4IR skills readiness in the South African warehousing sector

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I. Abstract

This exploratory qualitative study aimed to understand the 4IR Skills Readiness in the South African warehouse sector. The study sought insights and experiences from industry stakeholders, explored the impact of 4IR on skills, understood the then-current skills landscape in relation to 4IR in South Africa, and reviewed existing 4IR skills development programs from government, educational institutions, and the private sector. Addressing three research questions on the South African warehousing sector's 4IR readiness from a skills perspective, the study investigated the impact of 4IR from a role evolution standpoint, specific skills and knowledge required for effective 4IR technology adoption, and the necessary 4IR training programs and initiatives for upskilling and re-skilling. Employing a qualitative research approach and adopting the Interpretivism research paradigm, the study engaged key stakeholders in the South African warehousing sector, utilizing purposive sampling to select participants based on their roles, expertise, and experience. Interviews served as the primary data collection tool, allowing the researcher to explore participants' viewpoints, experiences, beliefs, and motivations.

The study findings offered a contextual understanding of the multifaceted impact of the 4IR on skills evolution within the warehousing sector at that time. The results underscored the need for collaborative efforts among stakeholders, educational institutions, and government bodies, emphasizing the importance of strategic planning, education programs, and skills development to navigate the challenges and leverage positive outcomes in the sector. In conclusion, the study addressed three pivotal research questions, providing nuanced insights into 4IR skills readiness in the South African warehousing sector as of the study period. It highlighted the importance of strategic workforce planning, upskilling, and reskilling initiatives to adapt to the dynamic changes introduced by 4IR. A noteworthy recommendation emanating from this exploratory study was the proposal for a new theoretical framework - The Technology Skills Development Framework for the South African warehousing sector. This framework emphasized the need for accessible 4IR programs, collaborative partnerships, and a revamped education system, offering a tailored roadmap to navigate the complexities of the 4IR in the sector. The study contributed valuable insights and recommendations, paving the way for further research and actionable strategies in navigating the evolving landscape of 4IR in the warehousing sector.

II. Acknowledgment

I would like to express my heartfelt gratitude to all the participants who generously contributed their time, insights, and experiences to make this exploratory qualitative study on “4IR skills readiness in the South African warehousing sector” possible. Your willingness to share your valuable perspectives has enriched the depth and authenticity of this research.

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Regards,

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III. Table of Contents

4IR Skills Readiness in the South African Warehouse Sector

Chapter 1: Introduction

1.1 Background of the Study

The Fourth Industrial Revolution (4IR) is a transformative force that is changing the world, reshaping how industries operate with its disruptive technologies. The warehouse sector is at the forefront of this change in supply chain and logistics (El Nahrawy, 2020). The Fourth Industrial Revolution (4IR) is the latest industrial revolution, which aims at advancing technologies like Artificial intelligence (AI), Machine Learning (ML), Automation, and Internet of Things (IoT), these technologies have the potential to revolutionize warehouse operations in South Africa. The Fourth Industrial Revolution (4IR) technologies provide end-to-end digitalization, allowing the warehouse sector to do jobs previously handled by humans more efficiently through the use of automation and an digital information systems known as the internet of things (Kamali, 2019). As South Africa strives to stay competitive in the global market, understanding the readiness of the warehouse sector in acquiring and implementing 4IR skills becomes critical for the sustained growth and efficiency of the country.

The warehousing sector is one of the key value chains within supply chain management due to its ability to ensure efficient logistics operations, which in most cases is a key competitive advantage for any organization. Because logistics costs are a significant portion of an organization's operational costs, technology has become critical in supporting these lean logistics operations (Bag et al., 2020). The adoption of 4IR technologies in warehouses promises enhanced operational efficiency, cost-effectiveness, and improved productivity. However, the successful integration of these technologies requires a skilled workforce capable of navigating the complexity of 4IR tools.

The warehousing sector has benefited from the advancements of various industrial revolutions. The First Industrial Revolution (1IR) brought the steam engine and mechanical production, which introduced the use of material handling equipment in the warehouse sector and also the creation of semi-skilled operator jobs like materials handling equipment operators; this was key in improving the speed of movement of goods in the sector (Ramakgolo & Ukwandu, 2020).

The First Industrial Revolution had a positive impact on the warehousing sector from a skills and labor perspective. It prompted the workforce to adapt to technological changes, fostering a more skilled and versatile labor pool capable of handling the increasingly complex demands of industrial and warehouse operations.

The Second Industrial Revolution (2IR) introduced electricity and assembly lines enabling mass production of goods, this required the construction of large warehouses to store components to support this major manufacturing assembly lines and also allowed which then created the need for a large number workers (Sentryo, 2017). The Second Industrial Revolution significantly enhanced the skills and labor landscape of the warehousing sector. The adoption of electrification, assembly line technologies, and advancements in transportation spurred the need for a more specialized and adaptable workforce, setting the stage for a more efficient and capable industry.

The Third Industrial Revolution (3IR) saw the introduction of memory-programmable computers, which enabled partial automation of certain process, the introduction of partial automation and programming drove efficiency and productivity in the warehousing sector by enabling the use of Warehouse Management Systems (WMS) which was key in managing the inventory levels in the warehouse. The Third Industrial Revolution (3IR) also brought the requirement of highly skilled labour who can operate the warehouse management systems allowing the introduction of logistics professionals in the sector (Sharma & Singh, 2020). Warehouses require centralised monitoring, static deployments, and human engagement in today's 3IR.

Research found that while previous industrial revolutions were beneficial to human development through expansion of labour opportunities both unskilled and semi-skilled labour , the Fourth Industrial Revolution is distinct in that its technologies have the potential to disrupt all aspects of human activity by enabling the use of computer technology and robotics to perform previously performed by humans, thereby eliminating unskilled and semi-skilled jobs (Weiler, 2018) .Another study further added that the previous revolutions were exponential, however the Fourth Industrial Revolution is revolutionary because its technologies such as Artificial Intelligence breaches capabilities that were only done by humans , altering how people live (Sharma & Singh, 2020). Another study added that the Fourth Industrial Revolution's volatility and

complexity is unlike other revolutions as will enables disruptive innovation, which brings a lot of uncertainty and ambiguity and will change how humans work and live (Mpofu & Nicolaides, 2019).

Another study further added that the growing need from customers for need for same day order delivery has forced the warehousing sector to improve is process to cope with this demand through the implementation of 4IR technologies like Automation and Artificial intelligence by digitalizing their process to improve their efficiency and adaptability (Cai, 2020).Research has also found that COVID-19 pandemic has exposed the need for digitalization and optimization of supply chain process like the Warehousing Sector to improve its agility and to respond to the connected global goods market, the study further adds that this will require a long term transformation of process to allow real time visibility through the entire supply chain (Da Silva et al., 2019).

Prior research has found that Fourth Industrial Revolution technologies can significantly improve efficiency, which can lead to significant financial benefit in the South African Warehousing sector; however, this sector is still heavily reliant on 3IR technologies and processes which necessitate the need of much human manual processing, making the sector uncompetitive (Kattepur, 2019).According to studies, Fourth Industrial Revolution technologies such as robotics and , self-driving vehicle/ automated guided vehicles that can be used to perform warehouse tasks such as picking that were previously done by humans at a much faster rate with high levels of operational availability because they do not take breaks like humans. Fourth Industrial Revolution technology such as drones which can be used with information systems technologies such as the internet of things (IoT), can be used to count stock ten times faster and with 100% accuracy than people (Alexander, 2022).

The Fourth Industrial Revolution technologies are evolving exponentially rather than the leaner progression seen throughout the previous industrial revolutions (Garay-Rondero et al., 2020) . Due to this rapid change in the working environment brought by 4IR technologies it has become critical for the warehousing sector to re-skill and upskill the employees to improve their capabilities to adapt to this technological working environment (Wahab et al., 2021). Wahab further added the rapid pace of technological advancement often outpaces the development of

relevant skills among the workforces. Identifying the specific skills in demand, but potentially lacking in the current workforce, is crucial for developing targeted strategies to bridge this gap.

According to the World Economic Forum 50% of employees will be re-skilled and upskilled by 2025 to cope with the technological working environment. They further added that over two-thirds of the skills that are current deemed critical will change by 2025 (Li, 2022) . Research has also shown that lifelong learning has become key, with the future job survey stating that around 40% of the global workforce will require upskilling of at least six months, with half of the workforce requiring re-skilling every five year to keep up with the technological advancement (Whiting, 2020).

The successful adoption of Fourth Industrial Revolution (4IR) technology in the South African warehousing sector demands a strong policy and regulatory framework that encourages innovation while assuring ethical and responsible implementation. South Africa has a significant skills shortage, due to failings in its education, limiting the supply of managers, researchers, and workers required for 4IR. There are also issues with low infrastructure quality, which reflects poor governance and state capture. It has a track record of poor policy creation and execution, particularly across departments, with significant delays in cybersecurity and data protection (Sutherland, 2020).

This exploratory qualitative study aims to understand what future skills, re-skilling and upskilling is required to support the successful implementation of 4IR technologies in the South African Warehousing sector from an interpretivism point of view using insights and experience from relevant industry stakeholders. The study aims at exploring the impact of 4IR in terms of skills, understanding the current skills landscape in relation to 4IR in South Africa, reviewing the current 4IR skills development programs or initiatives from both the government, educational institutions, and the private sector. Finally, the study will explore challenges and barriers in order to come up with recommendations which can assist South African Warehouse Sector with their skills readiness.

1.2 Research Problem

The South African warehouse sector stands at the forefront of the Fourth Industrial Revolution (4IR), marked by the integration of advanced technologies such as automation, artificial intelligence, and data analytics. While the promise of increased efficiency and competitiveness is evident, a critical research problem arises concerning the readiness of the workforce in acquiring the necessary skills to navigate this technological shift. As the industry moves towards greater automation and interconnected systems, it is critical to assess whether the current workforce possesses the skills needed to fully utilize 4IR technologies, or if there is a significant skills gap that could impede the sector's successful transition.

The adoption of 4IR the South African industry is influenced by the variability of customer demands with more and more customers demanding organisation to be agile in terms of responding to their demands.Industries like Logistics and Warehousing are at the forfront of this uncertain denamand for goods and services with 26% of its customers requiring same day delivery for their goods which forces the industry to me more innovative to cope with this uncertain custmer demands . 4IR technlogies like automation are crictical in drving efficiency to meet the cutomer expectations (Alexander, 2022). Another study futher addded that 4IR is anticipapted to improve the the delivery of goods and services by 30%, so it is crtitical for South Africa to empbrace 4IR technologies in order to take advantage of this benefits (Serumaga-Zake, 2021).

According to a study by McKinsey & Company the introduction of 4IR will ignite South African economy by providing much needed economic boost and creating much needed jobs , the study also estimates that 4IR will increase productivity from 0.7% to 2.1% , income per capita from 1.1% to 2.4% and Real GDP growth from 2.1% to 3.5%, with the net gain of over one million jobs in 2030 and warehousing its key strategic sector to support this goals (Sharma & Singh, 2020). An address by newly elected president of South Africa Cyril Ramaphosa in 2019 in his state of the nation address stated that 4IR will be a key driver for economic growth and incorporated in his economic policy (Marwala, 2022). If the workforce lacks the required 4IR skills, it could lead to underutilized technologies, operational inefficiencies, and a failure to meet global industry standards. Understanding the precise nature and scope of the skills gap is

critical for developing targeted initiatives that improve the workforce's ability to properly leverage 4IR technologies, ensuring the industry's long-term growth and competitiveness.

A survey by Deloitte found that of more than 1600 executives worldwide, 100 of whom were from South Africa, South African executives are very skeptical of 4IR compared to their global counterparts, with social issues and preparedness being their main concerns given the country's high levels of unemployment and skills shortages. A study noted that 4IR would widen the inequality gap (Davies, 2022).Another study further supported by another study stating that South Africa is not ready for the implementing of 4IR due a skills shortage which are linked to a poor education system (PC4IR, 2020).Prior research found that after reviewing data from SETAs and Quarterly labor force survey there is lack of stakeholder knowledge and functioning skills development system in the South African industry in terms defining what skills are required to support 4IR implementation in the country, this shows that there is not enough research that has been done to understand what re-skilling and upskilling is required to allow all the stakeholders to operationalize plans to address those gaps (Gaula et al., 2022).Another study further supported this, concluding that 4IR is going to bring labour challenges if the government and the private sector does not collaborate to find ways to create new jobs, this will also lead to labour unrest in country that has high industrial action appetite, historical inequality and social challenges (Mpofu & Nicolaides, 2019).

Another study also found a lack of detailed knowledge regarding what skills programs and accreditations are sufficient to support 4IR technologies (Gaula et al., 2022). Another gap is the issue of developing a culture of lifelong learning, there is very little understating of how it can be implemented equitably without widen the already big inequality gap (Li, 2022). Previous research found that one of the contributors to the digital skills shortage is the lack of alignment with employer's perceptions, needs and expectations in terms of future skills that are required in industry. The study further suggested that there is a need for better collaboration amongst industry, government and universities to get the voice of the customers so that they can develop a curriculum that is fit for purpose (Gaula et al., 2022).

Although scholars agree that stakeholder engagement is necessary to understand what skills are needed to address the 4IR skills gaps, previous scholars have not conducted studies to understand the voice of the customers in terms of what skills are required by industry for the successful

implementation of 4IR. This study intends to close that gap by examining what skills in the South African warehousing sector requires to prepare for the eventual adoption of 4IR from the stakeholders' standpoint.

1.5 Research Questions

Below are the research questions on South African warehousing sector 4IR readiness from skills perspective?

RQ1	What is the impact of 4IR from role evolution perspective?
RQ2	What specific skills and knowledge are required to adopt and utilize 4IR technologies effectively?
RQ3	What 4IR training programs and initiatives are needed to accelerate the upskilling and re-skilling process?

1.6 Justification/Rationale of the Study

The strategic deployment of 4IR technologies has the potential to stimulate job creation, drive innovation, and position South Africa as a technological hub on the African continent. Understanding the Fourth Industrial Revolution (4IR) skills readiness in the South African warehousing sector is critical as the sector plays a pivotal role in the nation's economic landscape and global competitiveness. As South Africa strives to position itself as a leader in embracing technological advancements, the warehouse sector emerges as a critical linchpin in the supply chain, directly impacting the efficiency of various industries. According to a study by Stats SA, the warehousing sector is very strategic in South Africa, providing 1% of the total employment in the country (StatsSA, 2021).

The warehousing sector, with its intricate logistics network, is a prime candidate for technological integration, promising increased efficiency, reduced costs, and heightened competitiveness. Research has showed that implementing 4IR technologies in the warehouse sector is of paramount importance as it will help the sector service its customers through shorter

order lead-times , improved stock accuracy and improved agility to customer demands (Mannerfelt & Friman, 2022). Studies have already demonstrated the benefits of 4IR technologies such as automation in the warehousing sector, which has enabled same-day customer order processing, with major FMCGA and e-commerce giants such as Walmart and IKEA already using automated 4IR technology in their warehouses with great success, bringing lunch sums of revenue to their bottom-line (Somers,2019; Lind ,2019). However, the success of this integration is dependent on the workforce's readiness to learn new skills. Understanding the current condition of 4IR capabilities in the sector is crucial for aligning human capital with technical improvements and maintaining the warehousing industry's long-term success.

Several previous have highlighted the issue of skills shortages to support the implementation of 4IR in South Africa however they do not provide detailed plan on how this skills gaps can be closed or addressed (Gaula et al., 2022; Magwentshu et al., 2019; Mpofu & Nicolaides, 2019) . Another gap is that prior research has focused on how 4IR will impact unemployment in South Africa in terms of eliminating unskilled and semi-skilled jobs through the introduction of automation and artificial intelligence , however there is very little knowledge in terms of how to transform the unskilled and semi-skilled workforce to a highly skills workforce which can support the inevitable implementation of 4IR (Magwentshu et al., 2019). Conversely, neglecting the skills readiness aspect could lead to a workforce ill-prepared for the demands of the digital era, hindering economic growth and global competitiveness.

The study endeavors to serve as a catalyst for informed decision-making, offering stakeholders, policymakers, and industry leaders a nuanced understanding of the current state of 4IR skills readiness in the South African warehouse sector. This exploratory study aims to help key industry stakeholders to answer the question "what skills are required to support the successful implementations of 4IR using a key strategic warehousing sector which is very labour intensive with the mostly unskilled workforce". Additionally, the study aims to gain better insights into how South Africa can prepare its labour force from a skills perspective to take advantage of the benefits of 4IR technologies. Through this exploration, the study intends to create the groundwork for strategic interventions that will not only fortify the workforce against the challenges of 4IR but will also rocket South Africa to the forefront of the global digital economy through this exploration.

1.7 Delimitations of the Study

Limiting the scope of the research on Fourth Industrial Revolution (4IR) skills readiness in the South African warehousing sector is critical for maintaining focus and ensuring that the research is manageable and meaningful (Ross & Bibler Zaidi, 2019). This study will only focus on the warehousing part of the supply chain within South Africa mainly in the FMCG and 3rd Party Logistics providers, recognising that different industries may face distinct difficulties and possibilities in terms of 4IR skills preparedness. While findings may have broader applicability, the research aims to provide specific insights tailored to the warehouse sector's dynamics and intricacies.

The study is also limited to the implementation of 4IR technologies from a skills development and readiness perspective. This encompasses both technical competencies related to emerging technologies and the broader set of skills necessary for a workforce to adapt to technological change. While acknowledging the interconnected nature of various factors influencing 4IR adoption, this study will not delve extensively into other aspects such as infrastructure readiness, financial considerations, or organizational culture. Furthermore, the study will not be exhaustive in its examination of specific 4IR technologies. While acknowledging the breadth of technologies falling under the 4IR umbrella, the focus will be on general technological trends shaping the warehouse sector rather than an exhaustive examination of each emerging technology.

In addition, the investigation did not include a detailed examination of companies or warehouses. While noting the variability within the warehouse sector, the research seeks to present a comprehensive view rather than a thorough examination of particular case studies. This approach ensures that the study's conclusions are applicable to a broader range of warehouses in the South African context. Due to the fact that very little known about this topic this qualitative study will follow an interpretivist method to gain insight from key stakeholders thought the use of interviews to collect data from the key stakeholders in the South African warehousing Sector.

1.8 Operational Definitions

Fourth Industrial Revolution/4IR	4IR is an unstoppable global movement that will have a far-reaching positive impact on governments, businesses, and economies in a sustainable way (Schwab, 2015). The Industrial Revolution is going to drastically change warehousing sector through automated operations that will increase productivity and improve errors, this will have a significant impact on redundancy for low skills jobs (Mannerfelt & Friman, 2022).
Artificial Intelligence (AI)	AI is a subfield of computer science that involves the creation of computer programs to perform tasks that would otherwise require human intelligence (Mohammed, 2019). Artificial Intelligence technology with its capability for machine learning allows the machine to be smarter over time by learning from what has been done before. This will enable the warehousing sector to automate standard processes previously done by humans (Regeringskansliet, 2018a).
Internet of Things (IoT),	IoT is the technology that allows secure transfer of data through a network with require human or machine interaction, this technology has improved the accuracy of capturing and communication of data (Boyes et al., 2018). Internet of Things (IoT) technology will enable the introduction of autonomous driving warehouse machines that can perform tasks without requiring an operator, making that skill redundant (Datta, 2023).
Automation	Automation is the development and adoption of new technologies that allow capital to replace labour in a variety of jobs. Because of the displacement effect, automation modifies the task content of production in a negative way for labour, as capital takes over tasks previously performed by labour (Acemoglu & Restrepo, 2019). Automation is the drive to increase the levels of control through the use of electromechanical production systems which requires very little human intervention to produce output with superior reliability , performance and reduced cost compared to human output (Endsley, 2018).

Machine Learning (ML)	Machine learning is a subfield of computer science that tries to enable computers to "learn" without being explicitly programmed, it uses historical task as experience to predict how to conduct, predict and optimize future tasks (Bi et al., 2019). Machine learning is a technique used to train machines in how to handle data more efficiently. This includes learning from the date though identification of patterns and different algorithms to solve data problems (Mahesh, 2020).
Automated Guided Vehicles (AGVs)	Automated Guided Vehicles (AGVs) are a type of mobile robot that operates in industrial environments to perform various material handling and transportation tasks. In a warehouse environment they reduce motion by bringing the good to the picker instead of the picker going to the picking station (Boysen et al., 2019). Automated guided vehicles (AGVs) are mobile robots that are widely employed in industry to deliver goods from point A to point B. They contribute to higher productivity, lower operational costs, and improved safety by automating material handling operations that were previously undertaken by human-operated forklifts or other manual means (De Ryck et al., 2020).

1.9 Structure of the Dissertation

This research paper was organized as follows:

Chapter 1: Introduction to the South African warehousing sector and the Fourth Industrial Revolution (4IR) concept. define the problem and questions that the study aims to unpack, explain the significance of examining the readiness of the warehousing sector from a skills perspective in the context of 4IR.Unpack key definitions, and the research delimitations.

Chapter 2: Define key terminologies linked to the research topic, critical review the existing literature and research related to the South African warehousing sector, 4IR, and skills development, unpacking key research gaps and future research areas discuss relevant theories, frameworks, and concepts related to skills readiness and 4IR adoption in the warehousing sector.

Chapter 3: Describe research approach and rationale for choosing it. Detail the research design, including data collection methods (e.g., surveys, interviews, observations), sampling procedures, and data analysis techniques. Discuss any ethical considerations and limitations of research.

Chapter 4: Presents and analyzes research findings related to the skills readiness of the South African warehousing sector in the context of 4IR.In discussion it relates the findings to the existing literature, theories, and frameworks discussed in the literature review—interpretation and discussion of findings to understand the study's implication from a policy, management, and practice. Discuss the significance of skills development and suggest strategies for enhancing skills readiness in the sector.

Chapter 5: Summarizes the main findings and conclusions of the study. Emphasizes the implications and significance of the research in the context of the South African warehousing sector's readiness for 4IR from a skills perspective. Lastly it provides a discussion of limitations of research and recommendations of future research areas.

Chapter 2. Literature Review

2.1 Introduction

This chapter reviews literature through a systematic evaluation and analysis of current scholarly works and publications related to our research topic, South African warehousing Sector 4IR preparedness from a skills perspective. A thorough review of the existing literature is undertaken to identify gaps, inconsistencies, and controversies and to emphasize the theoretical and empirical foundations upon which future research might be constructed. From the insights gained from the literature review relevant conceptual frameworks linked to our research questions are investigated to assist with the research process, data collection, analysis, and interpretation.

2.2 Definition of topic or background discussion

2.2.1 Upskilling and Reskilling

The oxford dictionary defined “re-skilling” as the process of learning a new skill that allows a person to perform a different job or task, meanwhile “upskilling” is the process of learning a new skill or training employees on a new skill. Re-skilling and Upskilling of employees will be key in successfully implementing 4IR technology and digitalization will change how people work, impacting future job profile and scope (Sima et al., 2020). Employees who are upskilled learn new abilities to aid them with their current job responsibilities. Employees who re-skill have the knowledge and abilities to take on new or different roles (Li, 2022).

2.2.2 Fourth Industrial Revolution

Fourth Industrial revolution technologies like Artificial intelligence , Internet of Things , Robotics and Automation are drastically changing the way we work, so it important that we should have education and training systems that can assist us in responding to this rapid technological changes by ensuring that employees have the right skills to support the implementation of 4IR technologies (Makwela & Olalere, 2021) .

The Fourth Industrial Revolution (4IR) refers to the current and evolving environment in which disruptive technologies such as the Internet of Things (IoT), robotics, virtual reality (VR), and artificial intelligence (AI) are altering people's lives and working environments (Mannerfelt & Friman, 2022).

2.2.3 Digitalization in the workplace

Digitalization is the use of technology in the working environment that allows process flexibility, speed, and visibility, improving customer experience and satisfaction. These digital technologies often replace manual task in the workplace that humans previously did (Mannerfelt & Friman, 2022). Digitalization is the process of transforming business operations through the use of digital technologies and information (Bloomberg, 2018).

2.3. Research Question 1 (RQ1): What is the impact of 4IR from role evolution perspective?

2.3.1 Impact of 4IR on Job Roles

The Fourth Industrial Revolution (4IR) has brought about a paradigm shift in the South African warehousing sector, revolutionizing established procedures through the use of new technologies. Unlike earlier revolutions and technological advancements, which concentrated on a range of back-office operations such as data entry, document management, customer service, and accounting, AI attempts to understand and emulate human interaction with computer systems (Jaiswal et al., 2022).According to research the Fourth Industrial Revolution (4IR) is unlike the three previous industrial revolutions which required a high number of unskilled workers into factories, 4IR is a skilled biased technological change which promises to eliminate all routine, dangerous, repetitive, and physical tasks (Rodrik, 2018).

Several studies have also urged that there is a rising number of skills that will likely me replaced by 4IR technologies like robotic over the next decade (Kosslyn, 2019; Martinho-Truswell, 2019).Another study further added that 4IR technologies will result in the disappearance of certain positions requiring manual labour, hence employees need to learn new skills like

computer literacy and advanced technologies to be redeployed in the organization (Benešová & Tupa, 2017). Scholars also suggested that there is a rising number of skills that will likely me replaced by 4IR technologies like robotics over the next decade (Kosslyn, 2019; Martinho-Truswell, 2019).Common routine warehousing roles like picking and packing which are performed by blue collar workers are more likely to be replaced by machines (Mkansi & Landman, 2021).

A McKinsey study added that the demand for manual and basic cognitive skills will drop by 14 and 15 percent by 2030, respectively. Research also showed that employees who currently perform less-technology intensive tasks are at greater risk of being replaced by 4IR technologies like artificial intelligence and robotics (Santiago, 2020).Research has also found that cognitive skills which were deemed top ten skills 2015, for example like quality control and active listening will entirely disappear from the top ten in 2025 due to 4IR technologies like artificial intelligence and machine learning providing decision support information with high accuracy compared to humans (Li, 2022). Research found that there is risk that 4IR technologies might result in workers getting a lower income due to increase technological competition which will result in jobs being more streamlined (Alexander, 2021). This was further supported by a McKinsey study stating that technologies like artificial intelligence, robotics and digitalization will force blue collar workers low paying service industry in the ideal situation however the likely situation will be permanent unemployment (White, 2019).

Research also pointed out that the impact of 4IR implementation in country like South Africa could have a significant negative impact on the already high unemployment as more jobs will be replaced by technology with more than 2 billon jobs expected to disappear by 2023 globally, this will exacerbate the already growing inequality in South Africa (Adendorff et al., 2018).This was further supported by another study urging that 4IR will further widen the inequality gap as it will exclude low unskilled earners which are mostly gaps for unskilled who are from the previously disadvantaged groups like black south African and women (Shivdasani, 2019). According to the OECD study employers are already de-bundling small tasks through automation and Robotics to be done offshore using low-cost service providers who use software to perform this task at a cheaper and more efficient rate. They further added that Emerging cognitive technologies such as machine learning (ML) is increasingly being used to supplement human labour activity in the

business process value chain. Automation and cognitive technology adoption are resulting in increased human-machine collaboration, with machines undertaking an even higher amount of productive work activity globally (Rotatori et al., 2021).Demand for so-called midrange skills, such as manual, operational, and visual-spatial abilities, is decreasing. On the contrary, some argue that integrating AI in the workplace may result in the creation of new jobs, particularly in industries focused on creating and implementing AI technology (Puzzo et al., 2020).

However, studies conducted in South Africa, Mexico, and Europe have concluded that 4IR technologies such as Artificial Intelligence and Machine Learning will not lead to unemployment, but rather that many functions will be downgraded or even eliminated as employees with low skills struggle to find good jobs and low skill jobs are being automated. The key thing is to ensure that government and industry have structured programs to upskill and reskill its employees to take advantage of the benefits that come with 4IR technologies (Li, 2022) . This was further supported by a another study which found that effective implementation of 4IR in South Africa is dependent on how the government implement the national strategy which includes the necessary policies to mitigate the unemployment risk through education programs to reskill and upskill the workforce, this will create new high paying job opportunities which will reduce the inequality gap (Marwala, 2019).

Research also argues that technology may supplement human efforts, resulting in increased efficiency and output, as well as prospects for upskilling and job stability. However, in order to reap these benefits, management must handle legal, psychological, and ethical concerns. It is also critical to emphasize the relevance of positive externalities, such as higher living standards and sustainable development, achieved through the optimal balance of human and technological resources in the framework of 4IR. Investing in training and development programs that help workers gain the skills needed to effectively use new technologies, as well as establishing flexible work arrangements that allow workers to benefit from 4IR based efficiencies while simultaneously keeping job security and growing their careers (Al Mubarak, 2022).

According to Boston Consulting Group research, Industry 4.0 will create around 390,000 new jobs in Germany alone by 2025. 4IR work environment is a knowledge-intensive workplace in which manual labour is being phased out in favour of high-skilled labour (Anshari, 2020). Furthermore, as a result of IoT, previously manual jobs are evolving, with workers executing the

same duties but in an augmented or virtual reality environment. The advent of the platform economy will also result in an increase in freelancing jobs, such as driving such as driving cars for Uber or performing microwork, such as taking on a project, breaking it down into tiny components, and distributing each component to a number of people to complete via crowdsourcing websites (Anshari et al., 2022).

The best strategy for a country is to create a culture of continuous learning by staying ahead of the changes in the labour market through reskilling and continually transforming the skills of the workforce (Mngxati & De Haas, 2019). Research found that a scalable approach to reskilling and upskilling would allow all employees to contribute to economic development which will lead to the reduction in inequality and improve social stability. It is important to focus on the full workforce rather than having a few elites highly skilled employees which creates disparity in society (Moritz & Zahidi, 2021). Survey in the South African manufacturing sector has found that the sector is still very depend on low skill -low earning jobs, so there big need to reskill and upskill employees to perform meaningful higher skills jobs using technologies like virtual reality and augmented reality which will also boost employee engagement and will enable them to get better earnings (Maisiri & van Dyk, 2021).

Research suggests that 4IR technology will bring new working model which is a hybrid of full-time employment and part-time employment making professional work more as consultants only focusing on specialized tasks which may results to unusual work arrangements, fewer opportunities for training, and the absence of a social safety net are all factors (Anshari et al., 2022).This was further supported by another study stating that the world of work is moving towards the “Gig Economy”, characterised by short-term contracts and freelance labour, is expected to increase job flexibility in the future. Other researchers refer to this as the 'uberization' of global labour.In the future, individuals may choose to work for multiple companies rather than a single large firm (Rapanyane & Sethole, 2020).Another study found that there growing population of portfolio workers. Portfolio workers are freelancers who offer services to numerous employers. Digital technology enables worker mobility and independence. The independent sector is expanding globally, becoming more diverse and younger. Almost one-third of Americans work independently (Eni et al., 2023).

However, there are research gaps in understanding the impact of 4IR on jobs with conflicting findings from different studies. A study by Oxford university suggesting that 47% of US jobs can be automated, however another study by OECD found that that only 14% can be automated due to the high levels on unstructured task that still exist in the workplace (Corfe, 2018). Another study supported the OECD study suggesting that 375 million people which is 14% of the population will need to transition to new occupations and skills sets before 2030 (Leopold et al., 2018).Another study stated that between 47-59 % of the global jobs are a risk of being replaced by 4IR technologies, it further added that the traditional way of working will change to more freelancing and consultants which will further widen the inequality gap (Kurt, 2019).Another study suggests that 375 million people which is 14% of the population will need to transition to new occupations and skills sets.

A Mckinsey study found that one in four business managers did not fully understand the impact of 4IR technologies on their operations from a skills requirement perspective. They also stated that they lack the tools and knowledge to develop business cases to justify the need for upskilling and re-skilling their employees. One-third of the business managers also felt that their Human Resource departments are not equipped from an infrastructure perspective to address the emerging skills shortage (Ellingrud et al., 2020).Several studies that suggested that 4IR technologies will result in job losses with (Benešová & Tupa, 2017) stating that manual task current done by humans will disappear and replaced by automation. This was further supported by a (McKinsey, 2018) suggesting that the demand for manual skills will reduce by 14 to 15 percent by 2030.

However, there is conflicting suggestion in terms of what will the extent of the impact of 4IR in the job market with Oxford university study suggesting that 47% of US jobs will be impacted whilst the study by the OECD suggest only 14%, this shows that there is significant gap in terms research with regards to the extent of the impact of 4IR in terms of the job market. There is a need for further research on the to understand the exact impact of 4IR technologies especially in developing countries like South Africa with high social challenges like unemployment and equality, this will help stakeholders to develop accurate 4IR skills development and training plans. Another gap is the lack of management supporting tools on how they should develop a skills roadmap to reskill and upskill their employees to support 4IR technologies.

2.4 Research Question 2 (RQ2): What specific skills and knowledge required to adopt and utilize 4IR technologies effectively?

2.4.1 What skills and Knowledge are required to implement 4IR.

According to research the Fourth Industrial Revolution (4IR) is unlike the other previous industrial revolutions that were pro low and semi skills to support industrialization and mass production, 4IR is disruptive in nature because it challenges the workplace by demanding high skills like digital skills and knowledge, creative thinking, analytical thinking including numerical competences as opposed to the previous revolutions (Ajagunna et al., 2020).Another study further supported this adding that 4IR has added a new skills domain like technological, programming and digital skills to the traditional skills domain (Maisiri et al., 2019). Research has found that from 2025 and beyond analytical and innovation competences will be a key skill set, it also highlighted that critical thinking and problem-solving skills will also key in supporting 4IR technologies, employees will need to be agile and creative to take advantage of the benefits that come with 4IR technologies (Li, 2022).Research found that Transversal skills which are transferable skills like critical thinking , problem solving, collaboration and communication are key in working effectively with 4IR technologies because they enable workers to adapt quickly to new technologies and procedures, as well as learn and grow in a quickly changing technology landscape (Hart et al., 2021). The study further added that since transversal skill are not restricted to a single context, they are very important in a world of rapid technological and societal change as it enable deep learning which allows employees to apply the skills and adapt in different complex situations.

However another study argues that there is a urgent need of a more industry focused demand - driven skills curriculum that can be easily accessible to employees, adding that employers must invest in free internet access and online learning material for their employees (Maisiri & van Dyk, 2021). Research by Sofia et al (2023) also states that AI technologies are already capable of performing any intellectual work that a person can, including ones requiring general knowledge and problem-solving. AI could have a significant impact on human skills in an organisations, either by automating tasks that currently require human intelligence and problem-solving abilities, resulting in the need for workers to learn new skills or retrain for different roles, or by

augmenting human intelligence and problem-solving abilities, resulting in increased productivity and efficiency, as well as the ability for workers to focus on more complex tasks requiring higher-level thinking.

A McKinsey classified 4IR workplace skills into five categories: manual and physical skills, higher cognitive abilities, basic cognitive skills, social and emotional skills, and technical skills. According to McKinsey, AI and automation may eliminate low-skilled occupations and physical labour positions that rely on fundamental and cognitive skills. They went on to say that while some occupations may be lost, new jobs would develop as a result of the three other talents: higher cognitive abilities, social and emotional skills, and advanced technology skills (Bughin et al., 2018).A study by the World economic forum found that roles like software developers , data analyst and scientist are amongst career path that have more stability and present a big growth trajectory in the world dominated by 4IR technologies like AI , big data and Machine Learning (Leopold et al., 2018).

According to Uys &Webber-Youngman (2019) the adoption of new technologies often encounters resistance from employees and stakeholders who may be resistant to change. It is necessary that leaders navigate cultural barriers, address fears and concerns, and effectively communicate the benefits and rationale behind their technological initiatives (Uys & Webber-Youngman, 2019). Another Scholar further emphasized the importance of leaders transitioning from decision-making to sense-making. In the 4IR era, economic decision-making requires a holistic approach that considers contextual and situational factors. Facts alone will not suffice (Kelly & Kelly, 2019). According to Kelly, leaders must transform their attitude from charismatic authority to swarm intelligence. Effective leadership involves collaborative networks that employ collective wisdom to make decisions, rather than relying just on the influence of a single leader. Fourth industrial leaders should move from an analogue to digital mindset. Learning new technological skills is crucial for digital transformation, but it is not sufficient. However, developing a digital mindset will help leaders to be agile in dealing with the ever-changing world of 4IR technologies. This was further supported by another study stating that leadership with a digital mindset enhances organisational success and worker resilience. Digital mindset leaders are proactive and poised to capitalize on new business opportunities (Naidoo & Potokri, 2021).

Identifying and comprehending this skills gap is a critical first step in designing effective strategies for worker upskilling and reskilling. Identifying the skills gap allows organizations to build upskilling and reskilling initiatives for their staff, ensuring effective 4IR utilization. Proper 4IR management is crucial for ensuring that all workers benefit from its benefits. Otherwise, employees may have performance limits due to troubleshooting the 4IR. This, in turn, may create a non-favourable atmosphere for employees to acquire skills that are relevant to their professions, causing delays in the process (Kar et al., 2020).

There is clear consensus in terms on the overview skills that will be required for the successful implementation of 4IR with studies stating that skills like problem solving , analytical thinking and digital skills will be key in transforming the workforce to the digital working environment (Ajagunna et al., 2020; Li, 2022; Maisiri et al., 2019). However there needs to be more research to understand the detailed skills programs and support systems are needed to help key stakeholders operationalize their 4IR skills programs.

2.4.2 What are challenges in terms of upskilling and re-skilling required to implement 4IR.

According to the World Economic Forum (WEF) in the new employment market, the window of opportunity for reskilling and upskilling workers has closed. Over the next five years, the abilities required in all occupations will shift, resulting in a substantial skills gap. This is true not only for individuals joining the labour force, but also for those who will remain in the workforce. The share of important skills is expected to change by 40% over the next five years, with 50% of all workers requiring retraining and additional education (Papakonstantinou, 2019). Research found that the high capital cost of acquiring sophisticated technology is a major barrier for developing countries to participate and reap the technical, operational, and administrative benefits of 4IR. They further added that poor ICT infrastructure in underdeveloped nations is one of the primary problems that the warehousing sector will face in embracing and benefiting from 4IR technologies. Broadband penetration, for example, remains low in underdeveloped nations when compared to wealthy countries; this feature, for example, impedes the transformation of digital connectivity (El Nahrawy, 2020).

Research found that countries like South Africa with poor education system are not keen in investing in upskilling and reskilling of its workforce, they study further added that to take advantage of 4IR technologies national skills plans are critical. However, little attention is devoted to the underlying social relations of production in which skills development practices occur, which is critical for understanding the outcomes of skills policies and practices (Hammer & Karmakar, 2021; Petersen et al., 2023).According to another study investing in upskilling and reskilling may be difficult in developing countries as access to education and skill development is challenging and does not transfer into job prospects. In this context, with the exception of a few highly skilled workers in the automotive and IT sectors, the inability of most workers to access skills development initiatives and the lack of recognition of informally acquired skills are likely to be persistent barriers to the up/reskilling required for the adoption of high-tech solutions. Organizations must devise methods to reverse the trends (Sofia et al., 2023).Research found that there is a lack of confidence in local, state, and federal government agencies' ability to use public resources to prepare workers for the new technological economy. The expanding skills gap has created a demand for on-the-job learning in organizations (Schwartz et al., 2019).

According to literature if 4IR technologies like AI is not correctly managed, it can limit employee performance because they must troubleshoot the AI technology when it fails. This, in turn, might create a non-favourable environment for the employees to acquire skills that are relevant to their jobs, causing delays in this process (Bérubé et al., 2021; Nylin et al., 2022).Research has found that although South Africa is a member of BRICS, it has a poor record of implementing complex policies compared to other BRICS nations like India and China. This has resulted in South Africa falling behind in advanced technological skills (Bang & Marsh, 2018) .This was further supported by another study stating that South African education system is not producing enough graduates in science, technology ,engineering and mathematics (STEM), which is key in supporting 4IR technologies (Schofield & Dwolatzky, 2018) .Another study added a need for a diverse education system that promotes innovation by incorporating STEM in the curriculum (Li, 2020).

However, research found that although Africa has a huge gap in STEM skills development these skills are costly compared to social studies, this is due to lack of infrastructure investment in the grass route levels of education especially in developing countries like South Africa (Technopolis,

2019). Research has also shown that majority of employers upskilling and re-skilling initiatives are still focused of a few high skilled and high value employees which a big challenge in terms of transforming the entire workforce to the digital future of work (Morgan, 2019) .Another study found that one of the biggest challenge is the employees' unwillingness to invest in their skills development from a time and financial perspective. The study found this was very prevalent in the older age group who were found to be very change resistant because they are very comfortable with their current work environment and have fear that they will not be able to cope with change (Ellingrud et al., 2020) .However another scholar urged that the cost of hiring a new employee is 6 to 9 months' worth of salary compared to upskilling and re-skilling current employees as recruiting requires advertising, interviewing and training which all comes at an opportunity cost (Eshna, 2019).

In conclusion there seem to be no clear consensus from different scholars in terms of what curriculum is suited for South Africa to close its 4IR skills gaps with studies suggesting that science, technology ,engineering and mathematics (STEM) curriculum the best option to support upskilling and re-skilling for 4IR (Li, 2020; Schofield & Dwolatzky, 2018).However studies suggest that science, technology ,engineering and mathematics (STEM) is costly to implement especially in developing countries with lack of infrastructure. Although scholars agree on skills gaps, there is a need for further stakeholder research to get the voice of the customer to understand what the best cost-effective way is to close the 4IR skills gaps in developing countries with limited resources (Technopolis, 2019; Morgan, 2019).

2.5 Research Question 3 (RQ3): What 4IR training programs and initiatives are needed to accelerate the upskilling and re-skilling process.

2.5.1 Upskilling and Re-skilling Initiative review from Developed Countries perspective

A study found that The Organization for Economic Co-operation and Development (OECD) Skills strategy which is comprised of countries like France, Germany and the UK had a skills strategy which looks at what are the weakness and strength in terms of skills each country using international benchmarking in order to develop skills investment plans to close those skills gaps (Co-operation & Development, 2019). Australia uses a similar skills strategy called ONET (The Occupational Information Network) which regularly surveys with global cross industry stakeholders like the USA to understand the future changes in the job taxonomies in order to close future skills gaps (Gaula et al., 2022).Research also found that higher learning in Japan have used 4IR technology to overcome the restrictions brought by COVID 19 by introducing tools like massive open online courses(MOOCs), open educational resources(OERs) and learning management systems which helps with accessibility of 4IR education, this has changed how education is consumed by bringing education to the people (Kant et al., 2021) .Japan embedded job rotation for their workers to drive cross skilling and multiskilling which has also helped with 4IR skills sharing (Olejniczak et al., 2020).

Research has found that developed countries like UK and Norway have made substantial investment both from a financially and policy perspective to fund research and development in universities to train and upskill its future workforce this was done in collaboration with the employers ,technology experts and the trade unions (Lloyd & Payne, 2019). Another study added that Germany is the leader in re-skilling and upskilling of its future workforce with forward thinking curriculum that incorporates vocational work linked to industry needs with high success rate as majority of graduates have the skills to be absorbed in the job market immediately compared to countries whose curriculum is mainly focused on the academic path only (Woetzel, Seong, et al., 2021). Research found that in order to address the skills challenges that come with 4IR technologies the European Commission launched an upkilling program called Up-Skill project. The project will identify the skills that existing workers will require to survive in the developing digitalised workplace and will provide training courses, an Up-Skill Platform, and

manuals for hardware and software upskilling. These examples highlight the need for a deeper understanding of how firms, particularly those in industrial settings, can derive value from human and machine integration (Sofia et al., 2023).

However a study in China found that the workforce is struggling to keep up with the advancements in technology due to the majority on employers in China lacking a comprehensive training plan due to their perception towards upskilling and re-skilling that is an expense rather than an investment on their work force (Wu & Ye, 2018)

2.5.2 Upskilling and Re-skilling Initiative review from Developing Countries perspective.

Research found that emerging economies have almost exclusively been takers of advanced technologies and of related policies, often with limited adaptation to national requirements. The availability of capabilities in the form of human capital, infrastructure, and intellectual capital is critical for the adoption of 4IR technologies. Countries such as South Africa and Rwanda have been early adopters of and integrators of 4IR technologies within their businesses. This is because their governments recognise the potential benefits of new technology as well as the need to compete with Western economies (Sutherland, 2020).However another study has found that South Affrica has put very little effort in ensuring that the education system is ready to meet the needs of a 4IR working environment from a capabilities and curriculum perspective, this is a major concern as 4IR has far-reaching ramifications for educational investments and the skills required to enable flexibility and rapid adaptation to technology-driven shifts to alternate career or exit pathways (Mkansi & Landman, 2021).

A survey indicated that African business leaders struggle to understand emerging technology and often lack a strategic framework to guide their efforts. Businesses lack clear decision-making procedures and organisational silos, hindering their ability to establish and implement creative initiatives (Mpofu & Nemashakwe, 2023). Fourth industrial technologies, including AI, robots, and automation, are complicated and require a thorough understanding to execute successfully. Leaders may lack technical competence to make educated decisions in today's fast-changing market. A study by (Maisiri et al., 2019) found that there needs to be a shift in workplace skills and competences to move away from theories to more target industry-specific programs that

prepare employees for 4IR .Another study further added that South Africa lacks a predictive skills model that can forecast what skills will be needed in the future due to the limited data from the SETAs, Quarterly labour force and Stats SA (Gaula et al., 2022) .Compared to the Global counterparts South Africa skills development system lacks basic traits like skills supply and demand forecasting, stakeholder collaboration and agility to respond to the changing world. According to research as of 2010 South Africa lacks institutional system to estimate future skill demand in the country. Although SETAs maintain multiple databases and research efforts, but there is no standardized approach for determining skill supply and demand across all sectors of the economy (Gaula et al., 2022).

However, another study found that there have been efforts to close the digital skills gap with South Africa Ministry of communication partnering with a digital learning provider Coursera to provide free courses in data science, coding, and artificial intelligence. Another study found that the South Africa government need to develop a futuristic curriculum to address the digital skills gaps driven by 4IR by looking at removing the digital language and illiteracy barriers through re-skilling the majority of its citizens and also increasing the number of IT professional to support the effective implementation of 4IR technologies (Olaitan et al., 2021)

In conclusion Research from developed countries shows the importance of a structured skills development strategy for example OECD Skills strategy and Australis's ONET program. Research also shows that investment in skills development from a policy and financial perspective is key. However studies concluded that there are still huge gaps when it comes to developing countries like South Africa with no clear understanding what skills are required due to poor forecasting and collaboration amongst industry, government and educational institutions (Gaula et al., 2022; Maisiri et al., 2019).The Lack of standardized skills development plans or strategies in developing countries is another gap that will require further research. There is a need for more research in developing countries to understand from key stakeholders what skills development programs/ strategy and policies will be more effective in a context of a developing countries considering that lack of infrastructure and financial muscle.

2.6 Theoretical review of models

The integration of 4IR technologies in the warehouse sector is a complex process that requires a multifaceted theoretical foundation. Here, we explore several relevant models that contribute to understanding and assessing skills readiness in the context of the Fourth Industrial Revolution. The demand for speedy access for goods is fast tracking the need for the warehousing sector to invest in technologies that will make the sector more efficient to respond to the market needs , technologies like automation , internet of things , robotics and Artificial is changing the future work in terms of the skills required in the workplace (Woetzel, Leung, et al., 2021). In this section we will unpack the theoretical underpinnings for this exploratory study by reviewing a few relevant conceptual frameworks.

2.6.1 The Agile Learning Framework:

This learning model focuses on creating a working environment that encourages a culture of agility, flexibility, and continuous learning. This is done through proving employee's opportunities to improve their skills though experimenting, continuous improvement and skills sharing (Kergel et al., 2022). A study found a growing demand for technologically competent employees, making it critical for organizations to create a continuous learning culture and invest more in employee's skills development (Gajdzik et al., 2021) . A study found that The Agile Learning Framework promotes learner collaboration and interdisciplinary learning. This collaborative approach reflects real-world work contexts in which people with varied skill sets collaborate to solve complicated challenges. It encourages collaboration, communication skills, and a broader grasp of a variety of subjects (Javadi & Tanner, 2018).

However, another scholar has argued that because Agile learning is based on inquiry-based learning, which is based on the learning demands of the learner, it can be disadvantageous because it necessitates a lot of constant follow-up due to learners learning at different rates, making assessing for competency difficult (Longmuß et al., 2016). The study further added that decentralized and iterative nature of the Agile Learning Framework may lead to variances in the quality and consistency of educational experiences. It might be difficult to ensure a consistent level of learning outcomes across varied courses and individualised techniques.

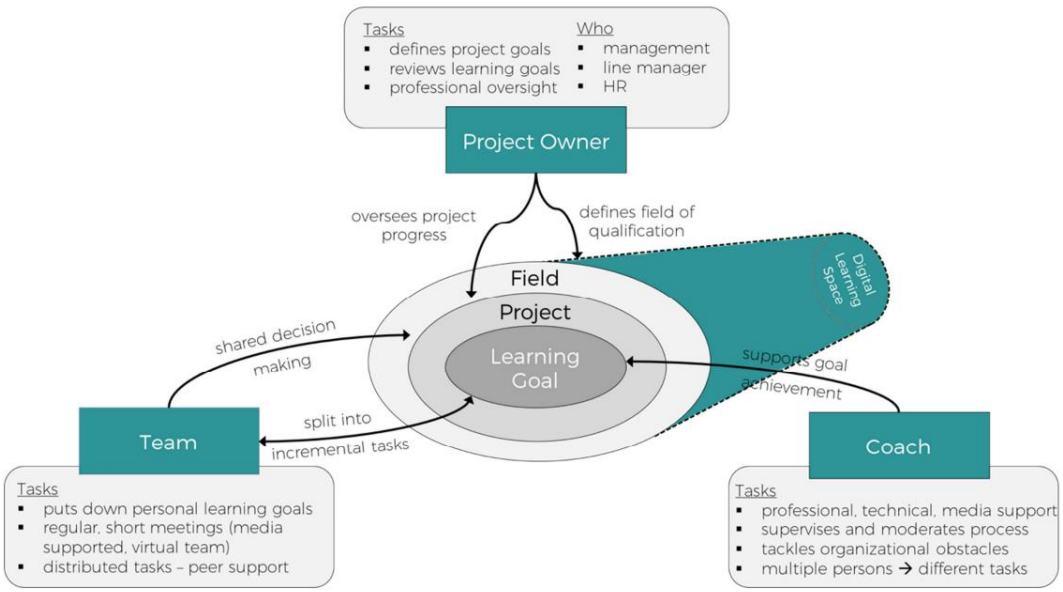

Figure 2: Agile learning and its core roles in the context of a company based embedded learning environment: (Longmuß et al., 2016)

By deploying the Agile Learning Framework in the South African warehouse sector, organizations may develop a culture of continuous learning, adaptation, and collaboration, allowing employees to gain the skills required for 4IR preparedness. This approach encourages individuals to take ownership of their skill development while facilitating the discovery and filling of skill gaps within the sector. However, there is very little research on the effectiveness of the Agile Learning Framework with scholars citing issues of inconsistency due to its decentralized way of learning which makes it difficult to access competency in learners.

2.6.2 Human Capital theory:

This theory suggests that there is mutual benefit for employers and employees from investing in skills development. Research shows that when organizations that invest in upskilling and re-skilling their employees have better employee experience ratings which boosts their morale resulting in loyal employees who are more productive because they feel valued. Study shows that over 70 percent of employees that had received training from their employers resulted better professional growth in their respective fields (Sasmita & Kumar, 2018).

A study found that education and training help to build a skilled and knowledgeable workforce that has the capability to drive innovation and technological progress. It further argued that Employers can use Human Capital Theory to strategically invest in the development of their workforce. By providing training and educational opportunities, employers aim to enhance the skills and capabilities of their employees, leading to improved organizational performance (Wuttaphan, 2017).

However, another study highlighted that Human Capital Theory frequently treats skills as homogeneous, failing to recognize the richness and multidimensionality of human abilities and talents. This may undervalue non-quantifiable or measurable talents such as creativity, emotional intelligence, and critical thinking (Marginson, 2019). This was supported by another study stating that human is very narrow its focus and does not fully account for societal factors, such as systemic discrimination, social structures, and economic barriers, which can significantly impact individuals' access to opportunities for human capital development (Wuttaphan, 2017).

By deploying the Human Capital theory, the South African warehouse sector may strategically invest in its staff, improve skill development, attract, and retain talent, facilitate information sharing, and promote adaptation. These measures will help the sector's readiness for the 4IR, ensuring it can effectively harness the promise of emerging technologies while remaining competitive in the global landscape. However, scholars have criticized the Human Capital Theory for being narrow focused ignoring historical inequalities and non-quantifiable attributes like talent, this is disadvantage especially in South Africa that has the history of marginalization against certain groups in society (Marginson, 2019; Wuttaphan, 2017).

2.6.3 The Digital Competence Framework for Citizens (DigComp):

The Digital Competence Framework for Citizens is a conceptual model designed to define and assess the digital skills and capabilities that individuals need to function effectively in a digital society.This theory identifies key competencies and skills required for people to come with the digital working environment (Guitert et al., 2021). The framework focuses on data literacy, collaboration amongst stakeholders, and problem solving. It emphasizes accessing current digital competency levels and designing training programs to address the competency gaps

(VUORIKARI Rina et al., 2022). According to Vuorikari et al (2022), the Digital Competency Framework (DigComp) since its development in 2013 has assisted organizations and governments worldwide to effectively develop their digital skills by providing policy and curricula guidelines.

The Digital Competence Framework provides a step-by-step process which empowers managers with the right skills to identify digital skills in their organization and develop plans to address those gaps (Vuorikari et al., 2022). The DigComp framework focuses of five key competences below:

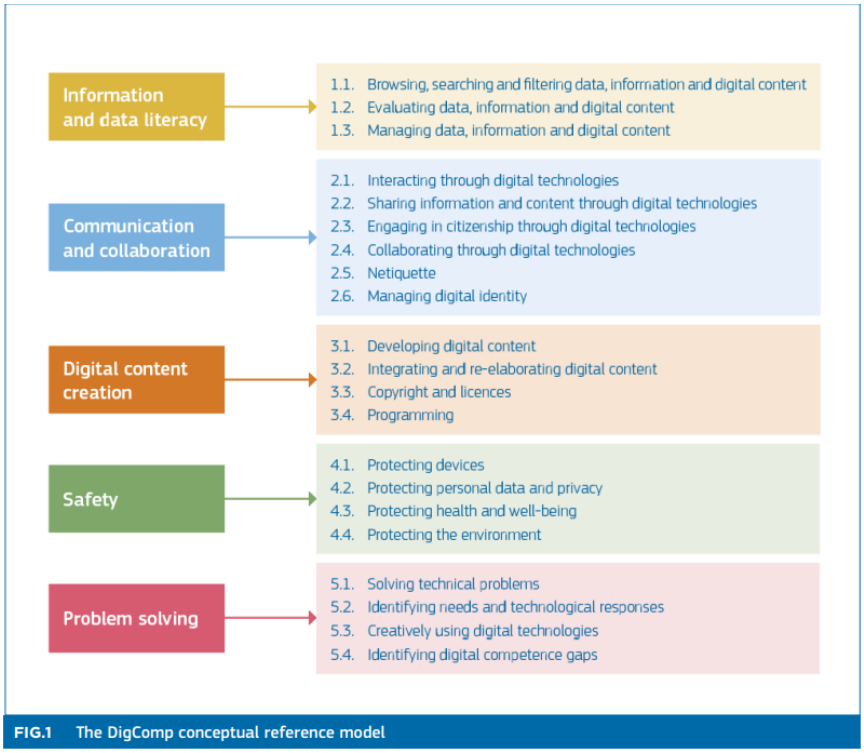

Figure 2: The DigCom conceptual reference model: (Vuorikari et al., 2022)

A study that the DigCom framework has been successfully used in many countries in teaching fields to develop strategies to help teachers improve their skills to empower 21st century leaners (Caena & Redecker, 2019) . The DigCom framework has been used to support teachers to drive continuous skills development and create a collaborative environment where best practice is shared to improve the quality of teaching (Caena & Redecker, 2019). This was further supported by a Finnish study which is a knowledge-based society stated that the DigCom framework enables the creation of an environment of continuous learning which drives collaboration and

skills sharing which is key in helping others improve the digital/technological skills.(Khan, 2019).

According to a study by Redecker (2017) ,the DigCom framework is not only limited purposes like information management personal development but is a tool that provides a creative way of learning and collaboration in an environment that is safe and ethical which allows individual to improve their digital skills for employability and personal gratification (Redecker, 2017) . According Law et al (2018), the DigCom framework has been previously successfully used in regions like Asia, Latin America, Middle East and North Africa including Sub-Saharan Africa in the sectors such as Finance, Agriculture, Transport, Energy and empowerment to understand better the societal digital competences (Law et al., 2018). A UNESCO study concluded that the DigCom framework is a valuable and suitable tool to be used as a base to develop a global literacy framework (Laanpere, 2019).

However, some critics state that Digital Competence Frameworks are frequently designed at the national or regional level, which may fail to account for contextual differences in digital demands and competencies among regions and demographics. They may fail to consider cultural, linguistic, or social aspects that can influence people's digital competencies and access to technology (Janssen et al., 2013). Another study argued that DigComp has only been tested I developed countries and developing countries with limited access to technology or who face socio-economic barriers may find it challenging to meet the proficiency levels outlined in the framework, exacerbating existing inequalities. It further states that DigComp is heavily reliant on formal educational systems to implement and teach digital competence. This dependency might exclude individuals who do not have access to formal education or those who rely on alternative learning pathways (Mattar et al., 2022).

By leveraging the Digital Competence Framework for Citizens (DigComp), the South African warehousing sector can effectively assess, develop, and enhance the digital competencies necessary for 4IR readiness. It provides a structured approach to identifying skill gaps, tailoring training programs, fostering self-assessment, and promoting lifelong learning, supporting the sector's transition to a technology-driven future. However, this framework has only been tested in developed countries and might not suited for developing countries which lack resources like infrastructure and strong educational curriculum.

2.7 Key Constructs coming out of the Frameworks.

Although this exploratory study aims to develop new theories and frameworks in the unknown areas of how the South African warehousing Sector can prepare for 4IR from a skills perspective.

Skill Development Initiatives: This construct explores various programs, initiatives, and strategies implemented in the sector to develop and enhance the skills required for 4IR readiness. It involves exploring the types of training, education, upskilling, and re-skilling initiatives available and their effectiveness and alignment with the sector's needs.

Perceptions of 4IR Readiness: This construct focuses on understanding how individuals in the warehousing sector perceive and interpret the concept of 4IR readiness. It involves exploring their beliefs, attitudes, and understanding of the implications of 4IR technologies on the sector's skills requirements and overall readiness.

Barriers and Challenges: This construct explores the barriers, challenges, and constraints individuals and organizations face in developing the skills necessary for 4IR readiness. It may include limited access to training opportunities, resistance to change, lack of resources, and other contextual challenges specific to the South African warehousing sector.

Opportunities and Enablers: This construct focuses on identifying the opportunities and enablers that facilitate the development of skills for 4IR readiness in the sector. It involves exploring factors such as collaborations with educational institutions, government support, access to funding and resources, and industry-wide initiatives that promote skill development and readiness.

Exploration of these key constructs will provide an understanding of the current state of 4IR readiness in the South African warehousing sector from a skills standpoint and shed light on the factors that facilitate or hinder the development of skills required for successful 4IR adoption and implementation.

2.8 Conclusion

In conclusion, from a skills perspective, this literature review highlights the current state of knowledge regarding the South African warehousing sector's readiness for the Fourth Industrial Revolution (4IR). The findings reveal several key insights and considerations for policymakers, industry stakeholders, and researchers. There are evident research gaps on the degree of the impact of 4IR deployment on job evolution. Although several scholars agree on what skills will be necessary to support 4IR, they disagree on the best and most cost-effective curriculum and training programs to expedite worker re-skilling and upskilling. According to studies, developed countries have benefited from investing in skills development systems/strategies to address the skills demands of an evolving digital working environment. In contrast, studies in developing countries show a lack of a clear skills development system and poor collaboration among key stakeholders such as government, industry, and education institutions. Frameworks like Agile Learning Framework, Human Capital Theory and Digital Competence Framework can assist South African warehousing sector address the 4ir skills preparedness question.

Chapter 3. Research Methodology

Introduction

This chapter focused on the research methodology for a research project that seeks to investigate South Africa's warehousing Sector 4IR readiness from a digital skills standpoint. This chapter discussed the research approach and design used during the study and the target population and sample selection. Then it covered the approach used in constructing the study instrument, data collecting, analysis, and interpretation of the findings. Finally, this report discussed the study's limitations, timelines, obstacles, ethical considerations, and quality assurance aspects.

3.1 Research approach

Qualitative research is a naturalistic inquiry technique that seeks an in-depth understanding of social phenomena in their natural setting. It focuses on the “why” rather than the “what” of social phenomena and is based on direct experiences of humans as meaning-making agents in their daily lives. Quantitative approach investigates psychological, social, and economic processes using numerical patterns and data by allowing researchers to perform simple to more advanced statistical analysis on the data (Ahmad et al., 2019).

This study adopted the qualitative research approach. This approach was chosen because it is exploratory, enabling the researcher to establish new theories and frameworks, discover emerging and gather preliminary findings that can be used to influence future studies and policy formulation (Bailey et al., 2010). The qualitative research approach gives the researcher the freedom to explore an ever-changing new phenomenon like 4IR by adapting new questions based on developing insights and new information from stakeholders, this is key in this study as the research aims do find out key unknowns with regards to 4IR skills readiness in the South African warehousing sector from key industry stakeholders perspective. The qualitative research approach usually adopts text or spoken words ,this allows the study to gain key first hand insights in terms of what are the constraints and concerns from a skills readiness perspective of key sector stakeholders which needs to be address for the successful implementation of 4IR in the sector (Basias & Pollalis, 2018).

3.2 Research Paradigm

This study adopted the Interpretivism research paradigm. Interpretivism uses relativist ontology which is based on the philosophy that a single phenomenon has multiple interpretations instead of a truth can be determined through a process of measurement (Pham, 2018). This paradigm was selected due to its subjectivity as it states that reality is subjective depending on the stakeholders interpretation of the phenomenon (Alharahsheh & Pius, 2020).These Interpretivism paradigm allows all key stakeholders in the South African Warehousing industry to provide their perspectives, meaning, and interpretation which are informed by their contextual understanding which incorporates South African's historical social challenges as to what skills they believe are essential for the effective implementation of 4IR in the sector. The use of opened ended questions allows participants to answer questions in an unrestricted manner, this enables researcher to reflect on the feedback to avoid researchers bias and gain deeper insight on this topic of 4IR skills readiness which is unknown (Ryan, 2018).

This paradigm is inductive in its approach to data analysis, allowing themes to emerge from the data rather than from existing frameworks (Azungah, 2018).Inductive approach allows the researcher to answer questions using concepts, themes and categories through the use of abstraction to reduce and group data into sub themes and subcategories (Kyngäs, 2020).This Inductive approach is important in this study because it allows the researcher to develop new themes and theories based on their own data coding, interpretation, and categorization to advance new knowledge and insight on how 4IR skills readiness can be approached in the warehousing sing sector.

3.3 Research design

The Grounded Theory method was employed in this qualitative study. Grounded theory aims to develop theory founded in evidence and influenced by the perspectives of participants, moving beyond description and towards theoretical explanation of a process or event (Turner & Astin, 2021). Grounded theory sets out to discover or construct theory from data, systematically obtained and analysed using comparative analysis (Chun Tie et al., 2019).

This qualitative study uses a grounded theory method to create a nuanced and contextually rich knowledge of the 4IR skills preparedness environment within the South African warehousing sector, providing useful insights for both academia and industry stakeholders.

Advantages of using Grounded Theory

Theory and Framework Development : Grounded Theory focuses on constant comparative analysis to generate a new framework or theory through constant revisiting of the data analysis process which involves categorization and coding of data to develop themes and patterns to ensure that the grounded data reflects the insights and perspectives of the participants, this aids the research in developing frameworks that address the 4IR Skills readiness questions in the South African Warehousing industry (Charmaz & Thornberg, 2021).

Applicability to Exploratory Research: Grounded Theory is well-suited for exploratory research where the goal is to generate new theories and insights. It is particularly effective when there is a dearth of literature the impact of 4IR in the warehousing sector from a skills perspective , as it allows researchers to explore and understand the subject in depth (Makri & Neely, 2021).

Theoretical Saturation: Grounded Theory deploys the process of continuous purposeful selection of participants and collection of data through interviews until no new insights are gained which is called the saturation point, this helps the researcher gain diverse and rich insights in the topic 4IR readiness from a skills perspective in the South African Warehousing Sector which will improve reliability of the study (Aldiabat & Le Navenec, 2018).

Disadvantages of using Grounded Theory

Subjectivity and Researcher Bias: Some scholars have argued that Grounded Theory lacks objectivity, reliability, and replicability which key for this study, this can be mitigated by constant comparative analysis which removes researcher bias which is a challenging exercise because it is very time consuming (Nelson, 2020).

3.4 Data collection methods

3.4.1 Population and Sample

Population

The population refers to the wider group or phenomenon the study seeks to investigate (Majid, 2018). However, in qualitative research, the definition of population is frequently more fluid and context dependent. The population in qualitative research is frequently defined by the research question and objectives, focusing on persons with the essential knowledge, experiences, or views relevant to the study (Ahmad et al., 2019). The population may be purposely chosen to represent a specific segment, community, or professional specialty (Casteel & Bridier, 2021) .Given that a qualitative study focuses on understanding the South African Warehousing sector readiness to 4IR from a skills perspective, the target population will be strategic warehousing professionals in the sector, including Senior Managers and Supervisors/Middle Managers.

Sample Method and Frame

The process of selecting a subset of individuals or cases from a wider group for research is referred to as sampling (Schreier, 2018). Probability sampling is a sampling approach where each member of the target population has an equal chance of being chosen as a study participant (Stratton, 2021).Probability sampling approaches are widely employed in quantitative research and experimental designs, and they serve as a foundation for drawing statistical conclusions about the wider population. Whereas non-probability purposive sampling is a non-probability sampling technique in which researchers consciously select people or elements for inclusion in a study based on specific qualities or criteria related to the research question or purpose. Purposive sampling, as opposed to random sampling, is a deliberate and selective strategy to ensure that the chosen participants are most likely to provide rich and relevant information for the research (Andrade, 2021).This study adopted purposive sampling approach by selecting participants based on key roles, expertise and experience in the South African Warehousing sector working for key strategic players who have a nationwide footprint .

A sampling frame is a list or source from which a researcher draws a sample for a research project, it is a comprehensive list of all the elements or units in the population from which the sample will be drawn (Lohr, 2021). The sample frame is used to choose a representative subset of the population for the research investigation, size of the warehouse and relevant job roles was used to select the sample frame (Kirchherr & Charles, 2018). Since the study aims to understand the South African Warehousing sector readiness to 4IR from a skills perspective size was also important, only warehousing service providers with more than 50 employees were chosen to take part in the study because they are the most likely to implement 4IR due to economies of scale which allows them to justify the technology.

Interviews provide detailed information about participants' experiences and perspectives on a specific topic (Turner III & Hagstrom-Schmidt, 2022). Previous research has concluded that most qualitative studies reached saturation within a range of 9-17 interviews (Hennink & Kaiser, 2022). Another study indicated that around 80% to 92% of all concepts identified in the dataset were recognised within the first 10 interviews and that little new information was gained when the sample size neared 20 interviews (Guest et al., 2020) .Previous exploratory qualitative study has recommended a sample size between 12 and 15 interviews to avoid information saturation (Armanious & Padgett, 2021). A total of 12 interviews (45 minutes to an hour) comprised of online and in-person interviews were conducted to gain insights into the research problem.

Table 1: Profile of respondents

Description of respondent type	**Number to be sampled**
Senior Managers	6
Supervisors/Middle Managers	6

3.4.2 Sample Design

For this qualitative research the purposive Sampling Method was used. Purposive Sampling identifies a participant based on the specific attributes, expertise and experience that can contribute to unpacking a specific research question (Shaheen & Pradhan, 2019).

According to a previous study purposive sampling has many benefits, allows researchers to target individuals with expertise, knowledge, or experiences directly related to the study's focus(Andrade, 2021). It also uses targeted selection to ensure that the sample consists of participants who can provide valuable insights and in-depth information. Additionally, purposive sampling enables the inclusion of diverse perspectives and ensures representation of specific groups while ensuring that data collection is optimized (Andrade, 2021). The purpose of this research was to gain insights of South African warehousing sector readiness to 4IR from a skills perspective, the target population will be warehousing professionals in the sector which includes Senior Managers and Supervisors/ Middle Managers.

Descriptions of the targeted respondents:

Senior Managers	These are highly experienced individuals are responsible for the overall running of warehouse operations including developing strategies for continuous improvement e.g. 4IR technologies
Supervisors/ Middle Managers	These individuals are responsible for the day to day running of the warehouse operations including training of employees, succession planning, skills matrix, and implementation of continuous improvement initiatives e.g. 4IR technologies

The purposive method was appropriate for this research because it selects participants based specific attributes, expertise, and experience in the South African warehousing sector to provide informed and rich insights on the sectors readiness to 4IR from a skills perspective.

3.4.3 The research instrument and Data collection procedures

Interviews were employed as a research instrument and a data collection tool for the purpose of the research. Interviews were suitable for this study as it enables the researcher to discover more about the participant's viewpoints, experiences, beliefs, and motivations (Gill & Baillie, 2018).Interviews allow the researcher to gain in-depth insights on the research question of South African warehousing sector readiness to 4IR from a skills perspective by allowing the researcher to use open-ended questions and follow up probes to gain rich and detailed insights. Interviews enable contextual understanding which will help the researcher gain industry specific knowledge for sector experts in terms of the challenges and opportunities that can help fast track the skills readiness for 4IR in the sector. However, interviews as data collection instruments have their limitations: bias, sample size limitations and resource/time constraints, so interviews must be carefully planned to achieve optimal and valuable insights (McGrath et al., 2019). Attached Appendix 1 is the interview guide for 4IR Skills Readiness in the South African Warehouse Sector.

3.5 Data analysis strategies and interpretation

This research adopted thematic analysis. Thematic analysis identifies reoccurring patterns that researchers convey as overarching statements or themes (Lochmiller, 2021).Through a structured thematic analysis process, the researcher can identify and analyze recurring themes and patterns within data, allowing the researcher to categorize and develop specific codes for common themes related to skills gaps, skill requirements, training needs, and challenges in adapting to 4IR new technologies in the South African Warehousing sector. The findings of this study will contribute to a deeper understanding of the skill requirements and inform the development of strategies to enhance 4IR readiness, thereby facilitating the sector's successful integration into the Fourth Industrial Revolution.

3.6 Contributions of the study

3.6.1 Theoretical Contributions

The qualitative study on “4IR Skills readiness in the South African warehousing sector” is theoretically situated within the intersection of technology skills development and supply chain management. This research addresses the critical nexus between emerging Fourth Industrial Revolution (4IR) technologies and the skill development necessary for their effective integration within the specific context of the South African warehousing sector. The study draws on theoretical frameworks from technology skills development to explore how the workforce in the supply chain industry acquires, enhances, and applies the requisite technological competencies. By focusing on the nuanced relationship between technology skills development and supply chain practices, the research contributes to a deeper understanding of how organizations in the sector navigate the challenges and opportunities presented by the evolving technological landscape of the Fourth Industrial Revolution.

Enhanced Understanding of 4IR Readiness: The study contributes to the theoretical understanding of 4IR readiness in the South African warehousing sector specifically from a skills perspective. It explores the skills required to adapt to and leverage the technologies associated with the Fourth Industrial Revolution (4IR) in the warehousing context.

Identification of Key Skills: The study identifies and categorizes the key skills needed for the South African warehousing sector to effectively embrace and utilize 4IR technologies. It provides insights into the specific technical, digital, and soft skills that are essential for individuals working in this sector.

Skills Gap Analysis: By assessing the existing skills in the South African warehousing sector, the study contributes to the theoretical understanding of the skills gap that may hinder the sector's readiness for 4IR. It highlights areas where the sector falls short in skills required for successfully adopting and implementing 4IR technologies.

3.6.2 Managerial Contributions

Skill Development initiatives and strategies: The study provides recommendations for skill development initiatives within the warehousing sector. Based on the identified skills gaps and challenges, the research findings can inform the design and implementation of training programs, upskilling and re-skilling initiatives, and other skill development interventions. This can enhance the sector's overall readiness for 4IR technologies.

Industry Collaboration: The study aims to highlight the importance of collaboration and partnerships within the warehousing sector. The findings may emphasize the need for industry-wide collaborations to address skills gaps, share best practices, and foster knowledge exchange. The research will provide recommendations for collaborative initiatives, such as industry-led skill development programs or platforms for sharing resources and expertise.

Policy Implications: The study's findings will inform policy-making decisions related to skills development and 4IR readiness in the South African warehousing sector. The research will provide evidence and insights that can influence policy formulation at the government level, leading to the development of supportive policies, regulations, and incentives that facilitate skill development and technology adoption.

3.7 Ethical considerations

For the purpose of the research, which investigates 4IR skills readiness in the South African warehousing sector following ethics considerations were followed:

- **Informed Consent:** Consent forms were obtained from all study participants, and clear information was provided about the purpose, procedures, potential risks, and benefits of the research. Participants were informed about their rights to voluntarily decide whether to participate or withdraw from the study without any negative consequences.
- **Data Protection:** Adhere to data protection and privacy regulations was followed as per the POPIA Act. Data collected will be stored on the researcher's password-protected computer with password protected file.
- **Confidentiality and Anonymity:** Confidentiality and anonymity of participants was discussed during the digital consent form explanation session prior to the interview. No proprietary information will be shared in the interview.
- **Researcher Bias:** Researcher recognized and managed their biases by being open about their background, perspectives, and potential conflicts of interest before their interview.
- **Ethical Review:** Ethics approval was obtained from Wits Business School and digital signed consent forms were obtained from the participants before interviews were conducted.

Chapter 4: Findings and Discussion of findings

4.1 Introduction

In this chapter discusses the findings for the set objectives to our topic which the 4IR skills readiness in the South African warehousing sector. Our inquiry is deeply rooted in a qualitative paradigm, aligns closely with the identified research questions, each probing into different dimensions of the sector's 4IR readiness from a skills perspective. Aligned with the research questions that guide our inquiry, this chapter reveals the lived experiences, challenges, and insights of those at the forefront of the industry, providing a comprehensive understanding of the impact of 4IR on role evolution, the specific skills and knowledge required, and the importance of targeted training programs.

RQ1: What is the impact of 4IR from role evolution perspective?

The first section of our findings ventures into the heart of the South African warehousing sector, dissecting the impact of 4IR from the perspective of role evolution. We present a diverse set of narratives and opinions gathered from industry stakeholders. The findings investigated how traditional roles in the sector are evolving to meet the demands of automation, artificial intelligence, and modern technology. Through thematic analysis participants highlighted the key themes in relation to the skills landscape, readiness, and challenges faced by the warehousing sector in adopting 4IR technologies. These insights will help the workforce and industry stakeholders navigate the shifting dynamics, offering a complete understanding of 4IR's multidimensional impact on role evolution.

RQ2: What specific skills and knowledge are required to adopt and utilize 4IR technologies effectively.

The second section of this chapter delves into the specific skills and knowledge crucial for the effective adoption and utilization of 4IR technologies within the South African warehousing sector. Drawing upon the voices of industry experts and key stakeholders, we identify and categorize the competencies deemed essential for navigating the challenges and opportunities

presented by 4IR. The findings not only pinpoint the technical skills but also shed light on the importance of soft skills and adaptability in fostering a workforce capable of harnessing the potential of advanced technologies. Through a synthesis of diverse perspectives, this section contributes a nuanced understanding of the skillset needed by the warehousing sector to navigate the 4IR new world of work.

RQ3: What 4IR training programs and initiatives are needed to accelerate the upskilling and re-skilling process?

The final segment of our findings focuses on the critical aspect of designing 4IR training programs and initiatives tailored to the South African warehousing sector. Building upon the insights gained from stakeholders and best practices globally, we outline specific recommendations for programs that aim to accelerate the upskilling and re-skilling process. Through a detailed examination of existing initiatives and their outcomes, this section provides actionable insights for policymakers, industry leaders, and training providers, outlining the roadmap for preparing the workforce to meet the challenges of 4IR head-on.

In this context, the research design employed semi-structured interviews with key stakeholders in various roles within the sector, the roles were divided into two groups which were Senior Managers and Supervisor/Middle Managers. Participants were selected based on their expertise and experience with 4IR technologies and skills requirements, with eight participants with over 10 years' experience and four participants ranging between 2 to 10 years' experience in the sector. From a demographics perspective we have eight male, and four female participates giving us diverse insights and perspectives. The study targeted warehousing providers who employ more than 50 people because they are the most likely to implement 4IR due to economies of scale which allows them to justify the technology. Against the backdrop of a rapidly evolving warehousing landscape influenced by 4IR technologies, the study took place during a period where the warehousing is being challenged to improve its efficiency though the exploration of technologies like Automation and Artificial Intelligence in order to become more responsive and agile to dynamic customer demands. Marked by notable advancements in automation and data-driven logistics. This exploratory study reviewed theoretical framework such as the Agile Learning Framework, Human Capital Theory and Digital Competence Framework were used to assist in unpacking the South African warehousing sector 4IR skills preparedness question.

4.2 Discussion of findings

Thematic Analysis was used to help identify and analyze recurring themes and patterns within data used the data on attached Appendix 3, allowing the researcher to categorize and develop specific codes for common themes related to skills gaps, skill requirements, training needs, and challenges in adapting to 4IR new technologies in the South African warehousing sector.

RQ1: What is the impact of 4IR from role evolution perspective?

The following themes, emerged on our research question number one which "impact of 4IR from role evolution perspective", using thematic Analysis: theme 1: Reduction in Unskilled Labor Demand and Redundancy, theme 2: Job Evolution and Human-Machine Collaboration

Theme 1: Reduction in Unskilled Labor Demand and Redundancy

The theme of "Reduction in Unskilled Labor Demand and Redundancy" is prevalent throughout the participant responses, reflecting a shared perspective on the transformative impact of the 4th Industrial Revolution (4IR) in the warehousing sector. Participant 5 specifically emphasizes that 4IR drastically reduces the need for unskilled labor, predicting a dramatic decrease in the demand for such roles. This sentiment is echoed by Participant 10 and 2, the current workforce, which is accustomed to manual operations, may experience issues due to resistance to change and are in most cases not willing to upskill themselves. Both participants highlight a fundamental transformation in the nature of employment in the warehouse industry, with conventional manual jobs being replaced by modern technology such as automation, robots, and artificial intelligence. Concerns about a reduction in the demand for unskilled labour are also linked to concerns about the potential negative impact on employment rates, particularly in high-unemployment areas like South Africa. This reduction in demand for unskilled labor is not only a technological evolution but also poses socio-economic challenges, necessitating a strategic approach to workforce development, reskilling, and adaptation to the changing landscape of the industry.

The findings align with the literature's discussion on the impact of the 4IR on job roles. The findings highlight a consensus among participants that 4IR technologies, such as robotics and automation, will significantly reduce the demand for unskilled labor in the warehousing sector.

This aligns with literature suggesting that 4IR is a skilled-biased technological change, eliminating routine, dangerous, repetitive, and physical tasks traditionally performed by unskilled workers (Rodrik, 2018). Participants 2,4 and 5 express concerns about the potential job redundancies and the swift obsolescence of certain skills, echoing findings that the demand for manual and basic cognitive skills is projected to decrease substantially by 2030 (McKinsey, 2018).

Moreover, both the research findings and literature emphasize the impact on routine warehousing roles, such as picking and packing, which are typically performed by blue-collar workers. There is a shared understanding that these roles are more likely to be replaced by machines, aligning with research suggesting that jobs involving unstructured tasks may be more resilient to automation (OECD). The literature review further supports the idea that jobs requiring manual labor are at risk of being replaced by 4IR technologies like artificial intelligence and robotics (Santiago, 2020). The literature and research findings also converge on the potential negative consequences of 4IR on employment and income distribution. Both sources highlight concerns about job losses, potential lower income for workers due to increased technological competition, and the exacerbation of existing inequalities. This aligns with the literature's argument that 4IR implementation could have a significant negative impact on unemployment, particularly in countries like South Africa, where more jobs may be replaced by technology (Adendorff et al., 2018).

However, it's crucial to note that the literature review also introduces a counterargument, suggesting that while certain jobs may be downgraded or eliminated, 4IR may not necessarily lead to widespread unemployment (Li, 2022). The emphasis is placed on upskilling and reskilling programs to ensure that the workforce can adapt to the changing job landscape (Marwala, 2019). This perspective is echoed in the findings, where participants 7 and 11 discussed the need for continuous learning, reskilling, and upskilling to mitigate the impact of 4IR on job roles. The literature review and participant responses collectively underscore the importance of strategic planning, education programs, and skills development to navigate the complexities introduced by the 4IR in the context of the warehousing sector.

In conclusion the prevalent theme of “Reduction in Unskilled Labor Demand” underscores the transformative impact of 4IR technologies, such as automation and robotics, leading to a

significant decrease in the demand for traditional manual roles. The concern over potential job redundancies and the obsolescence of certain skills aligns with existing literature, emphasizing the skilled-biased nature of technological change. However, both the findings and literature introduce a counterargument, emphasizing the importance of upskilling and reskilling programs to mitigate widespread unemployment.

Theme 2: Job Evolution and Human-Machine Collaboration

The theme of “Job Evolution and Human-Machine Collaboration” emerges as a central aspect of the participant responses, offering insights into the dynamic transition taking place in the warehousing sector due to the 4th Industrial Revolution. Participants 6 and 8 highlight the necessity for the future workforce to possess programming, engineering, creativity, critical thinking, and emotional intelligence skills. These skills are considered essential for adapting to the evolving nature of roles that increasingly involve the collaboration between humans and machines. Participants 1 and 5 anticipate a shift toward more sophisticated tasks, emphasizing problem-solving and creative thinking over routine, manual functions. The acknowledgment of the need for creative individuals who can solve complex problems indicates a growing emphasis on roles that require unique human qualities complemented by technological capabilities. The integration of technologies like artificial intelligence, robotics, and automation is seen not as a replacement for human workers but as a catalyst for the evolution of job roles, necessitating a workforce capable of collaborating seamlessly with advanced technologies. This theme underscores the importance of fostering a workforce that can adapt to, collaborate with, and leverage the capabilities of emerging technologies, marking a significant paradigm shift in employment in the warehousing sector.

The theme of “Job Evolution and Human-Machine Collaboration” in the findings aligns with the literature's discussion on the Impact of the Fourth Industrial Revolution (4IR) on Job Roles. Both sources acknowledge the transformative effects of 4IR technologies, emphasizing a shift from manual labor to a knowledge-intensive, technology-driven work environment. The literature review introduces the concept of cognitive technologies, such as machine learning, supplementing human labor activity, leading to increased collaboration between humans and machines (Rotatori et al., 2021). The findings echo this sentiment, highlighting the evolving nature of jobs in the warehousing sector due to the implementation of 4IR technologies.

While the literature emphasizes a decline in the demand for manual and basic cognitive skills, it also introduces a counterargument, suggesting that the integration of AI in the workplace may lead to the creation of new jobs, particularly in industries focused on implementing AI technology (Puzzo et al., 2020). The findings similarly express a recognition of the evolving job landscape, citing instances of jobs being phased out in favor of high-skilled labor (Anshari, 2020). The idea of jobs evolving, rather than simply disappearing, aligns with the literature's assertion that many functions will be downgraded or transformed as employees adapt to the changing nature of work brought about by 4IR technologies (Li, 2022).

Moreover, both the literature and findings discuss the potential positive outcomes of human-machine collaboration. The literature emphasizes that while technology may supplement human efforts, it could result in increased efficiency, output, and prospects for upskilling and job stability (Al Mubarak, 2022). The findings reflect this perspective, with participants 7 and 12 discussing the need for continuous learning, reskilling, and upskilling to harness the benefits of 4IR technologies. The concept of a hybrid working model, combining full-time and part-time employment, is highlighted in both sources, emphasizing a shift towards a more flexible and dynamic work environment (Anshari et al., 2022). However, the literature and findings also acknowledge the potential challenges associated with these transformations, including legal, psychological, and ethical concerns. Both sources underscore the importance of addressing these challenges to fully realize the positive externalities, such as higher living standards and sustainable development, stemming from the optimal integration of human and technological resources in the context of 4IR.

In summary, the theme of “Job Evolution and Human-Machine Collaboration” in the findings aligns with the literature, recognizing the changing nature of jobs and the need for effective collaboration between humans and machines to navigate the complexities introduced by the Fourth Industrial Revolution. The synthesis of these perspectives highlights the dual nature of 4IR, presenting challenges but also opportunities for a more dynamic and efficient workforce. Research findings and literature alike recognize the evolution of job roles in the warehousing sector, moving away from routine manual functions towards knowledge-intensive, technology-driven tasks. The notion of human-machine collaboration is seen as a catalyst for positive change, fostering a workforce capable of adapting to and leveraging emerging technologies.

While acknowledging potential challenges, both sources emphasize the positive outcomes of collaboration, such as increased efficiency and prospects for upskilling.

RQ2: What specific skills and knowledge are required to adopt and utilize 4IR technologies effectively?

The following themes, emerged on our research question number one which "What specific skills and knowledge are required to adopt and utilize 4IR technologies effectively" using thematic Analysis, theme 1: Necessary Skills for 4IR Adoption, theme 2: Skill Gaps and Challenges, theme 3: Government Policies, theme 4: Education System and Need Change Management

Theme 1: Required Skills and Knowledge

The participants in the thematic analysis provided valuable insights into the necessary skills for the adoption of Fourth Industrial Revolution (4IR) technologies in the warehousing sector. Participant 1 emphasized the significance of problem-solving skills and maintenance expertise, stressing the need for individuals who can troubleshoot and repair technological machinery. Participant 2 delved into the importance of a basic understanding of coding, machine learning, and data analytics, highlighting their key role in transforming current work processes. Participant 3 focused on the operational level, pointing out the necessity for warehouse employees to operate and troubleshoot technological machines, while also shedding light on the existing skills gap due to limited education and training. Participant 4 expanded on the need for advanced computer skills, programming, and data analytics, suggesting that current warehouse operations still heavily rely on manual and inefficient processes. Participant 5 drew attention to the importance of data analytics skills, recognizing the human analytical element required alongside AI and machine learning. Participant 6 stressed the requirement for coding and algorithmic skills for software development. These diverse perspectives collectively paint a detailed picture of the multifaceted skill set deemed essential by participants, encompassing technical proficiency, problem-solving abilities, and adaptability to the evolving technological landscape in the warehousing sector.

The theme of necessary skills for 4IR adoption, as identified in the findings, aligns with existing literature on the skills required for effective implementation of 4IR technologies. Participants 1and 5 in the findings emphasized the importance of problem-solving, analytical thinking, and digital skills for the successful adoption of 4IR in the warehousing sector in South Africa. This aligns with research findings indicating that 4IR demands high-level skills like digital skills, creative thinking, and analytical thinking (Ajagunna et al., 2020). The participants' emphasis on skills such as programming, data analytics, and machine learning resonates with the literature that highlights the addition of new skills domains like technological and programming skills in the 4IR era (Maisiri et al., 2019). Moreover, the emphasis on transversal skills, including critical thinking and problem-solving, in the findings corresponds with literature suggesting the importance of these skills for adapting to rapidly changing technology landscapes (Hart et al., 2021).

The literature review further supports the participants' views on the evolving nature of skills required for 4IR, emphasizing the need for analytical and innovation competencies beyond 2025 (Li, 2022). The mention of AI technologies impacting human skills and the need for workers to learn new skills or retrain aligns with the participants' focus on advanced computer skills, programming, and data analytics (Sofia et al., 2023). The McKinsey classification of 4IR workplace skills into categories such as technical skills resonate with the participants' mention of the need for advanced computer skills and programming (Bughin et al., 2018). Additionally, the literature review emphasizes the importance of leadership with a digital mindset, aligning with Participant 12 stress on change management as a critical aspect. The findings and literature both highlight the necessity for leaders to navigate cultural barriers, address fears, and communicate the benefits of technological initiatives (Kelly & Kelly, 2019).

In summary, the identified skills in the findings, including problem-solving, analytical thinking, digital skills, programming, and data analytics, are consistent with the broader literature on the skills required for effective 4IR adoption. The participants' insights provide on-the-ground perspectives that complement and validate existing research in the field. These findings align seamlessly with existing literature, emphasizing the evolving nature of skills demanded by 4IR and the importance of transversal skills for adapting to rapidly changing technology landscapes. The synthesis of participant insights and literature underscores the need for a multifaceted skill

set, emphasizing technical proficiency and adaptability to navigate the evolving technological landscape in the warehousing sector.

Theme 2: Skill Gaps and Challenges

The theme of skill gaps and challenges, as illuminated by the participants in the findings, sheds light on the current limitations and obstacles faced by the warehousing sector in South Africa in terms of preparing the workforce for the adoption of Fourth Industrial Revolution (4IR) technologies. Participant 1 pointed out the existing gap in basic IT and troubleshooting skills among floor employees, emphasizing the need for empowerment rather than overreliance on decentralized IT programmers. Participant 2 acknowledged that while engineers possess certain skills related to 4IR technologies, the challenge lies in transferring these skills to blue-collar workers. Participant 3 highlighted the limited availability of necessary skills, even though some training initiatives have been initiated for drivers and warehouse operators. Participant 4 expressed mixed feelings about skill readiness, citing the loyalty of employees but acknowledging a lack of development and skills matching industry demands. Participant 5 underscored the struggle in finding individuals capable of bridging the gap between warehouse, logistics, and IT, emphasizing the dearth of data analytical skills. Participant 6 discussed the prevailing dependency on IT personnel for troubleshooting, calling for a shift toward empowering employees for self-troubleshooting. These diverse insights collectively emphasize the prevailing challenges, ranging from resistance to change and inadequate training to a scarcity of individuals with the interdisciplinary skills required for effective 4IR adoption in the warehousing sector.

The theme of Skill Gaps and Challenges, as derived from the findings, aligns with the literature review on skills required for effective 4IR adoption, shedding light on the specific challenges and gaps faced by the workforce. The participants' concerns about the urgent need for an industry-focused, demand-driven skills curriculum resonate with the literature's emphasis on the evolving nature of skills demanded by the 4IR, including technological, programming, and digital skills (Maisiri et al., 2019). The call for investment in free internet access and online learning materials for employees, as mentioned in the findings, corresponds with existing research highlighting the importance of accessible and affordable education and upskilling opportunities (Maisiri & van Dyk, 2021).

The literature review and participants' perspectives converge on the challenges related to the high capital cost of acquiring sophisticated technology, particularly in developing countries like South Africa. Both sources identify poor ICT infrastructure as a significant impediment to the effective adoption of 4IR technologies (Bughin et al., 2018; El Nahrawy, 2020). Moreover, the participants' concerns about the lack of attention to the social relations of production in skills development practices align with literature pointing out the need for a holistic approach in skills policies and practices (Hammer & Karmakar, 2021; Petersen et al., 2023).The literature on the resistance to change encountered during the adoption of new technologies, as emphasized by Uys & Webber-Youngman (2019), resonates with the participants 4 and 11 concerns about employees' unwillingness to invest in their skills development. The literature review extends this point by emphasizing the importance of leadership transitioning from decision-making to sense-making, promoting a digital mindset to enhance organizational success and worker resilience (Kelly & Kelly, 2019; Naidoo & Potokri, 2021). This aligns with the participant 9 stress on the need for effective 4IR management and strategies for worker upskilling and reskilling, acknowledging the role of leadership in navigating these challenges (Kar et al., 2020).

Both the findings and literature underscore the challenges posed by the lack of confidence in government agencies' ability to prepare workers for the new technological economy and the resultant skills gap. The participants' concern about the non-favorable environment for acquiring relevant skills due to troubleshooting the 4IR echoes the literature highlighting the importance of correct management of 4IR technologies (Bérubé et al., 2021; Nylin et al., 2022).

In conclusion, the themes identified in the findings regarding skill gaps and challenges align closely with the literature, providing a comprehensive understanding of the obstacles faced by the workforce in adopting and utilizing 4IR technologies effectively. Participants' concerns about resistance to change, inadequate training, and a scarcity of interdisciplinary skills align with existing research, highlighting the challenges associated with developing countries, poor ICT infrastructure, and the need for a holistic approach in skills policies and practices. The participants insights complement and substantiate existing research, emphasizing the need for tailored, accessible education and training programs, supportive leadership, and a strategic approach to address the challenges posed by the 4IR era.

Theme 3: Government Policies

The theme of government policies, as discussed by participants in the findings, illuminates the impact of regulatory frameworks on the adoption of Fourth Industrial Revolution (4IR) technologies in the warehousing sector in South Africa. Participant 7 underscored the need for a foundational understanding of technological systems within the workforce, highlighting the existing barrier posed by the lack of support from the education system. Additionally, concerns were raised about the government's resistance to technological advancements, attributed to a potential lack of understanding and the fear of job losses. Participant 8 echoed these sentiments, expressing dissatisfaction with the education system's inability to provide relevant skills, emphasizing that the outdated knowledge being taught does not align with the rapidly evolving technological landscape. Furthermore, the participant pointed out that high-level jobs, such as CEO positions, are often filled by expatriates due to the scarcity of locally available skills. Participant 9 provided a comprehensive assessment, giving a rating of 2 out of 10 for the overall skills readiness in the warehousing sector, attributing the low score to resistance from the government in implementing technological advancements. The participant highlighted the lack of policies enforcing the adoption of new systems and the economic challenges hindering companies from voluntarily implementing costly technologies. These insights collectively underscore the pivotal role of government policies and support in shaping the readiness and adoption of 4IR technologies in the South African warehousing sector, revealing concerns about the current reluctance and potential consequences of lagging behind in technological advancements.

The theme of Government Policies, as evident from the findings, aligns with the literature review on the challenges and requirements for implementing 4IR technologies. The participants' concerns about the lack of confidence in local, state, and federal government agencies' ability to use public resources to prepare workers for the new technological economy resonate with literature emphasizing the role of government in shaping effective policies for 4IR adoption (Schwartz et al., 2019). The participants highlight the challenges faced by developing countries, such as South Africa, in investing in upskilling and reskilling due to poor education systems and the need for national skills plans. This is corroborated by the literature, which underscores the importance of addressing the underlying social relations of production and the outcomes of skills

policies and practices in the context of government interventions (Hammer & Karmakar, 2021; Petersen et al., 2023).

Moreover, the literature review discusses the significant barrier of high capital costs for developing countries in reaping the benefits of 4IR technologies, a point that aligns with the participants concerns about the challenges faced by countries with poor infrastructure (El Nahrawy, 2020). The participants 3 and 10 emphasis on the need for accessible and easily available industry-focused demand-driven skills curriculum, coupled with investments in free internet access and online learning materials, reflects the literature's suggestion that developing nations need to devise methods to reverse the trends hindering up/reskilling initiatives (Maisiri & van Dyk, 2021; Sofia et al., 2023).The participants 8 and 10 concerns about the lack of clear consensus on the most suitable curriculum for South Africa to close its 4IR skills gaps echo the literature's acknowledgment of the challenges in implementing science, technology, engineering, and mathematics (STEM) curricula, especially in developing countries with limited infrastructure (Li, 2020; Schofield & Dwolatzky, 2018). The call for further stakeholder research to understand cost-effective ways to address 4IR skills gaps aligns with the literature's recognition of the need for more research to identify detailed skills programs and support systems to operationalize 4IR skills programs effectively.

In conclusion, the themes identified in the findings regarding government policies resonate with the literature, providing insights into the challenges faced by developing countries, the need for effective government interventions, and the importance of accessible and industry-focused skills development initiatives to navigate the complexities of 4IR technologies. Participants' concerns about the lack of confidence in government agencies and the absence of policies enforcing the adoption of new systems resonate with literature emphasizing the role of government in shaping effective policies for 4IR adoption. The participants' perspectives complement and reinforce existing research, emphasizing the crucial role of government policies in shaping successful strategies for worker upskilling and reskilling in the era of the Fourth Industrial Revolution.

Theme 4: Education System and Change Management

The theme of the assessment of the education system and the need for change management, as revealed in the findings, highlights critical aspects influencing the readiness of the warehousing sector in South Africa for Fourth Industrial Revolution technologies. Participant 3 raised concerns about the existing skills gap, particularly among employees with limited educational backgrounds, pointing out that basic competencies, such as operating a computer, were lacking. This underscores a need for change management in the education sector to align with the evolving demands of 4IR. Participant 12 stressed the importance of change management in facilitating the adoption of 4IR technologies. The participant emphasized that without convincing employees and implementing robust educational programs to raise awareness about 4IR, sustainable change will be challenging. Moreover, Participant 5 highlighted the education system's failure to produce individuals capable of bridging the gap between warehouse, logistics, and IT, emphasizing the critical need for change in educational curricula to include relevant technological skills. These insights collectively underscore the urgency for change management strategies in both the education system and within organizations to effectively transition the workforce towards a 4IR-ready state. Addressing the existing gaps in basic education and implementing change management initiatives becomes crucial for achieving a seamless integration of 4IR technologies in the South African warehousing sector.

The analysis of the theme "Assessment of the education system and the need for change management" in the context of 4IR readiness in the warehouse sector draws attention to the participants 5,8 and 10 concerns about the challenges associated with the existing education system and the imperative for change management. Participants consistently highlight the inadequacies in the current education system, emphasizing poor foundational competencies, lack of digital skills, and outdated curricula. This aligns with the literature, which emphasizes the need for a shift in education to accommodate the specific skills demanded by the Fourth Industrial Revolution (Ajagunna et al., 2020; Maisiri & van Dyk, 2021).

The participants 1and 4 stress the importance of change management in overcoming resistance to technological advancements and fostering a culture of continuous learning. The literature resonates with this perspective, emphasizing the role of leadership in navigating cultural barriers and communicating the benefits of technological initiatives (Uys & Webber-Youngman, 2019).

The studies in the literature review underscore the significance of leaders adopting a digital mindset and leveraging collective wisdom for decision-making in the 4IR era (Naidoo & Potokri, 2021). Additionally, the participants 3 and 6 expressed concerns about the lack of investment in upskilling and reskilling initiatives, particularly in developing countries like South Africa. The literature corroborates this by highlighting the challenges associated with accessing education and skill development, the reluctance of employees to invest in their skills, and the high costs associated with implementing STEM-focused curricula (Sofia et al., 2023; Ellingrud et al., 2020).

The literature review outlines the skills and knowledge required for effective 4IR adoption, including digital skills, problem-solving abilities, and transversal skills. The participants echo these sentiments, emphasizing the need for industry-focused, demand-driven skills programs and access to online learning materials. The convergence between participant insights and the literature review underlines the urgency for educational reforms and strategic change management to bridge the skills gap and prepare the workforce for the challenges posed by 4IR technologies (Kar et al., 2020; Bughin et al., 2018).

In conclusion, both the participants and the literature highlight the critical importance of addressing the inadequacies in the education system, implementing change management strategies, and investing in upskilling and reskilling initiatives to effectively navigate the Fourth Industrial Revolution in the warehouse sector. Participants' concerns about the inadequacies in the education system, resistance to technological advancements, and the need for change management align with the literature, emphasizing the shift in education to accommodate specific skills demanded by 4IR. Both participants and literature highlight the urgent need for educational reforms, strategic change management, and investments in upskilling and reskilling initiatives to effectively navigate the challenges and opportunities posed by 4IR technologies. A collaborative effort involving stakeholders, educational institutions, and government bodies is essential to create a responsive and dynamic learning environment that aligns with the evolving demands of 4IR technologies.

RQ3: What 4IR training programs and initiatives are needed to accelerate the upskilling and re-skilling process??

The following themes, emerged on our research question number one which “What 4IR training programs and initiatives are needed to accelerate the upskilling and re-skilling process” using thematic analysis, theme 1: Lack of Formalized Upskilling Strategies, theme 2: Desire for Collaboration and Partnerships, theme 3: Awareness and Understanding Gap:

Theme 1: Lack of Formalized Upskilling Strategies

The theme of the lack of formalized upskilling strategies is underscored by participants who consistently expressed concerns about the absence of structured and dedicated programs within their respective companies. Participant 1 candidly admitted that their company lacked any efforts or strategies for 4IR preparedness in the warehousing sector. This sentiment was echoed by Participant 3, who mentioned reliance on short-term contracts with labor brokers, making it challenging to invest in formal upskilling due to the perceived absence of long-term returns on investment. Participant 5 emphasized the need for making people, including senior management, aware of the implications of 4IR, highlighting a gap in understanding that extends to the top echelons of the organization. Participant 7 stressed the importance of implementing strategies at the top management level, advocating for clear communication, program awareness, and the provision of accessible initiatives like XYZ. The recurring acknowledgment of the lack of a specific strategy, as voiced by multiple participants, underscores the critical need for companies to develop comprehensive, targeted upskilling programs dedicated to preparing the workforce for the challenges posed by the 4th Industrial Revolution in the warehousing sector.

The theme of the lack of formalized upskilling strategies, as evident in the participants responses, aligns with the literature review on 4IR training programs and initiatives. While the literature highlights successful strategies in developed countries, such as the OECD Skills strategy and Australia's ONET program, the participants reveal a stark contrast in their companies approaches (Co-operation & Development, 2019; Gaula et al., 2022). Participant 1 acknowledgment that their company currently has no efforts in place reflects a lack of structured strategy, mirroring the findings in the literature that emphasize the importance of a well-defined skills strategy for effective upskilling (Co-operation & Development, 2019).

Moreover, Participant 3 mentioned on-the-job training without a formalized approach echoes the literature's emphasis on the need for targeted programs. The literature review discusses how developed countries like Japan have utilized 4IR technologies such as MOOCs and job rotations to enhance skills accessibility and sharing (Kant et al., 2021; Olejniczak et al., 2020). However, Participant 3 description of on-the-job training being impeded by short-term contracts indicates a challenge in investing in long-term skills development, aligning with the literature's observation on the limitations posed by certain employment structures (Olejniczak et al., 2020).

The participants' comments highlight a lack of awareness and understanding about 4IR, consistent with the literature's emphasis on the importance of a deeper understanding of human and machine integration. Participant 5's insight that even senior management lacks a comprehensive understanding resonates with the literature's emphasis on the need for education and awareness programs (Kant et al., 2021). The disparity between the aspirations outlined in company documents and the actual implementation, as mentioned by Participant 1, parallels the literature's emphasis on the importance of translating aspirations into tangible actions (Co-operation & Development, 2019).

In comparison to the literature review's insights from developed countries, the participants' experiences underscore a significant gap in the implementation of formalized upskilling strategies within their companies (Co-operation & Development, 2019; Gaula et al., 2022). The absence of a structured approach, limited awareness, and challenges in investing in long-term skills development collectively emphasize the critical need for tailored, comprehensive, and intentional upskilling initiatives to address the demands of the 4th Industrial Revolution in the warehousing sector. The participants' experiences underscore a significant gap in the implementation of formalized upskilling strategies, emphasizing the critical need for tailored, comprehensive, and intentional initiatives to address the demands of the 4th Industrial Revolution in the warehousing sector.

Theme 2: Desire for Collaboration and Partnerships

The theme of a strong desire for collaboration and partnerships emerges prominently in the findings, with participants consistently expressing the need for coordinated efforts to address the skills gap related to 4IR readiness in the warehousing sector. Participant 2, for instance, discussed an internal program called Lean Six Sigma but acknowledged a lack of awareness regarding external partnerships. Participant 4 emphasized the role of government institutions like SETA but criticized their inefficiencies and suggested better collaboration among companies. Participant 8 advocated for industry partnerships with universities to develop tailored training programs and even proposed government intervention through tax breaks for companies investing in 4IR skills development. Participant 10 highlighted the need for collaboration between educational institutions, government, and companies to develop practical programs designed to close the 4IR skills gap. The repeated calls for collaboration with educational institutions and industry associations, as seen across multiple responses, underscore a shared recognition among participants that addressing the challenges posed by the 4th Industrial Revolution requires joint efforts, with industry bodies taking a more active role in driving collaborative initiatives and partnerships. This theme highlights the importance of creating a cohesive ecosystem that fosters shared responsibility for upskilling and re-skilling initiatives in the warehousing sector.

The theme of a strong desire for collaboration and partnerships, as evidenced in the participants' responses, resonates with the insights from the 4th Industrial Revolution. review on upskilling and re-skilling initiatives in the context of the 4th Industrial Revolution . The participants consistently express the need for coordinated efforts and partnerships to address the skills gap related to 4IR readiness in the warehousing sector. Participant 8, for instance, advocates for industry partnerships with universities to develop tailored training programs, aligning with the literature's emphasis on collaboration between higher education and industry for skills development (Sofia et al., 2023). Additionally, Participant 7 highlights the importance of creating partnerships between educational institutions and industry associations to create awareness and drive initiatives, reflecting the literature's emphasis on collaborative efforts involving multiple stakeholders (Sofia et al., 2023; Lloyd & Payne, 2019).

In contrast to the developed countries perspective outlined in the literature, where successful examples like the OECD Skills strategy and Germany's forward-thinking curriculum are cited, the participants' experiences underscore a gap in formalized collaboration efforts within their companies (Co-operation & Development, 2019; Woetzel, Seong, et al., 2021). The literature review suggests that developed countries have made substantial investments in collaboration with employers, technology experts, and trade unions to fund research and development in universities for upskilling and re-skilling (Lloyd & Payne, 2019). However, is the opposite in developing countries with participants' experiences revealing a disconnect in their companies strategies, with limited awareness and structured approaches.

Furthermore, the literature review highlights the challenges faced by developing countries, including South Africa, in understanding emerging technologies and lacking a strategic framework. This aligns with Participant 6's acknowledgment of the need for specialized institutions and partnerships to drive awareness in South Africa (Sutherland, 2020; Mpofu & Nemashakwe, 2023). The participants' expressed need for collaboration in developing tailored technological programs resonates with the literature's call for a shift towards industry-specific programs to prepare employees for 4IR in developing countries (Maisiri et al., 2019). The literature points out the lack of a standardized approach in South Africa's skills development system, a concern echoed by the participants in their discussions about the absence of formalized upskilling strategies and partnerships within their companies (Gaula et al., 2022).

In conclusion, the theme of a desire for collaboration and partnerships emerges as a critical aspect in both the participants' experiences and the literature review. While the literature highlights successful initiatives in developed countries, the participants' accounts reveal a gap in the implementation of collaborative strategies within their companies, emphasizing the need for intentional efforts to foster partnerships in the context of 4IR skills development in the warehousing sector. This theme underscores the importance of creating a cohesive ecosystem and joint efforts for shared responsibility in upskilling and re-skilling initiatives.

Theme 3: Awareness and Understanding Gap:

The theme of an awareness and understanding gap regarding 4IR technologies is a widespread concern highlighted by participants in the findings. Participant 5 emphasized the need to make individuals, including senior management, more aware of the implications of 4IR, citing a lack of comprehension even at higher organizational levels. Participant 11 echoed this sentiment, asserting that organizations should drive more awareness about 4IR among their employees, particularly since many operators are unskilled and unaware of the concept. Participant 1 noted that while the company aspired to be technologically advanced, the gap lies in the translation of these aspirations into tangible actions. The prevalent lack of understanding and awareness was acknowledged by Participant 7, who highlighted the importance of creating partnerships between educational institutions and industry associations to generate awareness. The identified gap extends beyond the workforce, as Participant 2 noted the challenges of accessing formal training due to the voluntary nature of the available courses. This recurring theme suggests the critical need for comprehensive educational efforts within organizations, particularly targeting senior management, to bridge the awareness and understanding gap surrounding 4IR technologies in the warehousing sector. Addressing this gap is essential for laying the foundation for effective upskilling and re-skilling initiatives.

The theme of an awareness and understanding gap, as evident in the participants discussions, aligns with the findings from the literature review on upskilling and re-skilling initiatives within the context of the 4th Industrial Revolution. The participants consistently express a lack of awareness and understanding of 4IR technologies and their implications on the warehousing sector. Participant 4, for instance, highlights the need for more education and training to bridge the gap between employees and technology, echoing the sentiment from the literature that businesses and leaders may lack the technical competence to make informed decisions in the rapidly changing market (Maisiri et al., 2019).The studies have shown that successful initiatives in developed countries, such as the OECD Skills strategy and Germany's vocational work-focused curriculum, which contribute to a deeper understanding of the skills required for 4IR (Co-operation & Development, 2019; Woetzel, Seong, et al., 2021). In contrast, the participants' experiences reveal a significant gap in awareness and understanding within their companies,

suggesting a disconnect between the global initiatives outlined in the literature and the on-the-ground realities in the warehousing sector.

Sofia et al., (2023) emphasizes that it is fundamental to gain deeper insight on how industrial firms can derive value from human and machine integration. However, the participants' discussions indicate a lack of such understanding within their companies, as they grapple with the challenges of integrating 4IR technologies. Participant 1, for example, highlights the need for companies to invest more in educating their workforce, aligning with the literature's call for a shift in workplace skills and competencies (Maisiri et al., 2019).In the context of developing countries, the literature review underscores that South Africa, despite being an early adopter of 4IR technologies, faces challenges due to insufficient efforts in preparing the education system for the 4IR working environment, leading to a potential awareness and understanding gap (Mkansi & Landman, 2021). The participants discussions align with this observation, as they share concerns about the lack of a predictive skills model and standardized approaches in their companies, reflecting broader issues in the South African skills development system outlined in the literature (Gaula et al., 2022).

In conclusion, the theme of an awareness and understanding gap emerges as a crucial aspect in both the participants experiences and the literature review. While the literature highlights successful initiatives in developed countries, however the participants' accounts in developing countries reveal a significant challenge in creating awareness and understanding within their companies, underlining the need for tailored strategies to address the specific context of the warehousing sector in the 4IR era. This theme highlights the need for comprehensive educational efforts, particularly targeting senior management, to bridge the awareness and understanding gap surrounding 4IR technologies. Addressing this gap is deemed essential for laying the foundation for effective upskilling and re-skilling initiatives, emphasizing the importance of tailored strategies to address the specific context of the warehousing sector in the 4IR era.

4.3 Findings comparison with key constructs coming out of the frameworks.

The findings suggest the alignment with key constructs identified in frameworks, highlighting the South African warehousing sector's 4IR readiness from a skills perspective. Emphasizing the necessity for upskilling initiatives, particularly in information technology, programming, and engineering, participants address a shortage of relevant skills in the current workforce. Their perceptions range from positive aspects like increased productivity to concerns about job redundancies and the potential loss of human elements in production. Challenges such as resistance to change and a scarcity of skilled workers are illuminated, emphasizing the existing skills gap. Participants advocate for comprehensive educational efforts, continuous learning cultures, and collaborative partnerships as crucial enablers for addressing these challenges and facilitating skills development for 4IR readiness. Overall, the findings validate and enhance key constructs, providing a nuanced understanding of the dynamics shaping 4IR readiness in the South African warehousing sector.

Also, the findings from the study concur with the key constructs identified which are Skill Development Initiatives, Opportunities and Enablers, emphasizing the critical need for skill development initiatives in the South African warehousing sector's 4IR readiness (VUORIKARI Rina et al., 2022). Discussions highlight the necessity for skills in programming, data analytics, machine learning, and basic IT competencies. The findings also show that challenges faced by the sector include limited presence of these skills within the workforce, resistance to change, a lack of investment in upskilling, and deficiencies in the educational system. The sector's overall readiness for 4IR technologies is consistently rated low, underscoring the urgency for comprehensive skill development strategies, collaboration, and transformative change management. The findings emphasize the importance of understanding and addressing identified constructs to effectively navigate challenges and capitalize on opportunities presented by the 4IR in the South African warehousing sector.

4.4 Conclusion

In conclusion, the study findings provide a contextual understanding of the multifaceted impact of the Fourth Industrial Revolution on role evolution within the warehousing sector. The highlighted complexities and opportunities underscore the imperative need for a collaborative effort involving stakeholders, educational institutions, and government bodies. Creating a responsive and dynamic learning environment is crucial to align with the evolving demands of 4IR technologies. The identified themes collectively emphasize the importance of strategic planning, education programs, and skills development to effectively navigate the challenges posed by 4IR while harnessing the positive outcomes it brings. The participants experiences, in conjunction with literature, underscore the necessity for tailored strategies, collaboration, and comprehensive educational efforts to bridge gaps and prepare the workforce for the dynamic landscape of the warehousing sector in the era of the Fourth Industrial Revolution. Addressing these themes collectively is paramount for successfully navigating and adapting to the transformative impact of 4IR technologies in the warehousing sector.

Chapter 5 Recommendations and Conclusion

5.1 Recommendations

Based on the comprehensive findings and insightful recommendations from the data collected several overarching recommendations emerge to enhance the 4IR readiness of the South African warehousing sector in terms of skills. First and foremost, there is a critical need to develop dedicated 4IR programs that are easily accessible to the majority of employees, covering a spectrum of skills such as problem-solving, digital literacy, programming, and data analytics. Additionally, fostering a long-term vision and collaboration among stakeholders is essential, encouraging regular meetings and aligning programs based on future technological advancements. To address the gap in training programs, industry-tailored initiatives specific to 4IR skills should be developed, supported by government policies incentivizing permanent employment and collaboration with international institutions. A key recommendation involves revamping the education system, introducing technology-focused curricula from primary school levels, and promoting a continuous learning culture.

In order to practically implement change management, organizations can conduct awareness programs and workshops to communicate the positive aspects of 4IR, engaging strategic stakeholders through targeted presentations for understanding and support. Collaborative partnerships, both local through industry bodies like SAPICS and SETA with international bodies like The Organization for Economic Co-operation and Development (OECD) and ONET (The Occupational Information Network) can assist in establishing connections with industry bodies and global institutions, creating a cohesive ecosystem through shared platforms for effective collaboration in upskilling initiatives within the South African warehousing sector.

Promoting a growth mindset and continuous learning culture within organizations is crucial, encouraging investments in tailored training programs and removing the stigma associated with technology. Finally, establishing an industry leadership forum and training roadmaps specific to the industry are recommended to expedite upskilling and create a future-ready workforce. These recommendations collectively provide a roadmap for the South African warehousing sector to navigate the complexities of the Fourth Industrial Revolution successfully, requiring

collaborative efforts from industry players, educational institutions, government bodies, and international partners. This exploratory study aims to develop a framework adapted to the sector's specific challenges and possibilities, addressing the changing roles, skill needs, and strategic measures required for a resilient and future-ready workforce.

The suggested theoretical framework intends to provide a complete and adaptive guide for stakeholders navigating the revolutionary waves of the 4IR in the South African warehousing industry. Below is the proposed theoretical framework that can assist the South African warehousing sector prepared for 4IR from a skills perspective:

Technology Skills Development Framework

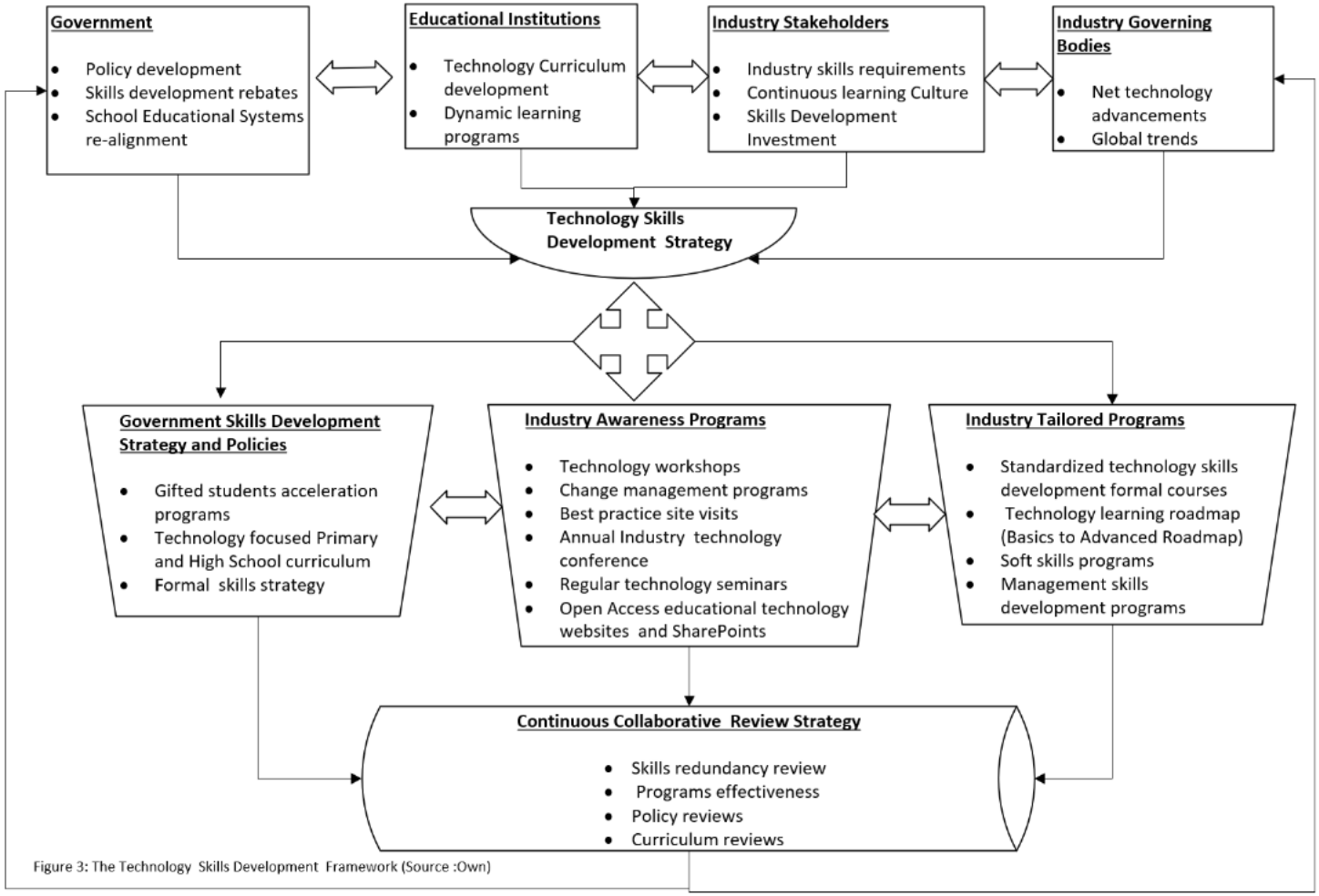

Figure 3: The Technology Skills Development Framework (Source :Own)

The proposed theoretical framework, termed the Technology Skills Development Framework, emerges as a strategic response to the imperatives laid out by the comprehensive findings and recommendations from the exploratory study on 4IR skills readiness in the South African warehousing sector. This framework pivots on the foundational recommendation to develop dedicated 4IR programs that are not only comprehensive but also easily accessible to most employees within the sector. Central to its design is a spectrum of technology skills, encompassing problem-solving, digital literacy, programming, and data analytics, aligning precisely with the multifaceted demands of 4IR technologies. Incorporating the crucial need for fostering a long-term vision and continuous collaboration among stakeholders, the framework emphasizes regular meetings and alignment on programs based on future technological advancements. The industry-tailored initiatives, a key component, address the identified gap in training programs specific to 4IR skills. This recommendation further resonates within the framework, advocating for the collaboration with international institutions, ensuring a globally informed and contextually relevant approach to skills development in the South African warehousing sector.

The Technology Skills Development Framework is intricately woven to accommodate the transformative recommendation of revamping the education system. By introducing technology-focused curricula from primary school levels and promoting a continuous learning culture, this framework acknowledges the imperative of preparing the workforce from the foundational stages. Moreover, it incorporates strategies for effective change management, encapsulated in the suggestion to implement awareness programs and secure buy-in from strategic stakeholders. Collaborative partnerships, both domestic and international, are integral components of the framework, echoing the need for a cohesive ecosystem and shared responsibility in upskilling initiatives. A distinctive feature of the Technology Skills Development Framework is its emphasis on promoting a growth mindset and continuous learning culture within organizations. This involves encouraging investments in tailored training programs and dismantling the stigma associated with technology, aligning with the study's recognition of the importance of overcoming resistance to change. Finally, the framework accommodates the recommendation to establish an industry leadership forum and training roadmaps, offering a structured approach to expedite upskilling and create a future-ready workforce. In essence, this proposed framework

serves as a comprehensive guide, intricately tailored to address the nuanced challenges and possibilities within the South African warehousing sector amid the Fourth Industrial Revolution.

5.2 Limitations

While the exploration of 4IR skills readiness in the South African warehousing sector has yielded valuable insights, it is essential to acknowledge certain limitations and reflect on the study's process. Firstly, the qualitative nature of the research may limit generalizability, as the findings are context-specific to the South African warehousing industry. The emphasis on participant perspectives, while providing depth, may not capture the full spectrum of experiences within this diverse sector. Additionally, the reliance on self-reported data introduces the possibility of social desirability bias, as participants might shape their responses based on perceived expectations. The cross-sectional design offers a snapshot, but a longitudinal perspective could enhance understanding of changes over time. Furthermore, the study primarily explores industry perspectives, potentially overlooking broader societal impacts. Reflecting on the research process, the researchers' own biases and perspectives may have influenced interpretation, highlighting the importance of transparency in conveying the study's context. Despite these limitations, the synthesis of participant insights and existing literature provides a nuanced understanding of the multifaceted impact of 4IR on role evolution in the warehousing sector, emphasizing the complexities and opportunities introduced by 4IR technologies. The themes collectively emphasize the need for strategic planning, education programs, and skills development to navigate the evolving job landscape, acknowledging the challenges while recognizing positive outcomes for a more dynamic and efficient workforce in the era of the Fourth Industrial Revolution.

5.3 Future Research Directions

The comprehensive exploration of 4IR skills readiness in the South African warehousing sector opens avenues for future research to further enhance our understanding and guide practical implementations. Firstly, a longitudinal study could provide insights into the evolving dynamics of 4IR impact on role evolution, offering a more nuanced understanding of long-term trends and adaptations within the sector. Additionally, a comparative analysis across diverse industries could uncover sector-specific nuances and variations in the adoption of 4IR technologies and corresponding skill requirements. Exploring the effectiveness of specific upskilling programs and initiatives, along with the measurement of their long-term impact on workforce readiness, would contribute practical insights for policymakers and industry stakeholders. Further research on the role of regulatory frameworks and government policies in shaping successful 4IR strategies could shed light on the facilitators and barriers to implementation. Lastly, investigating the broader societal implications and ethical considerations surrounding 4IR technologies within the warehousing sector could provide a holistic perspective, addressing potential challenges and fostering responsible technological integration. Overall, these future research directions aim to contribute to the ongoing discourse on preparing workforces for the challenges and opportunities presented by the Fourth Industrial Revolution.

5.4 Conclusion

In conclusion, this study has delved into the intricacies of 4IR skills readiness in the South African warehousing sector, addressing three pivotal research questions. The examination of the impact of 4IR on role evolution unveiled a nuanced narrative, emphasizing concerns about diminishing demand for unskilled labor while recognizing the transformative potential of job evolution and human-machine collaboration. This underscores the importance of strategic workforce planning and proactive upskilling and reskilling initiatives to navigate the dynamic changes introduced by 4IR. The investigation into the specific skills and knowledge required for effective 4IR technology adoption revealed a demand for transversal skills such as problem-solving, digital literacy, programming, and data analytics. The identified challenges, including resistance to change and skill gaps, underscore the necessity for a holistic approach involving collaboration, government policies, and change management. The exploration of 4IR training programs highlighted the lack of formalized upskilling strategies, the desire for collaboration and partnerships, and an awareness gap.

The recommendations put forth emphasize the need for tailored programs, collaboration, change management, and continuous learning culture. The key constructs emerging from the study, including Skill Development Initiatives, Perceptions of 4IR Readiness, Barriers and Challenges, and Opportunities and Enablers, provide a comprehensive framework for understanding and addressing the current state of 4IR readiness in the South African warehousing sector. The proposed Technology Skills Development Framework for the South African warehousing sector strategically addresses the need for accessible 4IR programs, collaborative partnerships, and a revamped education system. It emphasizes continuous learning, change management, and industry-specific initiatives, offering a tailored roadmap to navigate the complexities of the Fourth Industrial Revolution in the sector in essence, this study contributes valuable insights and recommendations, laying the groundwork for further research and actionable strategies to navigate the evolving landscape of the Fourth Industrial Revolution in the warehousing sector.

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Appendices

Appendix 1: Interview Guide

1. Introduction and Background Information:	**Responses:**
i. Begin the interview by introducing yourself and the purpose of the research goal. ii. Ask the interviewee to provide their name, job title, and a brief explanation of their experience and role in the warehousing sector.	
2. Understanding the Impact of 4IR on Skills i. What's your understating of 4IR in the context of the warehousing sector. ii. What, in your opinion, are the key technological advancements linked with 4IR that are relevant to the warehouse sector? iii. How do you think 4IR technologies and improvements are influencing warehouse skill requirements?	

3. Current Skills Landscape i. What specific skills do you feel necessary in your organisation for successfully adopting and implementing 4IR technologies in the warehouse sector? ii. Are these skills currently present within the workforce? If not, what are the main skill gaps or challenges faced? iii. How would you rate the overall skills readiness of the warehousing sector in South Africa in terms of adapting to 4IR technologies?	
4. Skills Development and Training Programs i. What efforts or strategies does your company have in place to help employees learn the skills required for 4IR preparedness in the warehousing sector? ii. Can you share any examples of successful skill development programs or training initiatives implemented to prepare the workforce for 4IR technologies in warehousing? iii. Are there any partnerships or collaborations with other stakeholders (e.g., educational institutions, industry	

associations) to address skills gaps related to 4IR readiness in the warehousing sector?	
5. Challenges and Recommendations i. What are the biggest challenges or barriers you anticipate in developing and maintaining the skills required for 4IR preparedness in the warehouse sector? ii. What recommendations would you make based on your experience and insight to improve the warehouse sector's 4IR readiness in terms of skills? iii. Are there any specific future skill requirements or trends that the warehousing sector should anticipate in relation to 4IR technologies	
6. Conclusion i. Is there any additional information or insights you would like to share regarding the 4IR readiness of the warehousing sector from a skills perspective? ii. Thank the interviewee for their time and contribution to the research.	

Appendix 2: Participant Information Sheet

4IR Digital Skill Readiness in the South African Warehouse Sector

Dear Participant.

My name is Lavhelesani Michael Mukhwa. I am a Master's in Business Administration Student at the University of the Witwatersrand, Johannesburg. My supervisor is Dr. Thubelihle Ndlela. As part of my master's degree, I am conducting a research study about the South African Warehousing sector's readiness for 4IR implementation from a digital skills perspective through stakeholder insights. The study title is 4IR Digital Skill Readiness in the South African Warehouse Sector.

I'd like to invite you to participate in a semi-structured interview. If you opt to participate, your time in this research project will range from 45 minutes to an hour. The interview will take place online on Teams or on your company's premises at a time and date convenient for you.

With your permission, I would like to audio the interview. This Audio recording will be transcribed and stored safely in the researcher's password-protected computer with a password-protected file for five years and/or deleted after five years.

Only the researcher will have access to the data. During the research activity, I will need to ask for some personal information about you, including your name, job title, and a brief explanation of your experience and role in the warehousing sector.

The interview will be confidential and anonymous. When I share the results of the research study, I will not include your name or anything else that could identify you. With your permission, other researchers may use the data collected from this research study, but your name and any personal information will not be used or passed on.

If you decide to take part in the research study, it should be because you want to volunteer. You do not have to take part. You can stop being in the study at any time. You do not have to answer any questions if you do not want to. If you agree to participate in the research study, you will not receive any direct advantages. If you choose not to join, you will not lose any services, advantages, or privileges that you would normally enjoy. It will not cost you anything to

participate in the research study. You will not be compensated for your participation in this research study.

This research study will be written up as a research report. The report will be available on the university library website. If you would like to receive a summary of this report, I will be happy to send it to you.

If you have any questions during or afterwards about this research study, feel free to contact me or my supervisor at the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical) telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Yours sincerely,

Lavhelesani Michael Mukhwa

Researcher:

Lavhelesani Michael Mukhwa ,2454478@students.wits.ac.za, 0726329148

Supervisor:

Thubelihle Ndlela, thubelihle.ndlela@wits.ac.za, 0722063071

Appendix 3: Consent Form Sample

4IR Digital Skills Readiness in the South African Warehouse Sector

Name of researcher: Lavhelesani Michael Mukhwa

Name of the organization: xxxx Title: xxxxxx

I, xxxxxxxxx, agree to participate in this research study.

I agree to the following:

(Please circle the relevant options below)

The research study was explained to me. I understand the purpose of this research.	(YES) NO
I understand that I am taking part in this study on voluntary basis.	(YES) NO
I agree that the interview will be audio recorded	(YES) NO
I agree that the researcher may use direct quotes from my interview in their research report.	(YES) NO
I agree that my participation will be kept anonymous (the researcher will not use my name or any other identifiable information in their research report).	(YES) NO
I accept that other researchers may utilise the information I offer in my interview (if they have their own ethics clearance), but my identity and any personal information will not be used or disclosed.	(YES) NO
No proprietary information will be shared in the interview	(YES) NO

Name of Participant ……..……

Signature ……..…..…

Lavhelesani Michael Mukhwa ……

Signature ……..…

Appendix 4: Permission Letter Sample

CATERPILLAR®

Caterpillar (Africa) Pty Ltd
Johannesburg Distribution Centre

Subsidiary of Caterpillar
SARL Switzerland
Co. Reg. No. 1962/002063/07

7A Lindsay Street, Witfontein, 1620
P.O. Box 197, Isando, 1620
Telephone: +27 (0) 11 961 5000

19 September 2023

From: Kavilan Moodley
Caterpillar Africa Pty Ltd
7A Lindsay Road
Witfontein
1632

To whom it may concern

SUBJECT: PERMISSION TO CONDUCT ACADEMIC RESEARCH INTERVIEWS AT CATERPILLAR AFRICA Pty Ltd

This letter serves to confirm that Lavhelesani Michael Mukhwa has been given permission to conduct academic research interviews Caterpillar Africa Pty Ltd, for them to fulfil the requirements of their master's in business administration degree (MBA) at the WITS Business School.

The research will entail collecting data through interviews with 1x Manager and 3x first line managers/Supervisors.

The following condition will apply:

- Permission is granted for the interview with the relevant employees.
- Caterpillar Africa Pty Ltd may not be named as the research site, the organisation will be referred as a "large warehousing organisation "
- All interviews are entirely voluntary.

Regards

Kavilan Moodley

Human Resource Manager

T: 082 889 5333

E: Moodley_kavilian@cat.com

Signature :