix A)

3.5.7 Limitations of the study

The study has some limitations. Firstly, the results are based on the outcomes from interviews conducted. The results are seen from the view of industry experts who have a wealth of knowledge on the related topic. Although this is a qualitative study, the study can be expanded in future to a quantitative study, and this will be able to provide more insight to the adoption of AI in South African supply chains.

The second limitation is that the study is focused on one global company in the supply chain industry where 8 executives were interviewed to understand the adoption from a company perspective. Their insights were used to unpack adoption from an industry perspective. The number of participants is limited to 8, and is based on their expert knowledge, this can be expanded further to understand the adoption of AI.

Lastly, quantitative studies can expand the study beyond the current geography of Johannesburg, Gauteng, which will in turn expand the results. The study was limited to the Johannesburg metropolitan.

3.5.8 Ethical considerations

The study is a low-risk study as the interviews do not present radical views or intend to cause harm. Consent was obtained verbally and recorded prior to the interviews beginning. Data captured will remain confidential. The identities of the

participants will be kept confidential. Details can be found in the Wits Business School Ethics clearance. The interviews were recorded using an online platform, the interviews will be kept for a period of 12 months from time of the interview being completed. The data will be stored on a secure cloud platform.

Strategies for mitigating data distortion, that the researcher has employed, was ensuring anonymity and confidentiality. Standardised transcription was utilised to mitigate this.

CHAPTER 4. RESULTS AND FINDINGS

4.1 Introduction

The focus of this chapter is to present the findings of the interviews. The purpose of the interviews is to understand the adoption of AI in supply chain. It will look at if there has been adoption of AI in supply chain, how the adoption worked, and has there been any challenges in adopting AI. The interviews will also look at whether AI can work in a third world country with high unemployment, low skills level.

This section was completed by using the interview structure guide. This was done to ensure the framework was covered. The interview questionnaire guides looked at it from an organisational level and then from an industry perspective. The below recuring constructs were found through using thematic analysis. These constructs were broken down into sub constructs, which will be explored in more detail below.

4.2 Adoption factors

The participants spoke around the Adoption Factors where they have seen adoption and the subcategories were barriers influenced adoption and change management. There were different adoption factors that participants unpacked.

4.3 Barriers

Participants spoke manly around the challenges faced in South Africa from a skillset perspective. This comes down to South Africa not having the sufficient level of higher educated (above high school) employees. This is as a result of the lack of infrastructure at a grass roots level that would provide children with exposure to technology. The participants felt that due to the economic challenges facing South Africa, South Africa does not have the skills level to develop these skills. One of the participants had the below to say. The challenge facing South Africa is that there is excess of low skilled labour versus that which is required for the adoption AI (Charl & Fatima, 2011).

Executive: Transport Managed Client Services: Male (African – Participant 7)

> *"Number 2 you look at the skill that is there, it's very limited."*
> *"So, we should just make sure that we get the best people as they come out of institutions that focus on technology. And if you look at our macroeconomic space, which is our own space you are operating in supply chain, there's very few players. So, you need that differentiator and technology, or AI will be the differentiator in the market."*

This becomes a concern as it means South Africa will need to outsource the skills from other countries to develop AI. As the company researched is an international company, one participant confirmed that the skill set for AI adoption exists in the organisation in their head office. Larger international companies can leverage the skills internally through their international workways. This still poses a challenge to locally based companies. South Africa's unemployment rate is high, with a third of the working population unemployed (W. B. R. Department, 2023).

The second concern around the adoption of AI is the current unemployment rate. There is an opinion that in a country with high unemployment, adopting AI may contribute to further losses. One participant said that implementing AI may not necessarily mean loss of jobs as there is still a lot of waste and AI can help eliminate this. A report published by McKinsey and Company indicated that the country could see an increase in jobs by 1.2 million by 2030. This will be the result of investment in skills and in technology by the government and businesses. (Nomfanelo Magwentshu 2019).

> *Executive President – 4PL – Male – (White -Participant 1)*
>
> *"So it's somewhere between those two. In my sense is that there is lots of waste in the supply chain, so if you can reduce the waste and lots of that waste isn't around people, It's around inefficient stockholding inefficient inventory locations. You know, wasted activities."*

“It’s 100% I think you won't be able to fully automate everything, and specifically in the South African landscape, also don't think it's a good cost decision to try and automate everything.
I mean labour and it's still relatively affordable if you look at the expense of technology. So that cost is coming down, you know time but for now, I I don't think in South Africa makes sense to start investing in technology with the cost being so high

This was the only participant talking about weighing up the cost implications of adopting AI versus the cost of employment as labour in South Africa is still relatively low compared to elsewhere. As AI is still a recent technology, it is expensive, and companies would like to not risk the implications of failure.

Another participant spoke about how AI will enable fast and more accurate decision making, and not necessarily impact the employment. Below is an extract from a participant talking to how supply chains can benefit from using the time more efficiently.

Executive: Transport Managed Client Services: Male (Indian - Participant 5)

“There's either fear, lack of mention before of job losses, but I think something like this if we could do something better with the with the reduction of time , because obviously people doing this stuff manually now, and if we if we streamline that there's a surplus time we use those times to get time to actually upscale the people that are that are currently doing those task or use their time more efficiently”

This in essence gives a new dimension in taking into consideration that the concern around the adoption of AI in a country with high unemployment rates should not be as AI can work hand in hand to improve supply chains as it use cases are not limited to reducing overhead costs.

Another participant backed this up with the below statement, although there was a contradiction that over time, you would be able to reduce the costs.

Managing Director – Female (White - Participant 2)

“So I think from a labour perspective that will make tasks lighter for people instead of being having to have four or five screens open and trying to balance a whole lot of different worksheets, it could ease the flow of worksheets and functions.
So the stress levels would be down, you would probably have a labour saving, you know as you progressed with it.
And I think you would get information quicker on back to customers.
So you'd have a higher customer satisfaction index I mean suppose with any customer once feedback, it makes the ease of doing business with customers better.”

The above highlights that there is a contradiction and definitive limitation on the impact of AI adoption on employment.

The next barrier that was unpacked was data. Having a clean set of data is imperative to AI adoption. This is evident from analysing cases from the literature review where AI was deployed to forecast demand. The AI tools utilised historic data as part of the dataset to forecast demand. Participants also spoke about the importance of this. This study further unpacked the use of big data, IoT and AI to deliver. Big data (virtuous triangle) plays a crucial role in this, therefore data is crucial to this. One participant had the below to say around data.

Executive President – 4PL – Male – (White - Participant 1)

“when it comes to data, garbage in garbage out”

This is one of the factors impacting AI adoption as AI algorithms require complete and accurate data to provide reliable insights (Ehioghae & Idowu, 2021).This simple line tells a bigger picture on how crucial data is.

4.4 Change management

Change management is crucial in any environment. With the adoption of AI, it is even more crucial, as there is the fear of the unknown. Employees needing to feel safe and at ease that the technology is not there to replace them but improve their jobs and assist them focus on more important aspects of their jobs as opposed to doing manually mundane tasks. Employees will need to understand how they will work with the tools and how the tools will benefit them and the organisation.

Taking employees on the journey will benefit the process of acceptance and embracement. One interviewee commented on if the process is done correctly the benefits can be significant. When looking at the Westerman's representation of digital maturity, in order to be a "digirati" it is important to have an overarching digital strategy and vision (Westerman et al., 2014). Westerman's Digital Transformation Compass, also emphasises this, as discussed in the literature review.

> *Managing Director – Female (White - Participant 2)*
>
> *"yeah, I think if you did the change management process correctly then it yes, then you would. There would be a sense of readiness."*

Another participant gave an interesting view on a question that needs to be asked when adopting AI.

Executive: Transport Managed Client Services: Male (African - Participant 7)

So, if you were to move into AI space, it will open new opportunities. The problem that you have it goes back to what we discussed earlier. Change management. How will we manage it?

Planning in advance around how you implement the change to enable a successful adoption is paramount. Many organisations adopt innovative solutions with forgetting to include the change management. If employees do not embrace the new solution and buy-in is not received, it will make the implementation tougher.

To summarise these adoption factors, the study found that skills are necessary to the adoption of AI. It is important for the investment in education to have skills within the country. Larger international companies can leverage the skills from overseas. The study further found that AI does not need to impact employment negatively, there can be a positive impact without the loss of jobs, although there is contradiction on this and no definitive answer.

4.5 Skills development

Skills development looks specifically at how supply chain organisations adopt AI. The previous section affirmed that South Africa does not have the necessary skills. The question now becomes, with the lack of these skills, how AI can be adopted?

Participants affirmed that the skills to deploy AI does not exist within the organisation and will need to be outsourced. As mentioned in the summary in the previous section, one participant expressed that the skills to deploy AI exists in their overseas offices. Another participant spoke about how the skills exist, how their department uses the technology and how in the next 2 years there will be use of AI.

One participant made a valid point around the skills set depends at which point in AI deployment you are at, so if you are in a space where your digital maturity is low and you are using AI to compile prescriptive analytics, the skills set is there.

However, if you looking for machine learning, then the skills set does not exist. South Africa will require 1.7 million graduates (with specialisation in technology) in order to meet this demand. This shows the requirement to develop the necessary skills in the country (Nomfanelo Magwentshu 2019) to ensure that the unemployment rate remains low, and is not increased through adoption of AI.

In terms of whether the skills will be outsourced permanently or if the organisation will look to outsource at first and then bring these skills inhouse by recruiting, there were mixed responses. One participant explained that they will look at insourcing, although backing up that the skill set does not exist in the country, they will look at utilising resources in Dubai (where the organisations head office is based).

Senior Director – Technology Female (White -Participant 4)

"But ultimately, we will employ people.
It will sit with the development team, product development team in India, that consists of hundreds of people."

This shows that South Africa misses out on the opportunity to get its employment numbers up. An interesting finding was that one participant spoke about splitting the functions, where business processes should be owned by the business, although development and deployment which is specialised should be outsourced.

Senior Executive President 4PL – Male (White - Participant 1)

"But specialists around using software implementing software might always be remote, but there'll be an element of business ownership."

The long-term view is one of ensuring continuity. Like any other technology, AI will continue to evolve. Therefore, the discussion moved to a long-term view and the executives then spoke about how they would look to retain the skill to then

develop and maintain the system. South Africa does not have the skills as discussed above, so supply chain companies looking internationally for the skills will have the resources working remotely from their home countries. As mentioned, this company will use the skills from India to ensure that the business can continue to evolve. An interesting point raised by one participant is not having extra capacity in structures to build the skills either. The business is lean to ensure competitiveness to customers in terms of pricing, so it is difficult to have any additional capacity to grow the skills in the business.

4.6 Readiness

There was consensus from the executives on whether their organisation was ready for AI in certain aspects. This was important, as companies need to understand as part of being ready, you will need the necessary infrastructure and skills. Clearly as being a part of an international organisation, they find that it is ready.

The literature review chapter discussed how AI is being deployed. In South Africa, international companies can leverage this as AI has been deployed in other countries.

One participant explained:

Executive: Transport Managed Client Services: Male (Indian - Participant 5)

> *“So, from a majority level, I don't think they are ready now to switch over.”*

> Looking at these statements we can see that this organisation feels they are ready to expand their AI adoption. A few cases were given where in the organisation AI had been deployed.

> *“Now using a system that is called Story Chart, it's based on data that understands historic trends and there are other businesses like Canvas AI .I have clients where they use data trends and when you run a live*

dashboard see you exceeding your three month trend or you know historically one year trained. It generates workflows that goes to people that the resolves the problem and then gives you know a form it goes and sits again that's that event and our next time if that happens again there is now 1000 forms that have been completed and the solution then helps you make a decision so that in a simple form is AI.I think it's already adopted in lots of cases right they go to automated workflows generates data that helps decision support the next you know time it happens so all of that's happening I think it's still in a simpler and dumber form than what we think AI will be but it's there."

This is interesting as the definition of AI is broad, but simpler forms of AI still apply.

4.7 Technology

The next evaluation is technology solutions. This section will focus in on the two sub themes namely technology and strategy; does the organisation have the necessary infrastructure for adoption; and does it form part of the organisation's strategy. Is it a strategy that is long term or short term?

The participants discussed the importance of technology, as customer expectations and demands are increasing. Technology in general is assisting in delivering on these expectations. Supply chain customers are looking for competitive advantages through their supply chain partners. Technology has been able to deliver lower costs and increased efficiency. This has given the customers the appetite for more.

The participants provided examples of AI being used in supply chains, although not all examples were based on use in their organisations. This shows that the level of knowledge of AI use varies between the executives in the organisation. From the participants who spoke about use cases in their organisation, it is

evident that the business has the technology infrastructure for the adoption of AI. One of the participants provided the below as a use case for a customer that operates in Europe as well. The participant spoke of a beverage company who is utilising AI in sourcing of raw materials. The business was impacted by the war in Ukraine, and as a result implemented AI to use predictive analytics to understand where there will be bottle necks in supply and giving options for alternatives to find the supply. This shows the level at which Europe is utilising AI.

The participant below provided a use case of AI in their organisation which is in South Africa.

Executive: Operations Executive Male (Indian - Participant 8)

> *"One specific example for a current client of ours, so we receive the raw materials on rail, the client doesn't have the resources or ability to weigh every wagon.*
> *So, there's 40 wagons that that come through on rail, they measure 4 and then use the average across the rest. So, their investigations with AI showed that they identified what a perfect wagon should look like and then use AI to identify wagons that did not meet these specifications and assisted in weighing those wagons. This gave the customer more accuracy, as you pay based on weight."*

We can see different uses of AI above although it shows that AI adoption in South Africa resembles that of Europe, although it is thought that Europe has more accessibility to the skills and in Africa it will need to be outsourced.

From the above, it is evident that technology infrastructure exists for the business to build on.

4.8 Strategy

The next phase discussed is strategy. From the interviews, all the participants mentioned that AI is part of the company strategy, although the way it was communicated did not show a common understanding.

One participant explained the importance of organisation's having a defined strategy in terms of AI.

> *Managing Director: 4PL Male (White - Participant 3)*
>
> *"So, I think it's there's Yeah, they are definitely pockets where you focus on, but I think each business and the different levels in the business needs to have a defined strategy of how do we apply AI, where is it practical? What's the feasibility? What's the business case? ""*

Another participant had the below to say.

> *Executive President: 4PL Male (White - Participant 1)*
>
> *"Yeah, I think AI is a is a part of the digitalisation strategy. So, I think AI is installed with the digitalisation strategy and using technology as differentiate."*

We can see from the above responses, there is no consistency in the answers as to if AI is part of a long-term strategy. This shows that as much as this supply chain organisation has adopted AI, the executives do not have a clear idea of the strategy for continuing to use and expand their AI adoption. This causes a challenge as AI has positives impacts and potential negative impacts. These need to be understood, unpacked and the risk needs to be mitigated. There needs to be clearly defined strategy to AI in organisations as this will assist in managing risks and assisting with change management.

As AI forms part of technology, the impacts thereof can be experienced throughout the business. It is important to ensure that this is understood and agreed upon.

4.9 Other observations

Other observations were made during the interviews and are explained in more detail in the next section.

4.9.1 Understanding

The findings reveal that there were different understandings of AI and no consistent understanding of AI. The understanding varied in terms of the capabilities of AI. Some spoke of how AI is all about automation, which is true, although it does not clearly define it. One participant spoke about how AI has building blocks in Big Data, again this is true.

Another participant spoke about how AI as a plug into existing technologies. While all of these are true, it shows that there is different understanding to AI and capabilities.

4.9.2 Regulations and laws

As explored in the literature review, South Africa still needs to develop a framework for the use and development of AI. None of the participants mentioned the need for this. When an organisation adopts AI, they will become users in the development of this technology. As an organisation using the technology, the business should be coming forward to contribute to developing the framework around the use of AI. South Africa should be looking into evaluating companies that have already adopted AI to assist in developing the framework.

4.9.3 Risk management

There was no discussion from the participants on how the business managed risks when adopting AI from business continuity to changes in structure. It appears this organisation adopted AI in its infancy to minimise risk, there is still risk in terms of expansion of the adoption.

There was no discussion around risk or the costs involved in failed implementation or scope creep. As AI is a new technology, this is something that needs to be explored more. The case study on Nike's failed implementation, as noted the in this study's literature review, should be considered.

4.9.3.1 Cost of implementation

There was a discussion on the costs of implementation by only one participant, who spoke about the low labour costs in South Africa and how there needs to be cost comparisons on which would be a cheaper alternative. AI is growing as a fairly new technology, so cost benefit calculations would need to be compiled as a business case for the investment. Only one participant had spoken around the need for business case. One participant spoke about the organisation's readiness.

> *Director – 4PL Male (White - Participant 3)*
>
> *"Yeah, they are definitely pockets where you focus on, but I think each business and the different levels in the business needs to have a defined strategy of how do we apply AI, where is it practical? What's the feasibility? What's the business case? Yeah."*

4.9.3.2 Strategy

The organisation lacked a clear roadmap for the adoption of AI. The different participants spoke of the different ways AI is being utilised in the organisation. There was no standardisation around how AI was used. Some participants gave different use cases for AI in the organisation. This in turn will eventually cause challenges as there is need for alignment and not for the organisation to operate in silos. The reason the organisation could be at this point, is due to the migration of two companies into one. This means now aligning a roadmap and understanding where the organisation currently is and where the organisation would like to be. It also means communicating the strategy and measuring it.

4.9.3.3 Environmental impact

One of the factors mentioned by a participant emphasised how AI was used in network modelling and day to day vehicle optimisation. AI is utilised to provide insights to ensure the correct size fleet is used in deliveries (e.g. larger vehicles are not used, and the capacity utilisation of the vehicles is low). This ensures that the vehicle fleet size and capacity size is an ideal fit. This reduces the carbon emissions of using larger vehicles which attract higher running costs. The second point by another participant was around how AI should be adopted in the transport planning environment. By implementing a TMS (transport management system, with AI, like UPS) using a planning tool ensures maximum utilisation of the vehicles, and the least amount of kms driven to ensure there is a reduction of carbon emissions. AI is also used to give turn by turn directions, optimising routes on the go, to avoid traffic delays. This again will result in lower carbon emissions. This shows how AI can be effective in assisting with the environmental impact.

One participant spoke around how dynamic routing utilising AI can have an impact on lowering emissions.

> *Executive Vice President – 4PL Male (White - Participant 1)*
>
> *"So for me, if the routing was dynamically learning and improving and for me it would be lower(emissions) which would be what the technology is supposed to do so."*

4.10 Conclusion

The findings in the interviews showed a lack of structure to the adoption of AI. It shows that AI adoption in South Africa is still in its infancy as there are learnings that will need to be considered in supply chains as it evolves. It is crucial that these learnings are shared across the industry. The study found other factors that impact the adoption of AI and this means the conceptual framework will need to be revised. This will be discussed further in the upcoming chapters.

CHAPTER 5. DISCUSSION OF FINDINGS AND RESULTS

5.1 Understanding

The interviews showed inconsistencies in the understanding of AI and its adoption value. The understanding varied from basic understandings to higher levels of understanding of AI as a technology and its adoption.

There was no common thread of understanding, between the participants. Looking at the participants answers to where they see the benefits of adopting AI, the answers varied showing a difference of understanding.

> *Executive: Transport Managed Client Services: Male (Indian - Participant 5)*
>
> *"I think when mainly on the manual process, some of the stuff being presented to us at the moment is quite intresting this thing (AI) will be lots of streamlining of processes."*

Executive: Transport Managed Client Services: Male (White - Participant 6)

> *"I think that the value will definitely be for demand forecasting and where is there's a lot of work done behind the scenes in Industry, let's say transport and warehousing, and there's a lot of time of what was lost."*

Executive: Transport Managed Client Services: Male (Indian - Participant 5)

> *"So within supply chain.*
> *I would say from a phased approach."*
>
> *"Phase one would be, as I spoke to earlier, the finances in terms of all the issuance, all the payments or the receivables, accounts payable, accounts*

receivable, Step 1, Step 2 would be adding AI into the current mobility that's been extended supply chain and visibility in terms of E POD etc."

Director – 4PL Female (White - Participant 2)

"It will change their supply chains quite rastically and make them more agile and more adaptable to changing markets."

The data gathering shows how the understanding of adoption of AI varies between the individuals.

5.2 Common themes

Six out of eight participants spoke positively about how AI can influence employment, and not necessarily have a negative influence. A significant theme was around waste in supply chain and how AI can reduce the waste and reduce manual components, to free up time and aim to give opportunities to employees to focus other time on meaningful activities. (Gwagwa, 2020)

Some participants specifically spoke about AI being removed in completing of documentation.

Executive: Transport Managed Client Services: Male (White - Participant 6)

"So one person is not going to be able to analyse that.

So I think the big data analytics aspect of that is definitely seen a positive to actually use that data that's being transactional on a daily basis for when improved in the you know, in stock where stuff must be situated within the markets and allowing the sales and being able to turn that around and give that from you on a week to week basis versus having to look at that six months later."

Executive: Transport Managed Client Services: Male (African - Participant 7)

> *"So, these opportunities with AI and I believe it will solve most of our problems, because we are spending a lot of time, eight to five, it's a lot of time, time to prepare reports and fix things."*

The above shows that the main aim and purpose is to reduce inefficiencies. There was also consensus that the organisation was ready for the adoption of AI. The research further found the need for a digital maturity model to be considered. None of the participants raised the idea of a model being used to manage digital change in the adoption of AI.

This again speaks to the need for businesses to understand the need for a digital transformational change management process. The organisation had already adopted AI and change management was identified as key in adopting AI.

Director – 4PL Male (White - Participant 3)

"And with any technology in event, if you take a shotgun approach, then you lose credibility.
So then the change management afterwards becomes the issue.
It's very important that you apply this correctly, and then I think just a hype around AI as well is that lots of people fear that there."

Director – 4PL Female (White - Participant 2)

"And so, I think it depends on which company within the organisation.
And some are more ready than others and more willing than others to try new things.
But yeah, I think if you did the change management process then it yes, then you would.
There would be a sense of readiness."

The above reveals that change management is an important factor in the adoption of AI although no digital change management process was identified by the participants. Participants spoke of readiness in different divisions although none of the participants spoke about the digital maturity of the organisation and how this could affect the adoption of AI. The organisation can be defined as a fashionista according to Westerman's model.(Westerman, 2014) The organisation was able to adopt AI as they had the infrastructure, although there was no overarching vision to support the deployment and their divisions operated in silos.

5.3 Conceptual framework

Below is the original Framework developed through the literature.

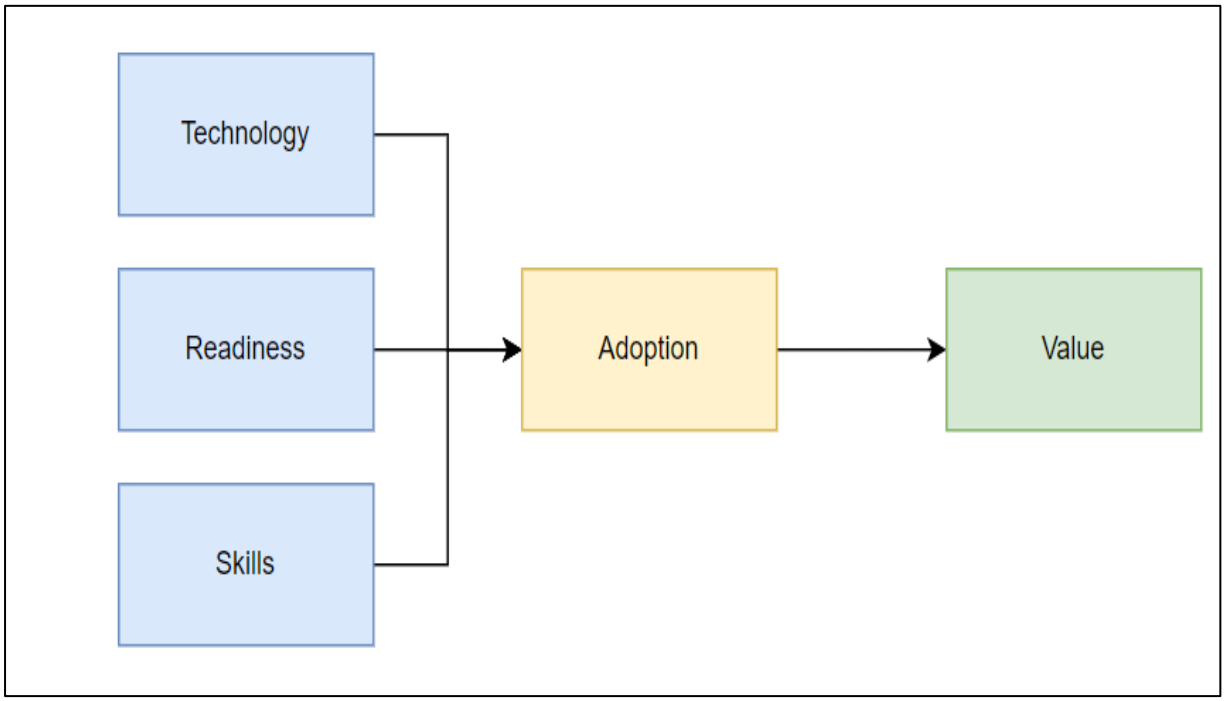


Figure 15: Original Conceptual Framework

The conceptual framework was re-developed based on the results of the of the interviews.

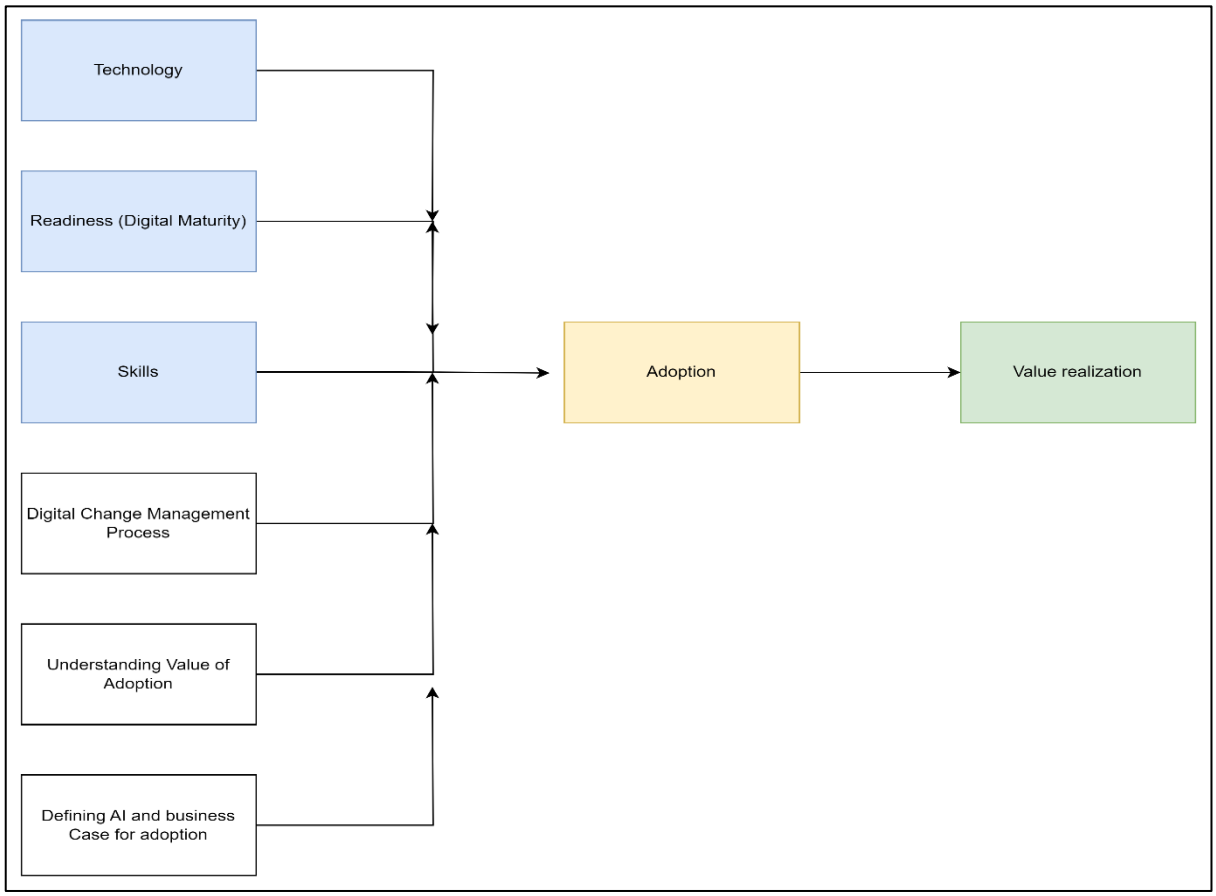


Figure 16: Re-developed Conceptual Framework

Other factors influence the adoption of AI. The three additional factors include:

5.3.1 Digital change management process

All participants spoke of the importance of digital change management, although none of the participants spoke of a digital change management model that was adopted. There are various models that could be used. This study went into more depth around the digital change management models, especially with the fears of increasing unemployment.(Westerman, 2014)

5.3.2 Understanding the value of AI adoption

This varied and participants showed the need for organisations to have a clear understanding of what the proposed value of AI is going to be. This will assist in measuring and realising the adoption of AI. Through the process, the participants did not mention how success would be measured. (Simon Krause, 2022)

5.3.3 Business case for adoption

Only one participant spoke about utilisation of a business case for adoption of AI. This becomes important as the participant spoke about technology still being expensive versus the labour cost in South Africa which is still relatively low. This means a clear understanding of the required investment and return of investment. This will enable assessing if organisations can free up funds to invest in AI and understand how long it would take to see the efficiency of the adoption. These brought together gives the conceptual framework more conclusive way to understanding the adoption of AI.

5.4 Additional findings

One additional finding was whether AI could be deployed at scale through supply chains in South Africa. The simple answer was no, due to a lack of skill and expertise. The mention of cost was also noted by the participants. There is a need for the industry to first understand strategy and understand where the gaps are and the ways to bridge the gaps.

Executive: Transport Managed Client Services: Male (White - Participant 6)

> *"I think technology is fairly slow, expensive and in terms of the scalability".*

Senior Director: Technology: Female (White - Participant 4)

> *"Do we have enough of the necessary skills?"*

“This might be the question, and if we have all, they're not in any case, being poached to go elsewhere because it's a very attractive, whether it's Silicon Valley, whether it's India, whether it's wherever.”

5.5 Conclusion

Results showed that AI has already been adopted in supply chains in South Africa, although there is a lack of framework in how the technology has been adopted. There is a general idea of how AI adoption benefits supply chains, although this understanding is still in its infancy. More structure on the development of AI, as well as organisations recruiting specialists in digital change management will assist organisations in having standardised structure to adopt the technology. The challenge remains that there is no clear understanding of the benefit and how to measure success or failure. There also is no way to understand failure and to fail forward by learning and improving on this. The digital transformation compass was unpacked in the literature review. This will enable organisations to drive the adoption of AI and technology. The organisation does not have a constructive framework. The organisation has elements, although a constructive framework can speed up the adoption.

CHAPTER 6. CONCLUSION

This study found that AI adoption in South African supply chains is still in its infancy. The study aimed to answer the research questions:

- What is the value of adoption of AI in supply chains?

From the participants answers and the literature review it is evident that AI has a major role to play in the advancement of supply chains. We see this in the studies completed by Simon Krause(Simon Krause, 2022). Specifically in South Africa, where due to the failing infrastructure, high unemployment low economic growth, (Samuel, 2012) AI can contribute by bringing efficiency removing manually process, automating tasks so employees can focus on value added tasks.

South Africa has begun to develop frameworks for AI development and deployment, although there is a lack of conversation on how to start growing the AI skills in South Africa. This is important if AI is to have a positive impact on employment. More will need to be done not just for AI but for digital skills in general. South Africa has a high population of low-level skills. This needs to change to accelerate the adoption of AI in supply chains. It will mean organisations must source these skills locally and not feel the need to outsource skills considering the higher labour costs. South Africa can then leverage outsourcing these skills to overseas countries.

- Do the necessary skills exist to deploy AI in supply chains in South Africa?

The study found that the necessary skills to deploy AI in supply chains, does not exist currently. There is some skilled labour and this is becoming an in-demand skill. The adoption of AI depends on the organisations. International organisations have access to skills in their overseas offices, while local companies may struggle with this and will need to then outsource these skills.

International organisations can also ensure that current employees are trained on this skill set by leveraging internal skills from international employees.

- Are supply chain organisations ready for the change to adopt AI in South Africa?

The research found that supply chains are not ready as they currently do not employ any framework to adapt the digital change management. There is no framework that was mentioned during the interviews to highlight how a framework can be adopted.

- Do companies have the required technology to move forward and adopt AI?

From the interviews, participants were confident that the organisation has the necessary technology to deploy AI. This will go hand in hand with having the necessary skills. This points to the ability of certain supply chain organisation's ability to deploy AI. The organisation seems to fall into the fashionista category of the Westerman model. This is due to the there being a lack of strategy with AI being adopted.

6.1 Next steps

Further in depth studies should be conducted among more supply chain organisations, including a blend of international and local supply chain organisations. Further studies can investigate and analyse how local supply chains intend to deploy AI to compete with their competitors who have international roots and have an advantage in utilising the skills that exist in their organisations. This will enable an overall picture of the adoption of AI.

The investigation should go lower into unpacking benchmarking used to assist organisations understand where they are and where they aim to be, by investigating the digital maturity for the organisation. The study will also need to unpack the digital maturity model that can understand if other organisations are

ready to adopt AI and where those organisations sit in the Westerman model. This will in turn give a view of where the overall supply chain industry stands. The Digital Change models will also need to be applied to unpack which is the most suitable model for supply chains for the adoption of AI.

This can give a full picture of how organisations in the supply chain industry intend to use the adoption of AI to improve.

6.2 Conclusion

The study has provided an in-depth analysis the on the adoption of AI in South African Supply Chains. From the literature and the qualitative research, we see that there is many gaps in unpacking how AI would be adopted in full scale.

Further research where AI has been fully deployed in a supply chain in South Africa would provide greater details as to the challenges faced considering South Africa is a third world country. The research would also give guidance as to digital maturity assessments and models adapted.

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APPENDIX A: PARTICIPANT LIST

Participant	Industry	Sub-division	Role	Gender	Race
Participant 1	Supply Chain	Supply Chain Services	Executive Vice President	M	W
Participant 2	Supply Chain	Supply Chain Services	Managing Director	F	W
Participant 3	Supply Chain	Supply Chain Solutions	Managing Director	M	W
Participant 4	Supply Chain	Supply Chain Technology	Director: Digital and IT	F	W
Participant 5	Supply Chain	Supply Chain Solutions	Executive: Transport Management Services	M	I
Participant 6	Supply Chain	Supply Chain Solutions	Executive: Transport Management Services	M	W
Participant 7	Supply Chain	Supply Chain Solutions	Executive: Transport Management Services	M	A
Participant 8	Supply Chain	Supply Chain Solutions	Operations Executive	M	I

APPENDIX B: VERBAL CONSENT (RECORDED DURING INTERVIEW)

I require consent to the below before we procced with the interview.

You are voluntarily participating in this interview. The interview will be conducted with open ended questions to allow in depth knowledge and experience sharing of the topic.

Interviews will be recorded and transcript for use of referencing. You may decline to answer any or all questions and may terminate your involvement at any time during or after the interview. The purpose of the study is the adoption of AI in South Africa Supply Chains. Do you agree and consent to the above?

APPENDIX C: COMPANY AGREEMENT

DP WORLD

dpworld.com

Dear Wits Business School

DP World grants Prenesen Naidoo, Student number: 2377983 permission/consent to complete his dissertation topic at DP World:

"The adoption of AI in South African supply chains"

Prenesen Naidoo can make use of the data within the TMS environment, always keeping client confidential information confidential and in alignment with my approval if client specific information is required to be published.

Permission granted to Prenesen Naidoo to conduct interviews, questionnaires and any methods required to gather data from DP World staff that can be scheduled for the purpose of the data gathering. Stakeholders and participants are guaranteed confidentiality.

DocuSigned by:
Emer.keegan@dpworld.com
126A75A7A0914DC...

.....

Emer Keegan
Vice President: L & D | Logistics | 4PL | Africa
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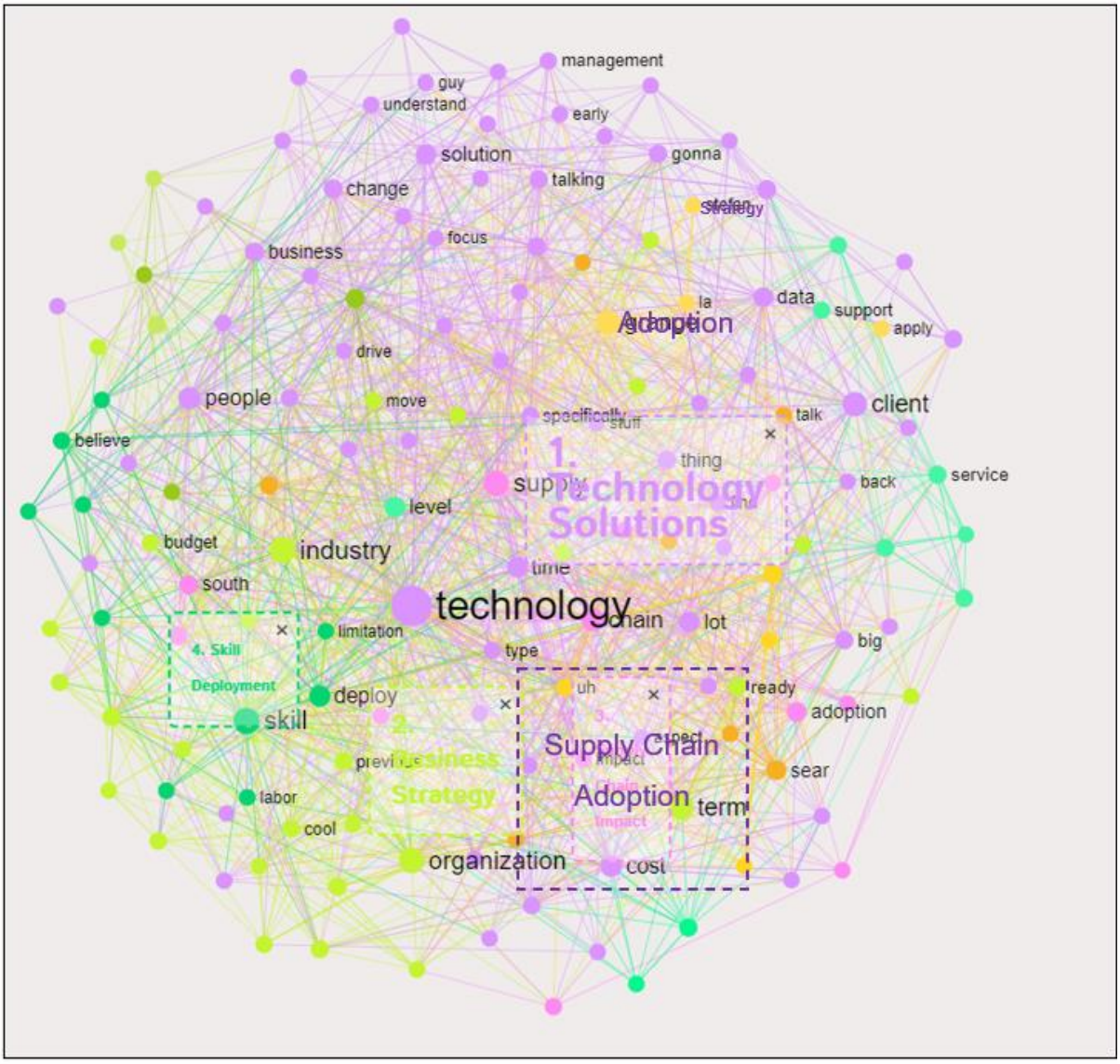
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APPENDIX D: INTERVIEW GUIDES AND CODING

Construct A	Sub-Construct	Code	Organsational/Industry	Interview Question
Adoption Factors	Barriers	BE	Orgnisational	External factors influencing AI adoption (competitors, micro-economic, skills market [labour])
		BE	Industry	Do you believe there are any limitations to deploying AI?
	Change Management	CM	Industry	How do you think this will impact employment within the Supply Chain Sector in South Africa?
		Sk	Orgnisational	Do the necessary skills to deploy exist in your organisation or will it need to be sourced?
	Skills	Sk	Industry	Do you believe South Africa has the necessary skills to deploy AI at scale throughout Supply Chains?
Skills Development		RD	Orgnisational	Following on from the previous question, will you look to employ labour to implement the use of AI and maintain AI? Or will you outsource this function?
	Readiness	RD	Industry	Have you seen examples of use cases of positive adoption of AI within the Supply Chain sector.
		CM	Orgnisational	In your opinion is your organisation ready for AI? Please elaborate on your answer.
		RD	Industry	where do you see the future impact of AI within Supply chain ?
	Technology	TC	Orgnisational	Have you seen a significant demand from clients to utilize technology to • Reduce cost, • Increase efficiency and • Deliver higher levels of customer service • Competitive advantage
		TC	Industry	What do you believe will be the value of adopting AI?
Technology Solutions	Strategy	ST	Industry	Does AI form part of a long-term strategy for your organisation/industry with investment being budgeted for this
		ST	Orgnisational	is there willingness in your organisation to explore the use of AI?
		TC	Orgnisational	If and how does your organization utilise AI currently? If not is there a strategy to explore the use of AI

APPENDIX E: CODING



APPENDIX F: ETHICS CLEARANCE

Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School Ethics Committee
Constituted under the University Human Research Ethics Committee (Non-Medical)

Ethics Clearance Certificate

Ethics protocol number: WBS/DB278933/268

This certificate is only valid with a legitimate ethics protocol number and signed by the Researcher (below).

This certificate is only valid if accompanied by formal permission from the relevant stakeholder(s).

Project title	The adoption of AI in South African supply chains
Investigator / Researcher	Mr Prenesen Naidoo
Nature of Project	MM (Digital Business)
Decision of the Committee	Approved, provided stakeholders and participants are guaranteed confidentialty.
Issue Date of Certificate	9/5/2023
Expiry date	Date of submission of the project / research report
Chairperson	Dr Pius Oba +27 11 717 3976 +27 82 733 6587 pius.oba@wits.ac.za

Declaration by Researcher

One copy must be signed by the Researcher and returned to the Chairperson of the Wits Business School Eti Committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research a guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I undertake to resubmit the protocol to the Committee.

Pnaidoo
Signature

11/09/2023
Date:

APPENDIX G: TURNITIN REPORT

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APPENDIX H: EDITING CERTIFICATE

NERESHNEE GOVENDER COMMUNICATIONS (PTY) LTD

REGISTRATION NUMBER: 2016/369223/07
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WRITING PRACTITIONER • EDITOR • COPYWRITER • TRAINER

PhD-Management Sciences: Marketing (gender and media); *PG DIP - Higher Education - Academic Developers (Cum laude;)* M-Tech Public Relations; B-Tech Public Relations *(Cum laude)*; B-Tech Journalism *(Cum laude)*; *N-Dip Journalism*

09/02/2024

Prenesen Naidoo
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RE: EDITING CERTIFICATE

FOCUS AREA: THE ADOPTION OF AI IN THE SOUTH AFRICAN SUPPLY CHAIN INDUSTRY

A research report submitted to the Faculty of Commerce, Law, and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in the field of Digital Business

This serves to confirm that this research has been edited for clarity, language and layout.

Kind regards,

Nereshnee Govender (PhD)