# THE FOURTH INDUSTRIAL REVOLUTION AND THE FUTURE OF JOBS:

# PROBLEMS AND PROSPECTS IN THE SOUTH AFRICAN AUTOMOTIVE INDUSTRY


By

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# DECLARATION

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Exact wording of the title of the dissertation as appearing on the electronic copy submitted for examination:

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I declare that the above dissertation was conducted by me in its entirety, independently and it is my own work and that all sources that I have used or quoted have been indicated and acknowledged by means of complete references and that this study has never been submitted to any academic institution for examination whatsoever. I further declare that I submitted the dissertation to originality checking software and that it falls within the accepted requirements for originality.

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

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SIGNATURE DATE: 22 November 2022

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# ABSTRACT

This study investigated the impact of 4IR technologies on automotive industry workers, focusing on job changes in VW, BMW, Lear Corporation, and Schnellecke, the identification of organisational problems faced by workers, 4IR technology affecting employment conditions and examining worker-specific problems within the context of automotive industry original equipment manufacturer (OEMs) and suppliers. The implementation of new technologies, brought about by the fourth industrial revolution, caused many companies in the automotive industry to digitise their production processes and increase technological changes, as we have seen by the number of industrial robots being demanded by the industry and the implementation of new technology. This transition is impacting the nature and context of work for workers employed in the (OEMs) and supplier companies, as a result of its implementation in production plants and supplier companies.

This study took a qualitative form of approach and used interviews to probe the implementation of the 4IR strategies in the automotive industry. Using qualitative interviews, it is thus noticed that the problems in the implementation of 4IR strategies, like the introduction of new machinery that replaces certain manual tasks, have adverse effects on workers, such as work repositioning, natural attrition and job losses, even though the aim of the implementation of the new technology was to increase speed and profitability of the industry, as well as to make workers' jobs easier with the prospects of eliminating harmful, strenuous and complex tasks from the body shop, paint shop and the assembly line and by creating opportunities for workers to use assistance systems to make work tasks easier and safer.

The study revealed that workers are faced with various problems of work reorganisation, short time, skills deficits, as well as health and safety problems, as a result of the implementation of the technology at automotive plants and supplier companies. This study further revealed, when evaluated, that there is an aspect of skilling and reskilling deficit for workers and suggests a model for implementation as an opportunity for workers to reskill themselves for their current and potential future job opportunities.

**Key Terms:**

Fourth industrial revolution; automation; original equipment manufacturers; supplier companies; digitisation; skills; electric vehicles

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| 4IR | The Fourth Industrial Revolution |
| AAAM | African Association of Automotive Manufacturers |
| AfCFTA | African Continental Free Trade Area |
| AI | Artificial intelligence |
| APDP | Automotive Production Development Programme |
| ASCCI | Automotive Supply Chain Competitiveness Initiative |
| BMW | Bayerische Motoren Werke |
| CPI | Consumer Price Index |
| CISL | Italian Confederation of Workers Trade Unions |
| CPIX | The Consumer Price Index |
| DTIC | The Department of Trade, Industry and Competition |
| ESOPS | Employee share ownership plan |
| EV | Electric vehicle |
| FCEV | Fuel cell electric vehicle |
| FDI | Foreign Direct Investment |
| GDP | Gross Domestic Product |
| GFA | Global Framework agreements |
| GVC | Global value chain |
| IDC | Industrial Development Corporation |
| IOT | The Internet of Things |
| IT | Information Technology |

| | |
|---|---|
| MNC | Multinational Corporation |
| NAACAM | National Association of Automotive Component and Allied Manufacturers |
| NAAMSA | National Association of Automobile Manufacturers of South Africa |
| NUMSA | National Union of Metalworkers of South Africa |
| OEM | Original Equipment Manufacturer (Vehicle Manufacturer) |
| PWT | Psychological Well-Being Theory |
| SA | South Africa |
| SAAM | South African Automotive Masterplan 2035 |
| SAQA | South African Qualifications Authority |
| SCCT | Self-Career Construction Theory |
| T1 | Tier 1: Suppliers: companies that supply parts or systems directly to Original Equipment Manufacturers (OEMs) |
| T 2 | Tier 2: Suppliers: Firms that supply parts, but not directly to the Original Equipment manufacturers |
| T3 | Tier 3: Suppliers: these are suppliers of raw materials or close to raw material like metal or plastic |
| VW | Volkswagen |
| WTO | World Trade Organisation |
| WSP | Workplace Skills Plan |

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# CHAPTER 1: INTRODUCTION AND BACKGROUND TO THE STUDY

## 1.1 Introduction and Background

This chapter begins by introducing the study, the background, the central question, and the objectives of the study, focusing on understanding the impact of technology on workers' jobs. The study highlights the objectives, rationale, and relevance of the study in addressing gaps in existing literature, particularly regarding the impact of technological transformation on workers in original equipment manufacturers (OEMs) and supplier companies Bayerische Motoren Werke (BMW) and Volkswagen (VW) and parts supplier companies (Lear Corporation and Schnellecke). This chapter offers insights into the continuous technical changes occurring within production plants at the chosen (OEMs) and supplier companies. By engaging in this practice, it facilitates the development of a thorough understanding of the subsequent chapters within the dissertation. Furthermore, this study situates itself within the economic environment of South Africa, emphasising the potential ramifications of digitalisation on the labour force. The understanding of the automobile industry's importance in the South African economy and its significant contribution to the country's gross domestic product (GDP) relies heavily on contextualisation.

The South African Automotive Industry is currently undertaking a number of technological changes and processes brought about by the fourth industrial revolution and previous industrial revolutions and this is evidenced by the South African Government recognising 4IR in the automotive sector and preparing for this revolution in its policy interventions to improve industrial development, as seen in the industrial policy action plan, as well as the South African automotive masterplan 2035 ( Bayode, van der Poll & Ramphal, 2019: 18-19).

Digital technologies are transforming the automotive industry production line where vehicles are being manufactured by means of automation processes and therefore reshaping conventional production and business models based on these new processes that are changing the way workers' jobs are currently being implemented at the various automotive companies in the respective departments (Athanasopoulou, de Reuver, Nikou, & Bouwman, 2019:73-83). Based on studies from a human capital point of view, analysis of previous phases of industrial revolutions, researchers have built an argument in support of the 4IR and its possible impacts whilst other studies have a contrary view. These views bring to light, that as different technologies emerged in the previous phases of the industrial revolution, the workplace as we know it, as well as the nature of work, the skills requirements in those previous revolutions have transitioned, based on the new fourth industrial revolution segments (Taiwo & Vezi-Magigaba, 2021:86-96).

This study is entitled *The Fourth Industrial Revolution and the future of Jobs: Problems and prospects in the South African Automotive Industry*

It was also observed by Industry week (2007) that sometimes, when workers are given new tasks due to technological innovation, they are unable to perform these, due to a lack of skills or the speed required to perform these tasks, as machines produce at an increased speed and double the work speed of manual labour, which puts extra pressure on workers, especially on workers based at the assembly lines at the automotive plants to increase labour and output, quickly hence adding to the problems of occupational health and safety issues for the worker.

If this pace is not adhered to, the worker is sometimes demoted as a result of "not performing", and this affects their employment grade and this also sometimes leads to work pressure that results in the workers quitting their jobs due to volume demands by OEMs, natural attrition by not employing replacement workers when a worker leaves the company for various reasons or retires, this in turn, affects workers' job satisfaction, which subjects the worker to additional pressure which often leads to resignations and consequently, unemployment Industry week (2007). According to (Chesters 2014: 755-769), this now "former worker", is then termed unskilled due to no formal qualification to re-enter the job market, as new job requirements and educational qualifications will have new specifications that the workers do not have, due to the skills challenge and deficit, ultimately this affects company profits and workers' bargaining power which has a domino effect on the entire South African socio-economic context.

There is a potential impact for workers, and various (OEMs) in the automotive industry value chain that are being affected by such changes. Since the automotive industry has various tiers that supply the OEMs, any changes in technology are felt throughout the value chain of the industry, including up to the level of the logistics sector of delivery of parts. As part of the fourth industrial revolution concept in itself, the elements of digitalisation, automation and mechanisation are used interchangeably, hence all three concepts are part of 4IR.

The use of new technologies in the OEMs and supplier companies also mean that workers face varied problems and new requirements stemming from these technologies. Some of these problems for workers include short-time shifts, which equate to lower pay (NUMSA, 2019). The declining employment statistics in the South African automotive industry indicate that automation is indeed impacting workers' jobs and position roles and responsibilities, as is evident from the increase in the number of retrenchments, as described in the various reports and media statements in 2020 and 2021 (NUMSA, 2019). This is further adding to the crisis of unemployment and inequality in the country (NUMSA Research Institute, 2019). Therefore, central to this study is answering the research question of how have workers' jobs in the automotive industry, specifically in OEMs and supplier companies (Lear Corporation and Schnellecke) been impacted by the implementation of the 4IR technological changes introduced at the South African automotive plants?

## 1.2 Problem statement

This study is premised on the problem under investigation and that is to identify how the introduction and implementation of 4IR technologies on workers' jobs in the production plants in OEMs and supplier companies are impacting them. Workers employed in the OEMs and supplier companies identified in this study are subjected to technological changes being implemented, in the form of the digitisation (4IR) that is currently taking place in South Africa broadly, and specifically in the automotive industry at an accelerated rate. This is potentially having both positive and negative effects on workers and their jobs, skills levels and working conditions (McKinsey, 2017:1-8). Currently, there are various changes taking place in the production plants at the two OEMs, as well as supplier companies, which are changing the nature, the job specifications, criteria, as well as job roles and responsibilities of workers employed at the above OEMs and supplier companies. The source of these problems, according to (Accenture, 2022:3) , is that various forms of new technology and innovation designs in the production plant processes have caused unilateral changes to the way workers currently perform their job functions resulting in workers being put on temporary leave. This comes in the shape of the kinds of tasks that workers used to operate, the type of methods of operation they used to adopt, as well as the kinds of skills they used to perform a particular work task, which are all changing, and, according to workers in these plants, these are primarily due to the change in work operations that have been implemented, both locally and globally, as a result of the new technologies, since all OEMs and supplier companies operate on a single mandate, specifically supplier companies Lear corporation and Schnellecke, in that changes and standards are implemented through the entire automotive value chain, both locally and internationally.

Studies done by Bormann, Fink, and Holzapfel (2018), reiterate changes in salary and wage structures due to work reorganisation adjustments at the production plants, health and safety concerns brought about due to the accelerated speed of the implemented robotics, as well as the extra workload due to work tasks not being replaced by actual workers due to the natural attrition approach by the companies to replace the work previously done by workers, now undertaken by robotics and automated systems of innovation. The problem under investigation in this study is how the introduction and implementation of 4IR technologies are impacting workers' jobs in the production plants in OEMs and supplier companies.

## 1.3 Research Questions

To arrive at certainty regarding the impact on workers' jobs by the implementation of 4IR technologies in the selected OEMs and supplier companies, this study sought to find answers to the following research questions:

i. How do new 4IR technologies impact job roles and responsibilities within the automotive industry, specifically at OEMs, and supplier companies?
ii. What are the specific organisational problems faced by workers during the implementation of 4IR technologies at OEMs and supplier companies?
iii. Why and in what ways do 4IR technologies lead to work changes in the automotive industry?

## 1.4 Research Aim and objectives of this study

To realise the goal of the research question of this study, the following theoretical and empirical objectives were addressed:

i. to explain how new 4IR technologies are impacting workers' jobs by means of actual job changes in the automotive industry, specifically in the two OEMs, as well as the two supplier companies.
ii. to analyse the worker organisational problems being experienced by the implementation of 4IR technologies at the respective OEMs and supplier companies that are affecting workers' conditions of employment.
iii. To identify in what ways and why do 4IR technologies lead to work changes in the automotive industry, and how do these changes manifest as "worker-specific problems" within the context of OEMs and supplier companies.

## 1.5 Significance of the study

This study contributes both to the theory and practice of the Development studies discipline. Since it is the reality that 4IR technology is a recent knowledge factor in the field of development practice, this study also contributes to the multi-disciplinary knowledge in Development Studies, Business Management and Business Technology, as well as Human Resources. Those in Business Management are likely to understand the impact of robotics on employment and the change in supply and demand. Those in the field of Human Resources are likely to learn how to deal with labour matters during the introduction of new technologies in the work environment. This research impacts future research in that workers in industries may use the research as a best practice or guideline in mitigating the impact of technology on the future of work. The study will play a significant role in academic and scholarly research.

## 1.6 Scope and delimitation of the study

The scope of the study focus was on workers in the automotive industry because this industry has been transitioning at a larger scale through technological changes. As seen in the various sector demands for industrial robots the International Federation of Robotics depicted the automotive industry as the industry with the highest demand level for industrial robots. Hence, the study scope focuses on workers employed at the two OEMs and supplier companies (Lear Corporation and Schnellecke) as the target population to the extent of showing how changes in the production process have caused job changes in terms of workers' conditions and specification changes during the duration of the research study. The study does not address the technological problems by workers in other OEMs and supplier companies, as production processes in each company varies accordingly. The findings of the study therefore cannot be used to generalise the impact of technology on other OEMs.

## 1.7 Definition of key concepts

This chapter defines the key concepts used in this study in the context of the study and the subject matter of the research.

**Fourth Industrial Revolution**: According to Hoque (2019:1) the term refers to "the unfolding age of digitalization from the digitally connected products and services, to advancements in smart cities and factories and increasingly common automation of tasks and services in homes and at work."

**Automation**: The concept automation in the context of Industry 4.0 can be identified as a group of technologies that are permitted to carry out machine functions and operations within systems, in the absence of crucial human involvement (Papulová, Gažová, & Šufliarský, 2022)

**Original Equipment Manufacturer**: The concept can be defined as Original Equipment Manufacturer. In essence, an OEM is any company that manufactures a system or part that is utilised in other companies' items or products respectively (Economic Times, 2023)

**Supplier companies**: According to Bailey, (2004:6-8), in an automotive industry, there are different TIER suppliers that deliver to OEMs. Tier 1 Supplier: Companies that supply OEMs with components and semi-manufactured goods and Tier 2 supplier companies that supply tier one suppliers which are those that supply directly to OEMs and lastly, the Tier 3 supplier companies that supply parts and sub-components to Tier 2

**Digitalisation**: The term "digitalisation" as defined by Schumacher, Sihn, Erol. (2016:1-5) as "the adoption or increase in use of digital or computer technology by an organization, industry, country"

**Electric vehicles** (EV): Electric vehicles (EVs) according to Wu, Freese, Cabrera, and Kitch, (2015: 52-67) include both plug-in hybrid (PHEVs) and battery-powered electric vehicles (BEVs). PHEVs usually have a moderately sized energy storage system and an internal combustion engine to ensure most miles are electrified while retaining the range capability of today's internal combustion engines (ICE) vehicles. BEVs are entirely battery dependent and provide complete petroleum displacement for certain vehicle sectors.

## 1.8 Structure of Dissertation

This dissertation is made up of five chapters as detailed below:

**Chapter 1: Introduction and background to the study**

Chapter 1 sets the scene of technological changes implemented in the production plants at the OEMs and supplier companies under study and provides a foundation for understanding and context as well; further, it introduces the dissertation, problem statement, research questions, research aims and objectives, the significance of the study, research scope and delimitations, definitions of key concepts and the chapter summary.

**Chapter 2: Literature review**

The literature review of this study presents an overview of research that has been done in the past but in the context of how previous industrial revolutions have impacted work and how new forms of technologies, as part of the 4IR technological transitions, have put jobs at possible risk, by reshaping the production process as well as the new skills requirements for the new forms of jobs. It also describes the theoretical framework of the research. Further, the literature review is organised, based on the objectives of the study and discusses various technological innovations and problems in the automotive industry, the individual technological changes and problems at specific OEMs and supplier companies and the dimensions of variables, such as the previous impact of technology on jobs and skills as well as what models of transformations look like.

**Chapter 3: Research Methodology and Design**

This chapter discusses the research methodology that was used to carry out the research study. The research design, research population and sampling, data gathering procedure and methods, data analysis strategy, including the reliability and validity, ethical considerations adopted for the research, are discussed in this chapter and lastly, the summary.

**Chapter 4: Research Findings and Discussions**

This chapter consists of three sections detailing the findings. The first section articulates the details of the impact on job roles and responsibilities that include, actual job changes experienced by workers as a result of new technology being introduced at their respective companies, noting work changes before and after the introduction of the new technologies as are seen in the relevant figures presented from findings at each OEM and supplier company, as well as the skills development landscape and current and future skills development requirements, as well as worker problems in achieving skilling and reskilling for the future forms of work. The second section, consists of worker-specific organisational problems and the third section, deals with work changes in the automotive industry. The research then returns to the research question and discusses the results extensively while relating them to the proposed conceptual model.

**Chapter 5: Conclusion, contributions and recommendation**

This chapter brings the dissertation outcomes to a close in this chapter with the conclusion, contributions and the recommendations of the research study. Ultimately, the areas of future research arising from this study are also briefly identified to create opportunities for workers in the future world of work.

## 1.9 Chapter Summary

This chapter contextualised the study by specifying specific research questions driving the study. The chapter then gives a background to the research problem and rationale for the study. It further explains the research aims and objectives, the significance of the study, the scope and delimitation of the study, key concepts and the structure of the dissertation. This next chapter provides an overview of, and provides a foundation for, the rest of the thesis.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Introduction

The previous chapter concentrated on the introduction to this study. This chapter present the theoretical framework and the literature review that explains the various technologies that (OEMs) and supplier companies have deployed at the factories under study. Further, the chapter presents the Global and the South African impact of the fourth industrial revolution. Additionally, it explores the problems that these technological changes present to the job functions of the workers, as described in the problems impacting workers in the various companies. The chapter offers a succinct overview of the conceptualised digitalisation models for the automobile sector. The identification of gaps in the current literature and insights is crucial in academic research. This literature review aims to provide historical insight into the automotive industry, its structure, and operations. It focuses on understanding how technological changes brought about by the Fourth Industrial Revolution (4IR) have impacted workers' jobs in the automotive industry and specific OEMs and supplier companies. It also discusses the theoretical and conceptual framework that guides the research in examining the impact of technology on jobs in the past. In addition, it explores innovation and its impact on jobs with industrial revolution technologies, as well as how jobs are being automated by digital work.

## 2.2 The global automotive industry and economic outlook

In understanding the local automobile industry, it is important to understand the global automotive industry that forms the base in which local markets operate. The global automotive industry manufactures approximately 60 million cars and trucks per annum, as well as being accountable for approximately half of the world’s oil consumption, employing approximately four million people in direct employment and more in indirect jobs Industry Week (2007). The automotive industry is one of the most global of all industries, with its products spread around the world, dominated by small companies enjoying worldwide recognition (Barnes & Morris 2008:32).

The global automotive industry, from the viewpoint of (Cassia and Ferrazzi 2018:3), is an origin of technological and managerial transformation, perceiving vehicles as not just a means of transportation but rather a means of status and privilege. Unlike other manufacturing industries, the automotive industry is seen as much more than vehicle manufacturing of passenger cars, and light commercial and heavy-duty vehicles. Rather it is seen as a driver of industrial development in several countries and a source of technological improvements and innovation with a major role in the economy. The local automotive industry, based on its revenue size, as described by the national association of automobile manufacturers of South Africa (NAAMSA) automotive dashboard data (2022), showed that the export value of vehicles and automotive components increased by R19, 8 billion, or 9, 5%, from the R207, 5 billion in 2021 to a record R227, 3 billion in 2022, comprising 12, 4% of total South African exports (NAAMSA, 2022). According to McKinsey (2013), the industry is also one that has seen constant change from role players to industry standards, demands, customisation from niche markets and technological as well as environmental regulation pressure, to conform to gas emission regulations and standards, as set out by the industry players and government regulations.

Based on the transformative changes in the automotive industry, it is dividing the industry into major vehicle segments based on the highest prices and margins that occupy the market, with problems of digital demands and a constantly shifting industry landscape with changing demands as the current status quo in the industry. Vehicle production does not only encompass the industry but consists of components to assemble the vehicle as well, which cuts across value chains supporting at least five other jobs in the supply chain, according to McKinsey (2016), therefore affecting the economy both directly and indirectly. The automotive industry is described as being the pioneer of Industry 4.0, organising the production process by technological devices communicating autonomously along the value chain. Industry 4.0 is described as “the result of a series of disruptive innovations in production processes” (McKinsey, 2013). The literature points out that vehicle manufacturers are expected to gain the most from industry 4.0 by increasing their manufacturing processes and production capabilities with increased productivity. The automotive industry is faced with environmental pressure to reduce their carbon footprint, but evolving into a greener way of production is expensive to the manufacturers in the industry and with the help of advanced technologies, manufacturers are said to be trying to save on labour cost, to increase their profit margin at the cost of labour, as shown, hence the “disruptive impacts of industry 4.0 for workers and their jobs”.

The following section looks at the developments in the automotive industry, trends in the automotive industry, and different types of technological advancements in the automotive industry, technological changes in the various OEMs and supplier companies, the (OEM), Bayerische Motoren Werke (BMW) globally, the South African Automotive Industry, Bayerische Motoren Werke ( BMW) South Africa, contextualising the South African economy and digitalisation's potential impact on workers and lastly, technology and jobs in the fourth industrial revolution.

### *2.2.1 Developments in the automotive industry*

In recent years, labour-saving technologies, along with globalisation, have decreased jobs in manufacturing, especially in advanced countries, such as Germany (Rothman, 2013). Numerous studies envisage major job losses due to automation (Frey & Osborne, 2013), and that almost half of United States (US) workers could face the risk of their jobs being automated by 2030. Developing countries, and South Africa in particular, are not immune to this trend either, as multinational companies in the automotive industry, such as those OEMs used in this case study as part of this research and supplier companies that determine the operating conditions in South Africa and other countries. As a result, some of these conditions are contained in global framework agreements (GFA) (2018), and countries have to adhere to such conditions, as stipulated in the signed agreement.

In the book by authors, (Comacchio, Volpato, & Camuffo, 2012: 104-107), titled " Automation in automotive industries" that bases the discussions on automation, manufacturing organisation and management of workers, the author is of the view that the key drivers of the technological and organisational change is the diffusion of the "lean management systems".

As a result of rapid automation in manufacturing, particularly in the automotive industry, as implemented in high-income countries, there will be less demand for manual work requiring workers, who are semi or unskilled and those who are employed in these emerging markets (Pardi, Krywdzinski, & Luethje, 2019). As seen in the employment figures projected in sustainability reports and financials globally in the (OEMs) and supplier companies, these companies show a decline in employment numbers from 2017 to 2020. Further, this is supported by the figures presented by the (International Federation of Robotics, 2020), which show the automotive industry as having the largest demand for industrial robots. This is mainly due to automotive production plants automating the processes in the production line and a change in the OEMSs and supplier companies' business models.

According to the World Economic Forum (2020), it is estimated that by 2025, 85 million jobs may be replaced by a change in the division of labour between manual work and machines, while 97 million new roles may emerge that are more modified to the new division of labour between manual labour, machines and formulas, across 15 industries and 26 economies (WEF, 2020). Currently, on the shop floor in the OEMs, as well as the supplier companies, changes experienced by workers in the above include change of job roles, for example, from assembling parts on the production assembly line to more administrative and analytical tasks, such as monitoring and reporting production using a tablet to analyse production in "real-time", remotely. Often older workers and unskilled workers initially in assembly job roles are unable, or find it challenging, to undertake the new roles assigned to them, especially as Information Technology skills are required for operating new technology, as per interviews done with workers in the companies under research.

Current competition in the global automotive market is also forcing car manufactures to reinvent and realign their growth strategy for manufacturing to remain competitive (PricewaterhouseCooper, 2017). Companies are required to manufacture a variety of new car models for an ever-changing niche market at the lowest possible cost (Auto Beat, 2008). With this strategy in mind, the view in the automotive industry is that manufacturing systems would have to evolve to accommodate economically viable product variations as well as current climate change regulations. It is therefore important to look at the various aspects of the automotive industry value chains, business models, production flows, and worker roles and responsibilities to show the impact of mechanisation on workers and the future of work in its current state of transition.

### *2.2.2 Trends in the automotive industry*

The paper by Sturgeon, Memedovic, Van Biesebroeck and Gereffi (2009: 1-2) identifies important trends in the automotive industry which includes a boom in developing country sales and production. The paper highlights how global, regional, national and local value chains are nested to create a pattern of global integration. It contributes to this study in that it shows the trends in the industry, specifically the increase in production with the use of industrial robots.

The International Federation of Robotics (IFR) (2020) clarified that the automotive industry is the most important client in terms of its purchases of industrial robots, with about 28% of all installations taking place in the industry with a peak of 125,581 units in 2018. From 2014 to 2019, there was an annual increase in industrial robots of 2% (CAGR); this resulted from car manufacturers restructuring their business models due to the economic crisis experienced in 2008/2009 but declined in 2019 by 5.2% as vehicle production transitioned from combustion engines to electric vehicles (EVs). From 2014 to 2019, annual installations in the automotive industry increased by 2% on average each year (CAGR). After the economic crisis in 2008/2009, car manufacturers started to restructure their businesses. Since 2010, investments in new production capacities in emerging markets and investments in production modernisation in major car-producing countries have driven the demand for robots. Figure 2.1 shows the upward trend of the installation of industrial robots year-on-year in the automotive Industry.

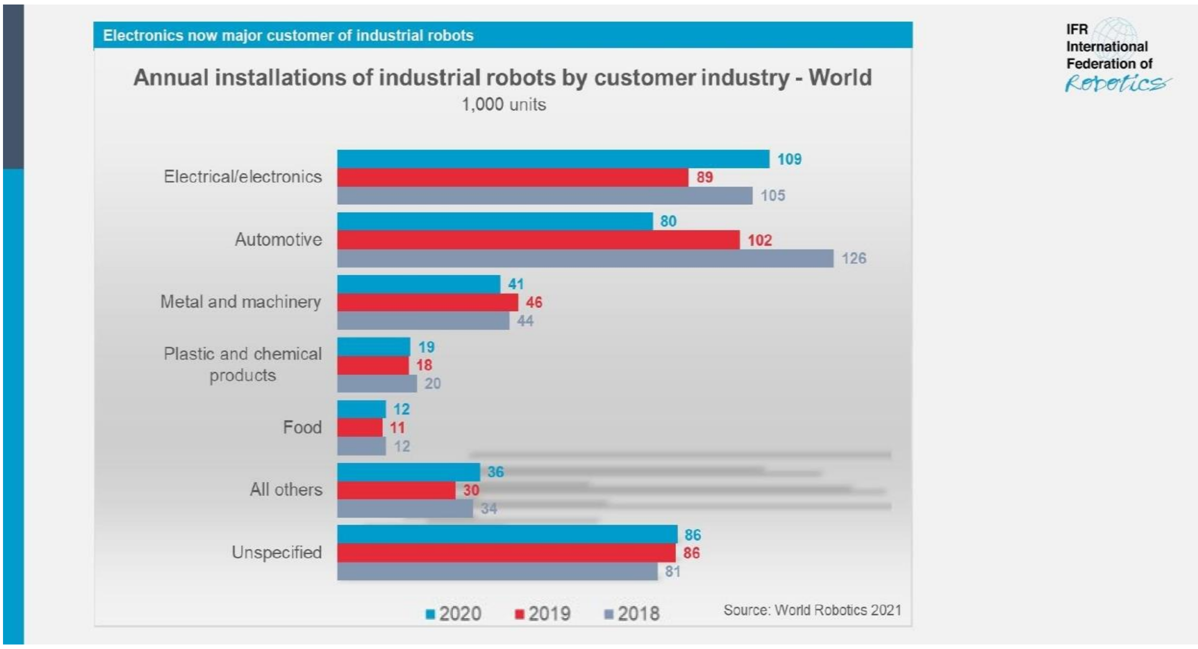


**Figure 2.1: Installers of Industrial Robots**

Source: IFR (2021)

Trends in the automotive Industry consist of battery technology as the most important enabling component in the manufacture of electric vehicles (EVs), which is powered by the major mineral component of lithium. The trends from the automotive industry transformation from combustion engines to electric vehicles are due to the move to the low carbon economy and reduced carbon dioxide (Co2) emissions that negatively affect the environment in the form of climate change, as well as other environmental changes, that include land and sea animals.

The largest trend impacting the automotive industry is the transformation of vehicle production processes with digitalisation and automation at the centre of the change, seeing man and machine collaboration, recently referred to as Industry 4.0. Figure: 2.2 is a graphic representation of the new and progressing trends in the global automotive industry.


**Figure 2.2: Trends in the Automotive Industry**

Source: VW (2021)

Further, the automotive industry consists of various automotive clusters, shown diagrammatically in Figure 2.3 (NAAMSA, 2021). The various clusters are strategically placed, regionally in the country and consist of global and regional value chains, both upstream and downstream.

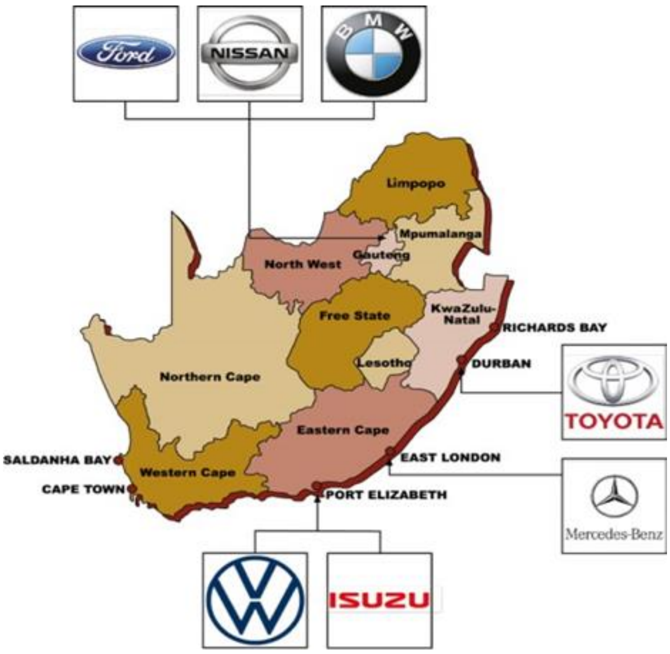


**Figure 2.3: Automotive clusters in South Africa**

Source: Mahomedy (2021).

### *2.2.3 Types of technological advancements in the automotive industry*

Sierzchula, et al. (2012:211-220) examines the technological diversities due to innovation in the automotive industry and further explains that the automotive industry has a high level of uncertainty because of its transitioning to electric vehicles as the dominant design and the results of the study, based on the data, showed an increase in technological diversity and that automotive manufactures are continuing to use technology and it also examines how institutions can support the transition toward more sustainable automobile transitions. This study builds on this knowledge of how the industry is transitioning technologically and using sustainability measures to mitigate problems.

One of the (OEMs), as part of this study, BMW, is working with additive manufacturers with the dissemination of the technology further, using aspects of the technology such as virtual reality (VR) and augmented reality (AR), where machines communicate with each other and their human operators, as a resource in addressing problems experienced in the manufacturing process. This often happens in real-time. New three-dimensional printing (3D) is being introduced to the automotive industry, called HP Metal Jet, which is intended for the production of steel parts, which is intended for use in Volkswagen, for the production of electric vehicles (VW, 2021:1) .

Since the transition and pressure from the World Trade Organisation, the automotive industry has been transitioning in the production of vehicles using combustion engines to a greener and environmentally friendlier approach to reduce the level of carbon dioxide emissions (Co2), hence the rapid move to the production of electric vehicles (EVs). Battery Electric Vehicles (BEV) comprise the technology to be acquired to minimise the input of vehicles to climate change, however for a constructive approach of BEV technology in the market, a significant shift to green energy generation may be required (Mamalis, Spentzas & Mamali, 2013).

### *2.2.4 The Original Equipment Manufacturers, Bayerische Motoren Werke (BMW) Globally*

BMW, as an original equipment manufacturer, is one of the leading luxury car brands in the world with an estimated revenue in 2020 of 99 billion euros (Carlier, 2021). It is based in Germany and has factories in many different countries, including Brazil, India, South Africa, the United Kingdom, the United States, Mexico, and China. The latter is becoming BMW's most important market with about one-third of vehicle sales in 2020 in China. BMW also operates in a joint venture with the Chinese company, BMW Brilliance Auto.

The OEM is said to represent the global number of BMW Group employees of approximately 120,700 between the fiscal year of 2006 and the fiscal year of 2020 (Carlier, 2021). Based on the current vehicle statistics at (NAAMSA, 2021), the increase in electric vehicle production (from 20 to 30) is a process to replace current combustion engines. The automotive industry is currently undergoing a significant transformation, resulting in various effects and modifications throughout the value chains. Specifically, the automotive value chain within BMW is experiencing shifts in job roles and positions, as well as systematic changes in working hours and salary adjustments. These adjustments are primarily due to a decrease in working hours caused by work stoppages resulting from mechanical breakdowns of robotics in the vehicle production assembly line. The repair of these breakdowns necessitates the expertise of specialists located exclusively in Europe. Consequently, these work stoppages have a ripple effect on the entire company and its workforce.

According to Whitton (2021), BMW Group's IDEAL works (IW) subsidiary's stated goal is for IW to become a leading supplier of autonomous mobile robotics (AMRs) solutions in the logistics sector. BMW has also been in partnership with other stakeholders in the development of mobile robots for internal use in factories for the specific purpose of automated material handling, as well as automated forklifts. Currently, BMW has been using the IW for its production facilities since 2017; this was done in the seat production and with more automation developments of up to eight robots, apart from the automated production and assembly line, and these IW hubs are responsible for running the seat assembly lines in ten-minute cycles with pre-assembled backrests, heads and centre armrests within BMW (Whitton, 2021).

Moreover, Greenfield (2021) reveals that to produce its custom-configured cars faster, BMW Group will be using the robotics platform as part of its factory logistic robots. At BMW, the assembly of vehicles involves the process of handling millions of parts circulating into the factory from more than 4500 supplier sites, as a result, there is a huge volume of configuration that goes into customised vehicles, hence the move towards using four types of material handling robots and a smart transport robot. BMW has the following robots currently operational in its plants: stationary split bots that take full plastic boxes from the pallet in the incoming goods area and place them on a conveyor system that transports the boxes to a warehouse. The split bot also makes sure the containers are lined up correctly for automated storage. BMW's autonomous smart transport robots (STRs) can identify obstacles, such as forklift trucks, as well as humans, to suggest alternative routes more accurately and quickly, as needed, in the BMW facility. Wagner (2021) specifies that the statistics show BMW vehicle sales between 2014 and 2020 as seeing some 28000 units of its electric vehicles sold. This is an indication of the demand for electric vehicles (EVs), as well as the lower manual labour that goes into the production of EVs.

#### *2.2.5 The German Automotive Industry*

The examination of the German automotive industry is important in this study, as the automotive industry's strongest player within the OEMs and supplier companies, is the German automotive industry as multinational corporations whose policy decisions affect the whole automotive value chain, both locally and globally. The German automotive industry, according to Bormann et al. (2018:16), states that the German automotive industry in terms of their mobility trends are transforming into four mobility trends, namely, electric vehicles, new networks new competitors, automation and mobility, as a service and the future paths for the automotive industry. Bormann mentions that the above trends have the potential to overturn the automotive industry but believes that true revolution would have to lie in the combination of the four trends. He further explains that new forms of organisational culture and new forms of employment, as well as the problems in employment, are a result of new technologies but describes as some of the strategies, such as organisational culture, to try and avoid structural distortions and the loss of jobs and skills. This literature is relevant to this study because this study examines and further expands on the problems that Bormann mentions, specifically skills, in a more descriptive manner and in a way that looks at specific OEM and supplier companies and their future development paths.

The German automotive industry, unlike the South African automotive industry, is highly advanced, due to the country's fully developed and prosperous economy. According to Bormann, Fink, and Holzapfel (2018), the future of the German automotive industry is guided by its design, rather than a disaster, with 20th-century models of the industry dissolving and thus putting the industry under pressure, affecting the economy and employment due to its innovation policies and its shift towards electrification and automation. The industry is moving from fossil fuels to renewable, battery and electromotive motors with digital platform ecology and new business models are becoming apparent.

The German automotive industry is Europe's number one automotive market in vehicle production and sales, also consisting of the largest concentration of OEM plants in Europe. The automotive industry employs 820,500 workers, in the 945 OEMs and suppliers' companies with an industry turnover of 423 billion Euros; the automotive industry has high and stable employment figures with innovation playing a key role in the sector, driven by mobility trends in urbanisation (Bormann et al., 2018). The German automotive industry has strong research and development leadership, as well as high investment in the industry, amounting to approximately 22 billion Euros (Germany Trade & Invest 2018).

Technological trends in the industry include sustainable mobility, the development of alternative drive technologies and an environmentally friendly path of carbon emission reduction targets with the unitisation of renewable energy. The automotive supply chain in the industry, according to the Germany Trade and Invest organisation (2018), is constantly changing in terms of its structure and business model, moving to a value creation return approach. The value chain consists of tier 2 and tier 3 suppliers, cutting across all industries with the goal of lightweight technology at the centre of the value chain. According to this literature, digitalisation may have the strongest disruptive and dangerous innovation effects that might cause structural distortions if losses of new forms of co-operation and organisational culture are not sought, endangering 600,000 jobs (Bormann et al., 2018).

The German automotive industry portrays the dynamics of the industry and its intricacy as a major multinational player in the automotive industry, however, in comparison to the South African automotive industry, the lack of investments in research and development as well as skills development, impacts the automotive industry in South Africa, as most workers are semi-skilled or unskilled. The changing structure of business models to a more "value creation approach," driven by technological innovation is moving vehicle production to sites offshore, impacting employment on a large scale with ripples in a socio-economic context in an already fragile economy, such as South Africa. OEMs and supplier companies implementing optimisation strategies have implications, both positive and negative, for workers.

## 2.3 The South African automotive industry

Barnes et al. (2008: 1) made reference in terms of sustainability in the global automotive industry, and ways in which developing economies could learn from South Africa about linking into global automotive value chains. This study builds on the knowledge of the automotive industry sustainability, in that it aims to expand on skills development which is a key element of sustainability of jobs. South Africa is a manufacturer and supplier of high-quality vehicle and automotive components to world markets. This includes the SA (OEMs) that manufacture passenger cars, light, medium, heavy, and extra heavy commercial vehicles, and buses. The top export destinations of these vehicles include the United Kingdom (UK), Germany, Japan, France, and Australia, with total vehicle exports of approximately 271,288 units (NAAMSA, 2021). The automotive sector employment is currently at 76,800 and represents about 460,000 highly skilled, direct jobs in its formal sector supply chain. The new vehicle sales are 380 206 units and the total vehicle production at 447 218 units. The percentage of South Africa's vehicle production as a percentage of Africa's vehicle production is 62, 1% (NAAMSA, 2021). The automotive industry has clusters for socio-economic improvement in geographic groups in Gauteng, KwaZulu-Natal, and the Eastern Cape, seeing a total of 430 automotive component companies. In terms of the South African automotive policy, this has evolved due to interventions from stakeholders who now see it at the level of the automotive master plan consisting of six pillars, which is allocated to the growth of the economy with a focus on six strategic implementation pillars, including local market optimisation, regional market development, localisation, infrastructure development, industry transformation and ultimately, technology and associated skills development (Barnes et al., 2019).

The South African automotive industry is facing a clear set of problems, such as global technology, environments, and competitiveness, together with depressed domestic and regional market conditions (Barnes et al., 2019). According to Koenig (2021), the automotive industry is advancing as one of the most rapid industries toward automation, seeing vehicle manufactures move towards using what they call collaborative robots known to them as "cobots." This new technology in the automotive industry is much smaller in size and can be used in collaboration with manual labour operators. The automotive industry is already, by far, the largest user of industrial robots and continues to see further potential for their use (White, 2021).

The automotive industry is one of the most successful industries among other economic sectors due to its Automotive Production Development Programme (APDP), as shown by increased levels of investment (R7.3 billion), according to the report in the automotive export manual (Lamprecht, 2020). The industry is undergoing various changes due to technological advances and changing business models brought about by new digital technology and the onset of autonomous vehicles and electrification. The shift to new technologies is to reduce costs. This industry has a broad value chain and because of its manufacturing capacity, impacts job creation on a large scale, having upstream and downstream linkages. Evidence from Lamprecht (2020) demonstrates that this sector has an average monthly employment by vehicle manufacturers of 30250 and the component sector contributes 80,000 to automotive sector employment.

### *2.3.1 The South African automotive industry value chain*

According to Tolmay et al. (2015), the automotive industry is one of the most successful industries in South Africa. The industry competes globally and applies practices considered as best practices, particularly those in supply chain management. The industry is characterised by networks of collaborative relationships on different levels which includes the relationship of the OEM with the supplier companies. These value chain relationships, as described, narrate the issues as described in this study, as the value chains and its relevance in this study is expanded by showing job impacts, specifically for workers in the actual supplier companies that are key in the value chain. Within the automotive clusters, there is a further value chain in the automotive industry. The automotive value chain covers the entire range of activities from the building of the vehicle bodies right up to the point that the vehicle is on the sales room floor before its final delivery into the hands of a customer. This entails various tasks and companies with associated roles for the final production of vehicles. The automotive value chain thus has both upstream and downstream activities associated with it, as shown in Table 2.1.

**Table 2.1: The Automotive Industry Value Chain consists of the following both upstream and downstream activities**

| **Suppliers to the Industry** | **Main Customers of the Motor Industry** |
|---|---|
| Steel companies | The public |
| Workshop equipment suppliers | Car rental sector |
| OEM parts manufacturers | Government departments |
| Generic parts suppliers | Public transport entities |
| Paint suppliers | Private transport companies |
| Insurance companies | Short-term insurance industry |

| | |
|---|---|
| Fitment companies | The public |
| Tyre companies | Car rental sector |
| Parts manufacturers | Government departments |
| Recycling companies | |
| Steel companies | |

Source: Automotive Vehicle report (2021).

According to a business report by the University of Fort Hare (2020), it was reported that with the increase of technology in South Africa's automotive sector, the majority of the work put into the assembly of a vehicle has been automated in an attempt to make the process of manufacturing and production of motor vehicles completed at a faster rate (Fourie, 2021).

Chigbu and Nekhwevha (2022: 726-747), indicated that body shops are fully automated, the automotive paint sector is 80% automated, and car assembly lines are 20% automated. Many workers are no longer fully using their skills as robots do most of the work. The increase in job automation and deskilling can result in job losses over time (Fort Hare University, 2020). A seen in the Figure (Figure 2.4), there was a downward trend of employment before the onset of the Covid 19 pandemic. The automotive employment shown is a graphic depiction of the downward trend of employment in the OEMs and supplier/component companies.

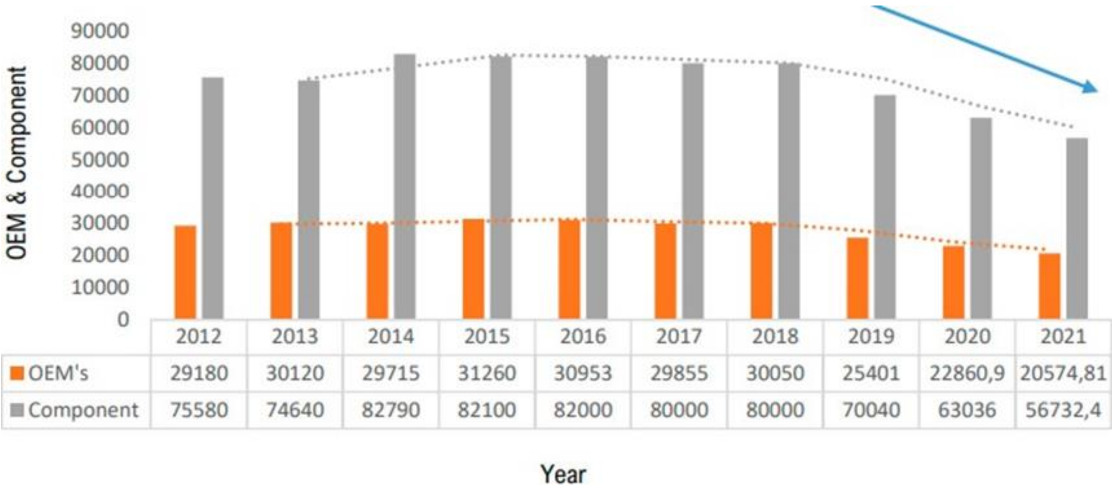


**Figure 2.4: OEM & Component Manufacturer Employment Forecast**

Source: NAAMSA (2021).

### *2.3.2 Technological Changes impacting workers in South Africa*

According to Millington (2017:2) "the estimates of how many jobs are vulnerable to being replaced by machine vary but it is direct that developing countries are more susceptible to automation compared to high-income countries". Millington further explains that blue collar jobs traditionally have been automated but with the appearance of automation, a greater area of jobs are at risk and that highly-trained and skilled jobs can be more at risk than more varied, lesser skilled jobs and ultimately, that the future of work should be inclusive and sustainable. This section presents the technological changes impacting the workers in the OEM (VW, BMW and the Supplier companies).

### *2.3.3 Technological Changes impacting workers currently in VWSA plant in South Africa*

Currently, at the OEM, workers are experiencing an influx of new technology in terms of robotics, especially in the use of industrial robots. Since 2016, 320 new robots have been installed at (VWSA) Body Shop in the Uitenhage factory, which consists of the new Kuka robots installed at the body shop, which form part of the Modular Transverse Matrix (MQB) platform, which is currently being used in the Uitenhage factory, according to workers BMW (2021). The Kuka robots will perform monotonous, high-precision work, which will allow Body Shop employees to focus on tasks which require human involvement. Workers are now said to perform tasks that require more human involvement, which according to them, is reducing jobs drastically. The reason for the introduction of the robots, according to workers' inputs from management, is that the specialised robots introduced at the body shop allow for higher expected volumes and improved quality and this technology enables VW to produce more than one model on one single assembly line (Cassia & Ferrazzi, 2018: ). These new robots are said to have advanced sensory capabilities that allow for increased safety, as well as using much less energy and contribute to cost-saving production outputs, however, for workers, it seems to be costing them in the production plants, such as changes in work conditions.


**Figure 2.5: New forms of technology in VW, the "Kuka" robots**

Source: Venter (2016).

### *2.3.4 Technological Changes impacting workers currently in BMW plants in South Africa*

In BMW, currently, lightweight robots, intelligent devices, and exoskeletons are supporting workers in their production atmosphere making it leaner, according to BMW. Workers are said to be undertaking tasks that have value creation, quality management, and precision work (BMW, 2021). The robotics' core function is to assist in carrying heavy material, for example, repetitive jobs. The robotics in these plants are said to be mobile and able to move around with ease even in awkward work areas as they are designed to fit a particular production process. Currently, more than 40 lightweight robots are operational at the BMW Group plants, and 60 will be functional by mid-year (Schillmöller**,** 2017: 1).

The employment of robots in the current and future world of work that is undertaken by automation and digitisation of production processes in the automotive industry largely will be by means of collaborative robots. These collaborative robots at BMW represent key technology to aid the transition at BMW plants. There are various problems, as well as, possible benefits, of using collaborative robots, emphasising the importance of a careful evaluation of their impact on health and safety on human work, (Weidemann, Mandischer, van Kerkom, Corves, Hüsing, Kraus, & Garus, 2023: 84).

Other interventions at the BMW plants include fitting workers with work mittens with product code scanners attached to the hand to exclude the weighty steps of elevating the scanner, scanning an object and putting the device back. The digital scan process in BMW is operated when the worker discharges a mechanism with the thumb that triggers the scan. These individual automated hybrids of manufacturing processes are meant to improve and accelerate enhancements in technique quality and functional design. Approximately 230 of these inventive safety mittens will have been in use at the OEM Group as of 2018, according to (Price, 2017: 1)


Figure 2.6: Collaborative Logistic Robotics at BMW

Source: Nvidia Corporation (2021).

Direct man-machine co-operation is practised in Germany, with conventional, expansive commercial robots. In the transmission insertion component at BMW Group Plant Regensburg, workers are said to lead sizeable industrial robots to the screw attaching depot. While a beam-based network bolsters the process of positioning the industrial robot, the precise location is determined by the skilled worker. These kinds of interventions and applications were formulated by the on-site team consisting of workers themselves.

### *2.3.5 Technological Changes impacting workers currently at the Lear Corporation plant in South Africa*

The technology used in the automated warehouse, which is a conveyance system, transports components from a multi–level storage racking to the production area with the least handling by manual labour; it also replaces stock and manages floor space by freeing up space for production (Duddy, 2018). The racking system can store approximately 20,000 trays of products in two sizes and is attended by 14 multi-level shuttles (MLS) in four of the lanes and a single mini-load crane in the central fifth lane. This design of this automated system is said to have the potential to put out 770 trays/hour to picking stations, where items for each order are assembled. This allows completed orders to be delivered by conveyor to a designated drop point in the assembly area (Duddy, 2018). This ASRS system also allows roughly 185 trays/hour to be dispatched from an incoming induction area into the racking area. The shuttles and cranes are dense and speedy, allowing Lear the maximum amount of storage and output required by the company, allowing all kinds of products to be stored in various parts of the system (Duddy, 2018). All of the above tasks, according to workers, used to be operated manually but now, due to the implementation of robotic and digitalisation systems, most job tasks have changed with workers being reorganised into other tasks, roles, and responsibilities.

Ultimately, job roles, such as stitching frame making, are now automated by the use of smart factory technologies in automation, additive manufacturing, as well as data and digitalisation, to perform these tasks in the seat company.

Figure 2.7: Smart factory technology at Lear Corporation

Source: Lear Corporation (2020b).

Schnellecke South Africa is also using many technologies to automate their processes, according to workers. They are combining all the processes of the company to offer a more digital solution that were previously manually done, for example, by replacing manual waybills for package delivery with scanning technology that now requires less physical manpower. Most of the processes in Schnellecke currently are nearly 90% autonomous and self-organised due to the internet of things (IOT) architecture and real-time reporting by systems put in place by the company, hence this affects the number of workers required for the previous manual operation (Schnellecke, 2001:1).

## 2.4 Bayerische Motoren Werke (BMW) South Africa

The BMW plant in South Africa is based in Rosslyn, Pretoria. This is largely due to BMW's billion-dollar investment in the Rosslyn plant in the mid-1990s. The investment, used to upgrade the production facility into one of the most modern in the world, brought Rosslyn in line with other BMW Group plants across the world and earned it the title of BMW Group Plant Rosslyn. BMW continues to invest in the South African facility in preparation for the production of future models. The BMW Group Plant Rosslyn is currently producing the sixth generation of the 3 Series and is capable of producing up to 75 000 units per annum and over 85% of all BMW 3 Series vehicles produced at the Rosslyn plant are destined for BMW markets in the United States of America, Taiwan, Japan, Singapore, New Zealand, Hong Kong, Australia, Sub-Saharan Africa and Canada (BMW Group, 2017). According to Morkos et al. (2012:101), advancement technologies in BMW, include BMW's preliminary investigation and applicability study of implementing mobile devices within their manufacturing environment to view potential benefits that could be achieved, include the use of technology within the vehicle that allows for more effective communication and data sharing/recording.

With the current synopsis on technological advances about the implementation of the fourth industrial revolution technologies, BMW as an OEM, is forging ahead with the continuing implementation of modernisation in the company's production processes and shop floor activities. This is being undertaken by the use of what is termed "assistance systems," that is, sophisticated technological systems put in place at each workstation. According to BMW, the implementation of the system is to mimic tasks that are ergonomically not viable for workers and hence allow them to utilise cognitive skills optimally instead.

Another example is the use of augmented reality applications on smart devices, such as tablet computers, on which the image of a component can be overlaid with virtual specifications. The tablet computer then compares and evaluates the actual and target states, allowing the worker to determine whether the part matches the target requirements to identify and resolve potential issues early on. These advanced manufacturing techniques are being used in the automotive industry due to its accessibility and potential for generating innovative solutions. It allows workers to obtain certain information they need about some aspects or procedures directly in the working environment (Boboc, Gîrbacia, & Butilă, 2020:1).

Other automation interventions at BMW include the wearing of exoskeletons worn directly on the workers' bodies that act as a second skeleton, i.e., as an external support structure for the body. The BMW Group uses both upper-body and lower-body exoskeletons. The exoskeleton vest for the upper body strengthens the movement of the upper arms of workers who have to carry out tedious tasks. The vest's joints have an integrated mechanical spring support that gives arms greater strength. Twenty-four of these exoskeleton vests are currently in use in the series production of BMW Group Plant Spartanburg; 44 more will be added over the year (BMW Group, 2020).

### *2.4.1 Technology overview in BMW*

Currently, BMW Group vehicles are being electrified hence the use of technological processes in the charging design and production of the newer models in demand, this in turn, changes the production of a particular model and the number of processes done by workers in the assembly of these new emerging models. The increase in electric vehicles is seen in Table 2.2, showing the share of electrified vehicle deliveries from the period 2017-2020.

**Table 2.2: BMW Group: Increase in Electric Vehicles**

| | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|
| Share of electrified vehicles in deliveries | 4.2 | 5.7 | 5.8 | 8.3 |
| Deliveries in the Automotive Segment | 2,465,021 | 2,486,149 | 2,537,504 | 2,325,179 |

Source: BMW (2021).

- **The plug-in hybrid vehicle** is supplied with power through a charging cable plugged into any fused domestic power outlet, a wall box, or an appropriate public charging post. The energy stored in its high-voltage battery enables pure electric, local emission-free driving. Recuperation is also used to recover energy during driving as soon as the driver takes their foot off the accelerator or brakes.

- **In the fuel cell electric vehicle** (FCEV), electricity is generated directly inside the vehicle. Within the cell, hydrogen supplied from a tank reacts with oxygen from the air.
- **Hydrogen vehicles** are an alternative and could become an additional pillar in the BMW Group's drive train portfolio, alongside battery electric drive trains. The BMW Group is already developing a vehicle based on hydrogen fuel cell technology, the BMW i Hydrogen. Since 2015, BMW Group researchers have been testing a small fleet of BMW 5 Series GT hydrogen fuel cell prototypes in collaboration with Toyota, featuring a jointly developed drive system with a Toyota fuel cell stack.

However, the BMW Group will not be able to offer customers fuel cell vehicles until the second half of the 2020s, at the earliest, depending on how market requirements and conditions develop.

## 2.5 Contextualising the South African economy and digitalisation potential impacts on workers

Technological changes brought about by 4IR are seen in various supply chains; these include various key sectors in the economy that contribute to the South African (GDP), such as the manufacturing sector which contributes 0.8%, the transport and communication industry at 6.9%, the mining industry at 1.9%, as well as the agriculture sector at 6.2% and trade at 2.2%, which are all impacted by the transition of technology, accelerated by the global pandemic, shifting from manual work to a large percentage of work, activities and interactions conducted remotely via technological innovations (StatsSA, 2022).

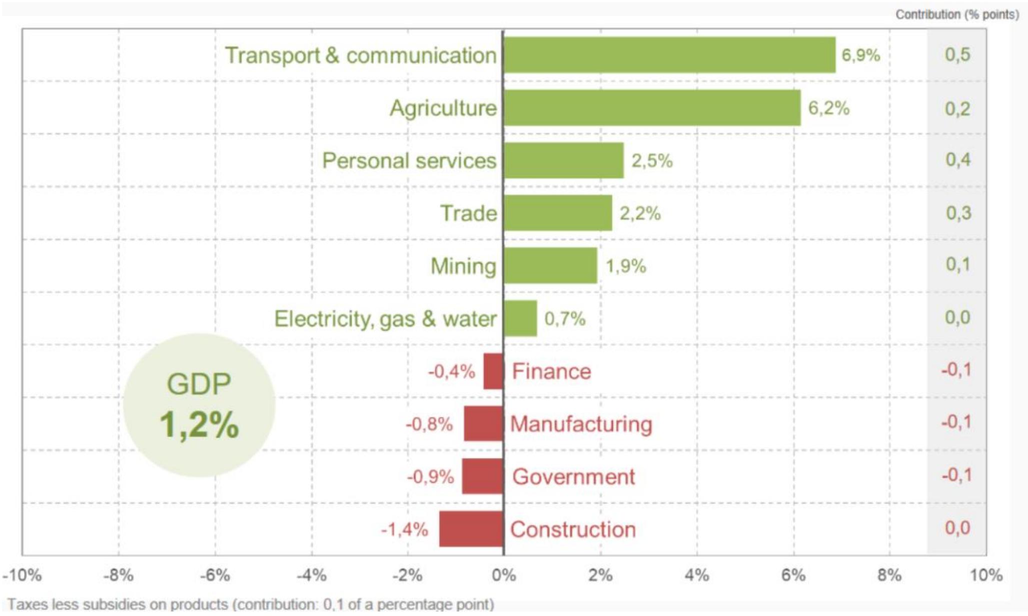


Figure 2.8: Sectors contributing to the South African Economy

Source: StatsSA (2022).

Manufacturing systems have become more flexible and self-organised in addressing changing demands and conditions in the automotive plants and in the supply network, based on changing needs. Hence, manufacturing systems are now capable of boosting manufacturing operations that are flexible, autonomous, and error-tolerant productions in the mass personalisation conditions, as seen in the automotive industry (Qin Lu, 2021: 35-47).

The wider automotive industry's contribution to the (GDP) in 2020 measured at 4,9% (2,8% manufacturing and 2,1% retail), reduced from 6,4% in 2019, reflecting the major impact of COVID-19 on automotive manufacturing and retail, as a result of the country's lockdown limitations during the year (StatsSA, 2022). As the most sizeable manufacturing sector in the country's economy, a significant 18.7% of value addition within the domestic manufacturing output was extracted from vehicle and automotive component manufacturing tasks, continuing to place the industry and its extensive value chain as a central player inside South Africa's industrialisation terrain. The automotive sector remained one of the most evident sectors allocated  foreign direct investments, with the seven OEMs investing a record of R9,2 billion in 2020, while the component sector invested R2,4 billion in 2020 (StatsSA 2022).

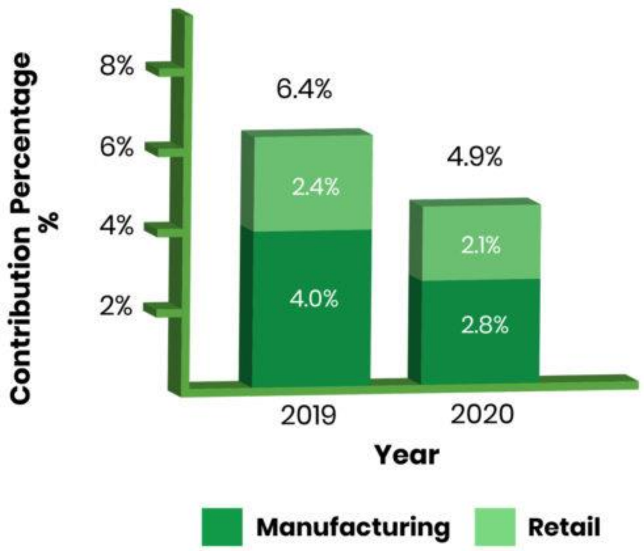


Figure 2.9: The Automotive Industry's contribution to the South African Economy

Source: National Association of Automobile Manufacturers of South Africa (NAAMSA) (2022).

Following Ndung'u and Signé's (2022) findings on unlocking Africa's potential, thus far it does not reflect that Africa has yet declared the 21st century as it ought to, and it still delays in several indicators crucial for a positive digital revolution. This, in turn, will cause problems for both industries and workers, as well as South Africa and the African continent as a whole (Ndung'u & Signé, 2022). Ndung'u and Signé's (2022) perspectives bring to light elements to improve the process of transformation, such as reinventing labour, skills, and production employing improved infrastructure and skills that could be an opportunity for growth as we see global systems of labour and production that require skills and capabilities for automation as a result of the technological advancements and 4IR (Ndung'u & Signé, 2022).

## 2.6 Technology and jobs in the fourth industrial revolution

The discourse on technology and jobs, as detailed by Arntz, Gregory and Zierahn (2017), and concerns around automation and artificial intelligence and the use of robotics are brought to the surface, again affecting both production facilities as well as service providers (supplier companies). All the debates raised by Frey et al. (2017) centre on automation making manual labour redundant, especially those jobs associated with routine tasks. The labour workforce is prone to the high risk of automation in a term called routine replacing technological change (Frey & Osborne, 2013).

Forsythe (2023: 27-30) explains automation and technological change for workers and economics by adding that, with mechanisation and digitisation, jobs are not deemed permanent but alternatively, employers are also adjusting job duties and pre-requisites in the absence of changing the title of the job. This translates to technology raising the possibility of replacing tasks, new tasks are also added to jobs as well as a range of manual jobs requiring lesser skills but technologically enabled jobs are requiring a higher level of skills in order to enable workers to interact with the new technology, causing job changes. Therefore, the impact of new technologies on the labour market is varied and technological innovation and automation transitions will require labour market policies to be more dynamic in order to direct change and that with these changes, there will be a level of problems as well as opportunities that will be unevenly dispensed. The problems will occur for those workers in the absence of the relevant skills and qualifications that will disrupt work and cause career imbalances by means of technological displacement which will be a challenge for workers to find new forms of employment and skills development and assistance will be needed in order to make the transition by means of accessibility of training to upskill them.

Athanasopoulou, Bowman, Nikayin, and de Reuver (2016) explains the disruptive effect of digitalisation on the automotive value chain and business model plan. The emergence of technologically enhanced vehicles with enabling technologies is impacting the number of components that go into a vehicle, as well as other mobility services being impacted by these new technologies; they also assert that the intricate variables of the automotive industry can lead to a new understanding of the nature of work and that the ongoing transformation in the automotive industry encompasses a level of digital and physical convergence.

According to Frey and Osborne (2013), companies are using more modern technologies compared to former technologies. Firm-level analysis of information aims to magnify the investigation in the automotive industry where work is often not complemented bur rather substituted and ultimately replaced, due to a lack of relevant skills. The literature makes important comparisons with the technology, compared to the European context of technological implementation, stating that diffusion of technology is happening at a slow pace, however the data from the robotics industry shows the automotive industry is the majority industry using industrial robots, and this indicates how the automotive industry, in particular, is moving with speed in automating the production line, based on their demand patterns for industrial robots.

According to Stolfa, Stolfa, Messnarz, Veledar, Ekert, Macher & Madaleno (2020), technological advances and new forms of work are transitioning in the automotive industry where development is moving at a rapid pace due to the need to meet environmental targets because of climate change and thus, the manufacture of vehicles, so, due to these evolving demands, we need to evaluate and initiate a variation of existing and new skills avenues that details future skills, job roles and responsibilities.

### *2.6.1 Recent technological developments and global changes to working conditions in the automotive industry*

There have been recent developments in the automotive industry and more specifically, in the vehicle manufacturing assembly line. Prashant (2019) elaborates on how human manual labour is substituted with artificial intelligence, robotics, machine adjustment and restructuring, etc. and how most assembly jobs are reconfigured which forms the basis of the future of the assembly advancement process in the automotive industry. The vehicle industry is moving closer to producing more electric vehicles. Using robotics as an advantage for the (OEMs) is the high speed of operations, as well as the flexibility coupled with the advantage of keeping down-time to a minimum. According Manyika (2017: 3), technology can help labour markets in terms of their digital work platforms by improving synchronising between workers and jobs and explains that skills and jobs do not always match. Some of the gaps in the research and the most important aim of this research is to show the impact of these technological innovations on the worker and their jobs, from a socio-economic point of view. This further shows how assembly line jobs are being lost and the problems of restructuring through altering workers' conditions of employment. By surveying a series of jobs, this research study shows how these robotics and other technological innovations are replacing and displacing workers. The research further shows how OEMS reduce costs in labour to increase profit margins and to meet costs imposed by environmental regulations with the ultimate goal of increased profit margin for a few minority shareholders and multinationals (MNCs).

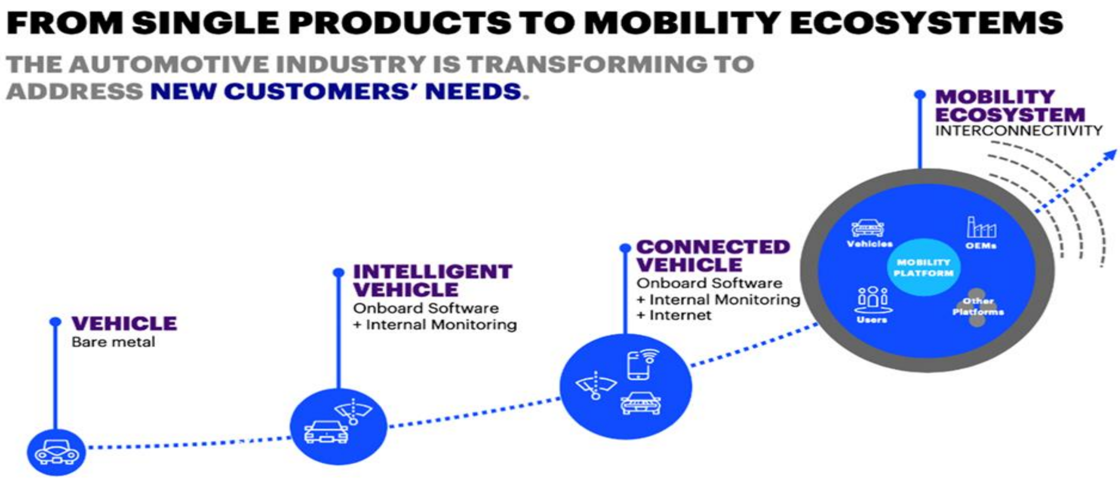


Figure 2.10: The Automotive Industry vehicle digital pathway

Source: Accenture (2022)

### *2.6.2 Skills development and preparing the workforce for the 4IR*

In addressing the pertinent topic of skills in the Fourth Industrial Revolution, Care, Kim, Anderson and Gustafsson-Wright (2017) explain how skills are needed for a changing world, with others raising issues of the movement of education systems and accompanying curricula towards a skills system that is required for this century. An education system, according to Care et al. (2017), is more than basic education and technical skills are required to remain relevant in the age of the Fourth Industrial Revolution and very few of these are accompanied with additional details on how these skills will be integrated in the education curriculum. Care et al. (2017) suggests that education, unlike in the past that was focused purely on formal education to benefit work-related responsibilities, now suggests that future education systems need to inform both work and life more generally. This kind of approach is favourable to address the new skill demands required by the automotive sector in which workers are employed and therefore this study aims to address particular skills gaps in the industry. Even though most literature emphasises the need for a broad range of skills, the specific details of the "broader" skills are largely missing. Hence, a suggested practical approach to assist workers in the automotive sector and the broader working class in terms of skilling for the present and future is having an holistic view of workers in the industry, such as the average age, gender and current skill level of workers in the automotive industry as this will assist OEMs and supplier companies, as well as government and the relevant sector education authorities (Setas) to develop an implementable skill development strategy and workplace skills plan that is context and industry-specific.

### *2.6.3 Skills development, policies, and systems for a future workforce*

The Global Commission on Work (2019) sheds light on the very different discussion of work in the digital age and more specifically, managing change during every phase of education in terms of skills policies and systems for a future workforce. This provides a unique contribution to the reform discussion on the type of skills needed, as well as the role of various organisations. Insights through the ILO (2018) emphasise issues such as security, equality and prosperity, but most importantly, bringing equity in the workplace in terms of having inclusive labour markets, including addressing the topics of gender equality and empowering workers already working in the informal economy and the importance of managing change effectively.

Vital in the key findings of the research is the type of skills, according to the International Labour Organisation (ILO) that would be necessary for the future of work. According to Freeman, Marginson, and Tytler, (2014), changes caused by technological advances will affect the demand and the composition of skills, affecting all levels of education and skill sets, stating that automation and digitalisation will increase the technical skills that would be able to assist problem-solving and innovations, particularly in careers related to engineering, science, and technology (Freeman, et al., 2014). Other skills required include specific vocational skills to operate new technology and to facilitate and maintain adaptability with continuous skills over the machines's lifecycle required to remain relevant.

According to Evans-Klock, Poschen, Sanchez, and Hofmann (2009: 8-19), the use of the appropriate combination of vocational, technical and key work skills will provide workers with sound future employment prospects and therefore skills development initiatives is necessary to evolve at the pace of change. There is a need to reinforce this study by emphasising the important role those various stakeholders play in shaping the necessary policies and skills for a changing workforce and acknowledging various suggestions to enhance skills development that reinforce educational and workplace skills with worker recommendations that suit and emphasise workers' problems in the automotive industry, coupled with practical pro-worker contributions in the process of managing change. Further emphasis on empowerment strategies that are gender equal and more specifically, for workers in the automotive industry, is required. This literature by the ILO is primarily focused on jobs created towards a renewable energy transition, hence little emphasis is given to the automotive industry skills requirement. Thus, even though some work transitions towards technological implementation at production plants and other forms of employment in supplier companies move to more environmentally friendly positions, these job roles are not necessarily "quality jobs" solely because they are termed environmentally friendly, hence job sustainability and the quality of the new job roles as a result of technological transition requires bolstering.

### *2.6.4 The 4IR and Reshaping the Future of Production*

Moavenzadeh's (2015) research related to some of the strategies that can be used in reshaping the future of production, as the Fourth Industrial Revolution (4IR) is seen more as a system change rather than a change in products or services. It can be argued that it is the evolution of production systems and that the transformations of industries due to digitisation present opportunities and threats (Moavenzadeh, 2015). Firnkorn and Müller (2012: 264-280) explain that the future of mobility in the automotive industry will be more a concept of exchanging the sale of mobility by changing their business strategy. These new strategies are said to bring about an increased growth in the automotive sharing industry.

Plorin (2022: 3-9) explains that the use of artificial intelligence (AI), will be a key form of new technology that will be transforming the automotive industry manufacturing process, as well as the internet of things (IIOT), robotics technologies, including robotics in the optimisation of logistic functions, as well as maintenance and the ability of the new technology to detect production disruptions or other possible disruptions in advance. This includes operational intelligence systems within the automotive industry that produces a level of real time information into the production process that provides for decision making for instructional operations to enhance the future of production. Most importantly, Plorin highlights the challenges these technological transitions can bring about; this includes the need for training to manage these sophisticated technological systems, in order to report on the data analysis systems in the automotive industry.

Felser and Wynn (2020:212-213) explain the role of digitalisation and transitioning strategies in the automotive industry by showing how digitalisation requires the realignment of strategies to address digitalisation adequately in their business models. The significant changes in the business functions with which the automotive industry is faced include the problem of formulating and implementing a company based digital transformation design. These technological changes are connected to accelerated transitions, especially in business models. This may provide an opportunity for the industry by acquiring previously outsourced tasks back internally, by means of a procedure known as back sourcing. This process will allow for a more agile and responsive approach to productively respond to the advancing transitional demands in the industry.

Slaughter and Rhoades (2004) explain how academic capitalism in the new economy impacts higher education systems and that by universities means of adopting a technological transfer approach, that might assist in reversing generations of ownership of research policy ,that promotes education and workplace policies that can be a catalyst to shift education systems and training that is less segmented.

Slaughter and Rhoades (2004) reiterate that the ownership of new technological transitions education should not create disputes but rather that educational activities should be developed to transition to the current and future employment markets that are linked to innovation. This is important to note in the reshaping of production processes because education and skills form an integral part of technological transitions.

Further emphasis is placed on the importance of responsible value chains, which reiterate how past violations should be a learning curve when future value chains are designed and how society is a key catalyst to change (Freeman, 2014). This points to the importance of having a human-centred strategic approach to the Fourth Industrial Revolution and how people should be at the centre of the change and core stakeholders in designing the changes in their respective workplaces, hence workers should be involved in the design and testing of new technologies in their respective companies at which they are employed.

## 2.7 The impacts of the 4IR on jobs in the automotive industry

Prisecaru’s (2016) theory on the fourth industrial revolution (4IR) is that all revolutionary technologies which drastically change industrial production may put jobs at risk. Hence the theory of Prisecaru is the 4IR limits labour demand and imposes new prerequisites for education. Prisecaru (2016) further states that, due to robotics, many jobs in the administration and office fields of work will decrease drastically. He bases his theory on the works of Moore’s (1975) second law in that the massive transformation in technological implementation will not be limited to the manufacturing sector but may also include all employment related to expertise and services, which will induce a much bigger challenge for society (Prisecaru, 2016). This theory is relevant to the current study because it emphasises key variables, such as the impact and risks of industrial revolutions, and the narrowing of the demand for labour as well as the new forms of skills that will be required for the changing nature of work which are some of the key discussions in this research study that forms part of development studies as a social science, as various industrial revolutions as well as technologies shape and impacts development both directly and indirectly and thus bringing into perspective the real problems and perspectives of workers in the automotive industry specific companies as argued by Marx that industrialization does not bring about development but rather worker alienation and dispossession (Petrović, G., 1963: 419-420).

Some workers in various industries already approach technological changes with fears concerning job security and their skills readiness for such changes; as we have seen in the automotive industry, production lines have changed and altered the flow of work, causing job roles to be re-organised as a result of new technology introduced in the automotive plants. Various jobs have been lost due to the redirection of the production processes and the reduced manpower needed along the value chain of producing a good or service (Numsa Research Institute, 2019). Workers in the automotive industry experience downtime (work stoppage) in the plants in which they work due to the use of robotics and digitalisation technologies. In the manufacturing sector, and the automotive sector in particular, digitalisation interruptions and robotics mechanical breakdowns, can bring a company to a position where it relies fully on technology for operations to operate smoothly (Numsa Research Institute, 2019). In these cases, a breakdown or other downtime for production machinery can bring operations to a standstill. Workers performing manual jobs can experience downtime often for weeks or months at a time. When a critical piece of manufacturing technology fails, the company begins to lose money right away, since integral machinery cannot be easily replaced or bypassed during the repair process. Downtime often causes manufacturers to miss shipment deadlines for customers, potentially causing them to lose accounts. The impact of this is on the worker, as less work with fewer hours of production equals less pay for the worker and eventually, an oversupply of labour, which leads to retrenchments and ultimately, job losses (Numsa Research Institute, 2019). Other problems include safety risks for workers due to the speed of robotics in plants. The ergonomics associated with the production output, puts pressure on the worker to keep up with the speed of the robots.

Using technology in manufacturing can also introduce new and dangerous workplace hazards and physical safety risks. Berlin, and Adams (2017) discuss the ergonomics around production and the design of work networks to support maximum human performance, emphasising important aspects of the psychosocial worker inclusion factors, especially participatory ergonomics, as well as workplace design as part of the industrialisation process, where the need to adapt workplaces to the transitioning requirements and constraints of innovation and diverse workforce that are inclusive but that takes into the consideration the ergonomics needs of the future production systems.

Despite warning labels in plain view and all workers wearing safety equipment, it is still possible for workers to have their limbs, hair, or clothing caught in machinery, which can cause serious physical injury in an instant. Such risks are not only excessive for employees, but they can also present potentially devastating financial liability to employers who thought they were saving money by using technology. For workers, new technology comes with increased machine productivity, with "speed" at the centre of the production process. Chui, Manyika and Miremadi (2016) explain that machines could replace humans - and where they cannot (yet).Workers would have to compete with the speed and accuracy of the automated machines in the production process and this causes many health risks, as human workers cannot keep up with the speed of an automated machine that produces ten times faster than an average worker can.

Various illnesses arise from such and often cause physical burnout to the worker, as they are required to stand long hours to cope with the faster outputs by machines. In addition, the expertise to maintain these industrial robots is scarce and they require sophisticated programming, while the number of people with such skillsets is still growing and is currently limited. Programmers are in short supply and expensive to acquire. On-going costs of automation introduce other continual expenses, such as preventive maintenance, troubleshooting, and programming. Finding skilled individuals for such tasks often requires outsourcing at a substantial cost to the company (Numsa Research Institute, 2019). According to Alexander (2022), the fourth industrial revolution can vary from adaptation being minor or to a more major transformation by the development of new industries and technologies that innovate the way that the economy functions and the manner in which individual operational work functions are organised. The major concerns raised are the problems and opportunities related to the implementation of the fourth industrial revolution as well as possible risks. An aspect identified was the impact of technology on jobs as an opportunity for transition into different forms of work in supply chains, as well as the improvement in job functions. However, major risks include automation reducing the need for manual labour in the future and therefore strategic planning is required for workers who will lose their jobs in the short term.

### *2.7.1 Effects of Digitalisation on workers*

This study shows the impacts of technological changes on workers' jobs on the automotive shop floor in the (OEMs), as used in this case study (Volkswagen, BMW), and supplier companies (Lear corporation, as well as Schnellecke logistics company), all of which are multinational stakeholders in the automotive industry. Parschau and Hauge (2020:120-122) explain the risks of automation in labour intensive manufacturing jobs , in particular, the loss of jobs especially in developing countries, therefore the threat of automation to employment is prevalent. Obstacles, such as skills development in adopting of new technologies are identified, and for workers to transition to the new technologies adopted, industry specific barriers to transformation must be addressed.

Cijan, Jenič, Lamovšek and Stemberger (2019:3-4) explain the dynamics of how digitalisation changes the workplace by means of the implementation of digital technologies and mentions the various challenges, as well as opportunities for companies. Worker autonomy and other risks are identified and placing emphasis on the work conditions of workers and their health and safety is important, as well as their ability to perform their new job functions that are automated. Bolli and Pusterla (2022:263-264) explain how the effects of digitalisation on workers' jobs can be decomposed. This is explained by showing how older workers who are not technologically skilled find it challenging to transition to new forms of jobs and this problem impacts their productivity and job satisfaction, therefore workers that do not possesses educational skills related to technological driven careers, perceive this as a risk to their jobs and job satisfaction, hence digitalisation of work tasks for older workers and workers lacking the necessary IT related skills pose various job sustainability risks to these groups of workers.

Currently, there is a lack of an adequate skills development model in place to facilitate the technological work transitions, as seen in VW, where most of the work tasks are being automated and the facilitation and equipment of workers with the necessary skills required for work sustainability, using skilling, reskilling and up-skilling is not fast enough for the transition that is taking place (McKinsey, 2017). Thus, this research paper's objective is to identify the impact of new technology on workers, to identify the current gaps in bringing workers fully on-board in the process of automation, as well as to develop prospective solutions in the form of a transition model that includes a set of guidelines to assist all stakeholders, including workers, using skills requirements for job sustainability, employers in the OEMs and supplier companies through a workplace skills plan so that all stakeholders may adjust to the process and that the technological transition to automation is exercised in a just and equitable manner.

Ciarli, Kenney, Massini, and Piscitello (2021: 104) explain how digital technologies raise challenges in terms of the necessary skills for the innovation transition. There is a need for a skills formation in order to allow for companies to converge the new technologies and adapt the changing digital technology by means of the classification of required understanding of new production activities with a clear evaluation of the necessary skills required, allowing for a clearer outline of a future digital course of action to follow that will allow for improved implementation on the employment value chain.

### *2.7.2 The next-generation operating model*

In addressing digitalisation, strategies and models that are sustainable, practical and context-relevant must be put in place. McKinsey (2017) noted that concerning a next-generation operating model, it is imperative to consider some important aspects in the development of a model and strategies when addressing the fourth industrial revolution, technological innovation, as well as digitalisation and work. In addressing the fundamentals of workplace automation, automotive industry players are of the view that artificial intelligence has the potential to improve the quality of life of many individuals and workers, in particular, and the results of this research show that focus on occupations is contradictory with more activities within occupations being automated rather than occupations in their entirety, with jobs performed by humans being refined rather than replaced. “Automation is likely to change the vast majority of occupations, at least to some degree which will necessitate significant job redefinition and a transformation of business processes” (Chui et al, 2015:3).

Chui, et al. (2015) are of the view that the risks must be understood and managed, and a strategic model needs to be devised. It is further explained that some of the strategies in dealing with digitalisation include splitting complex jobs into direct tasks, automating some, and deciding what humans can do more effectively, which gives humans more time to focus on the specialised tasks at workforce platforms. This can assist in determining details on employees’ skills, performance in past assignments, working technique, personality attributes, availability, and locations, and can add valuable pairing processes to ensure productivity.

The focus of the strategies is on talent management and capturing the “full value “of workers. As part of the strategies, McKinsey (2017) is of the view that the reinvention of business activities and assigning tasks, helping workers by identifying their core talents and specialities, is core to delegating tasks effectively that has a dual benefit. Often, when a segment of activity in the production line changes, the entire occupation is impacted, work is reorganised and salaries and hours of work are impacted.

Shukla (2009) explains the importance of the need of talent management in the task of incorporating and enhancing the skill level of workers for the new forms of work demands that have been accelerated by the advance of new technologies. Bollard, Larrea, Singla, and Sood (2017:1-8) describe the next-generation operating model for the digital world by reiterating the need for holistic thinking when developing models for the future. This approach encourages change management approaches to take place, based on all-inclusive supporting functions of an organisation. In essence, this is an inclusive model that allows all stakeholders to be involved in the digitisation of work, including workers. Chui, Manyika and Miremadi (2015:1-9) describe the fundamentals of workplace automation as physical and specialised work transitions, so jobs will be reformulated and designed in the short term, as opposed to completely being replaced .

Key concerns emerging from workers across supply chains in the OEMs and supplier companies is the length to which these technologies have begun to replace humans in the workplace. While there are evidence-based employment figures in the OEMs and supplier companies, changes in the employment data show a growing trend that has grown more widespread in the conditions of routine jobs and production, and automation has increasingly expanded into more complex tasks and processes that workers, both semi-skilled and unskilled, find challenging. Rifkin (1996) describes industrial revolutions, particularly the third revolution impact on the economy and the new technologies implemented as replacing workers and creating conditional work with the decline of stable work due to the transitional nature of work. This decline of the labour force in terms of the changing nature of work impacts workers' health and safety due to an increase in the level of mental health challenges impacting the social welfare of workers as their growing concern of how their jobs are being impacted are triggering negative responses to their companies and fellow co-workers. Ultimately, gaps between workers that have job sustainability and those that do not, reaches even more negative levels.

Susskind (2020) describes how we should respond to technological advancement and automations and some of the explanations include approaching the changing nature of work in the same way as we approached the Global Covid pandemic and that meant adapting to change whilst still keeping job sustainability at the centre of the technological transitions. This included finding innovative ways to re-augment manual work with digital work in a way that does not displace workers but rather transitions them technologically through training and skills development by means of all stakeholders enabling the technological change strategies to take place in a non-destructive manner. Further, it is important to show how workers' specialities can be redefined in terms of up-skilling workers to better specialise in a particular task themselves locally, rather than procure the skills and services of specialists abroad which further deepens the unemployment pool in South Africa (McKinsey, 2017).

### *2.7.3 The potential impact of the 4IR on jobs in South Africa*

In examining the potential impact of the Fourth Industrial Revolution on jobs in South Africa, Bhorat, Lilenstein, Khan, Rooney, Steenkamp and Thornton (2019) identified technological innovation as being the primary driver behind unemployment rates, with jobs, mostly administrative and routine in nature, being codified and replaced by technological innovations and made redundant. This further causes a shift in labour demand from routine to non-routine jobs, reiterating the affirmations of Frey, et al. (2017) that 47% of jobs are at risk in the United States alone. The methodology used by Frey et al. (2017) indicates a methodology whereby a computed automation probability was created for each occupation, dividing each occupation according to the risk of automation probability type, of low, medium and high occupations, therefore this methodology approach was used in this literature to give a sense of where a certain occupation would fit in. Further, the literature also shows from a gender point of view that women will be more susceptible to the impact of job losses due to automation as compared to men, with a percentage of 43.6% sitting in the "high" category (Bhorat et al. 2019). Other findings include those individual workers who will be highly affected by technological innovation, will be those individuals within the age group of 18-24 years old with poor education as a major disadvantage. Industries, such as mining (78%), construction (63 %) and Community, social and personal (CSP) services, according to the literature, will be highly affected by automation, with the highest number of jobs potentially at risk.

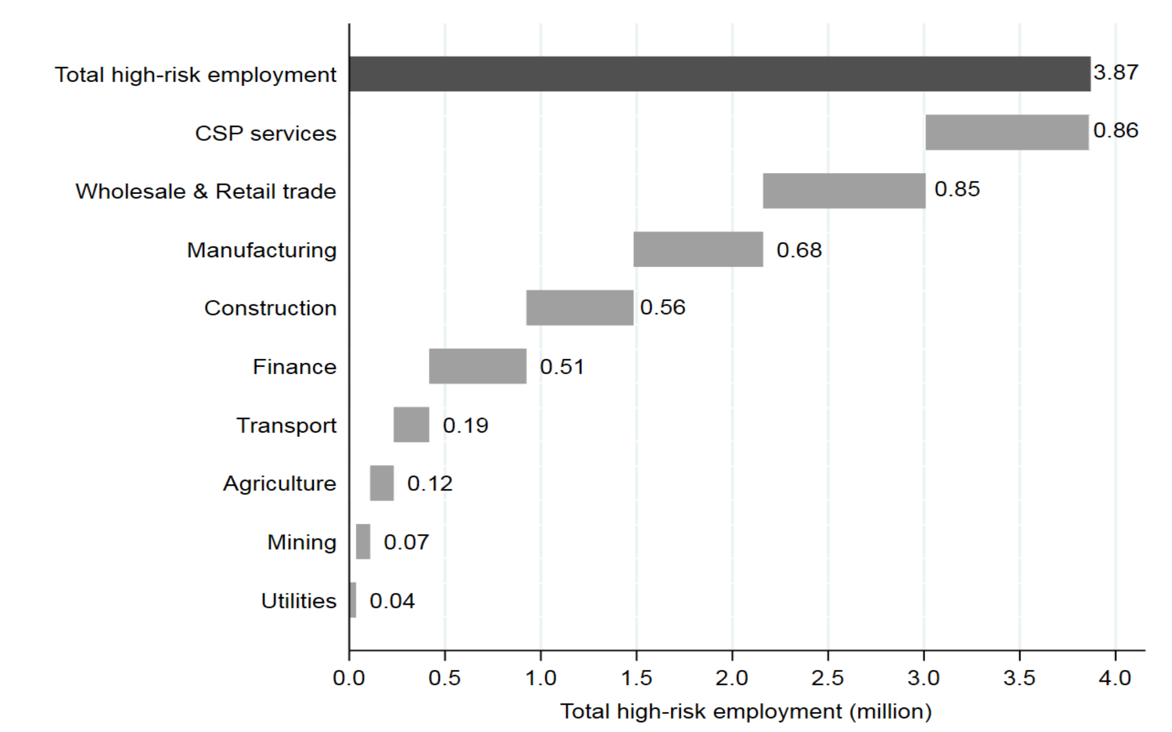


Figure 2.11: Types of high-risk employment

Source: Bhorat, et al. (2019)

The relevance of this graph is to show the types of employment that are at high risk of automation and the automotive industry and OEMs and supplier company workers are located in the manufacturing sector listed above. It shows that 80% of jobs have a potential high to medium risk of being automated. Bhorat et al. (2019) elaborate however, that due to recent developments, other industries have emerged to be transitioning into the Fourth Industrial Revolution, with automation especially in the automotive industry as seen more commonly in production processes, also in the variations in age, gender, and skill level as a contributor to job losses as one of the many impacts of the digitalisation as younger people are not adequately skilled and older employees are not formally skilled, as such, the need for skills analysis based on all kinds of socio-economic conditions is essential in assessing the skills deficit.

### *2.7.4 Automating the future of jobs and the rise of digital workers*

An information brief by the IDC 2023 report by Singh and Tarkar (2022: 239-260), examined the automation of work and the future of work, as a profound change to the concept of work and the traditional way of viewing work in terms of transformation of workers' skills and behavioural patterns as well as the organisational culture of performing tasks. This change in organisational culture is not centred on the norms of the usual way of work that is confirmed to a specific day or time, nor is it dependent on a particular workspace, all considered as part of the transition of the process of digital disruption and the automation of the future of work (Industrial Development Corporation, 2019).

The IDC's (2023) report describes the future of work as one where both humans and robots are in collaboration, redesigning how work tasks are accomplished. The technologies are said to augment and automate work to further the element of value creation. Asia Pacific identifies three major technologies that they believe will have the most disruptive effect in the next five years and this includes artificial intelligence, cloud computing and 5G technologies. It is emphasised that there will be a mix of humans and intelligent technologies with a distinct change in workspace and workforce work culture.

Autor (2015: 3-5) describes the history and future of automation in terms of automation being seen as a substitute, compared to as a complete replacement of labour and mentioned that digitisation should complement labour which will lead to the increased demand for work that increases the relative dominance of workers in contributing to creativity, troubleshooting and versatility in the change of the types of jobs.

According to Bughin et al. (2018), in addressing the skills shift in automation and the profound questions raised in the literature which are unanswered, are the problems that come with automation that will require the redesigning of functions, management of the change, reskilling and redeploying and the human resources to manage the robotic instruments in the workplace. In the automotive industry, it will be vital to show how certain tasks and duties are automated in the production process, how certain robotic mechanisms of automation fall short of totally replacing the human element of emotional intelligence and that even artificial intelligence has not reached that level of technological advancement. There is further, an opportunity to show how the transformation of work as a result of technological advancements using the crucial element of human emotional and other intelligence, will always be irreplaceable and is what makes and keeps us relevant as human beings, for example, by our ability of reasoning and weighing up the best possible solutions based on human centred decision making. As an opportunity, this will show how certain tasks in the automotive value chain that require a specific form of human intelligence, such as complicated and complex decision-making that robotics algorithms and software applications are unable to respond to or that electronic applications are unable to perform, as artificial intelligence is programmed to follow a set of predetermined rules and can often prove not to be an asset in times of crisis or conflict. It is also imperative to examine some unanswered questions in the research, especially on how workers manage automation and technological changes, which is addressed in this research study discussion section.

### *2.7.5 The Original Equipment Manufacturer, the Volkswagen Group*

The Volkswagen Group South Africa (VWSA) is a multi-national corporation and a wholly owned subsidiary of Volkswagen Aktiengessellschaft (VWAG) in Germany. It is the largest German investment in South Africa and is a major contributor to foreign direct investment, technology transfer and skills development. The Volkswagen Group South Africa (VWSA) plant is situated in Uitenhage, an industrial town in the Eastern Cape. Just over half (294,713 m²) of the plant's 520 963 m² area consists of production facilities. Apart from producing components for the entire Volkswagen Group, the Uitenhage plant currently produces the Polo and Cross Polo models and has approximately, 4023 employees, and a new vehicle market share of 16,7% (Volkswagen, 2021).

Wilson (2021) expounds that VW multinational is to replace the human workforce with robots in Germany to meet demand. The report states that Volkswagen intends to use robots to cope with a shortage of new workers caused by retiring employees. According to the company, the move to a more automated production line would ensure car manufacturing remains competitive in high-cost Germany. According to VW, as mentioned in the article, VW is noticing the trend of ageing employees and therefore predicts that most employees will retire between the period of 2015 and 2030 therefore the lack of skilled employees joining the business is forcing the company to look for alternative solutions. The company reiterates that the robots would handle the majority of monotonous and un-ergonomic tasks, allowing workers to focus on more skilled jobs (White, 2021).

According to a VW board member, from a cost perspective, it makes more sense to use robotics to carry out routine tasks since it costs VW about €5 an hour (R83 South African rand) over their lifetime, including maintenance and energy costs. This compares with about €40 an hour (R660 in South African Rands) in labour costs per worker in Germany (including wages, pension, and healthcare costs) and less than €10 in China, which equates to R166 in South African currency. The new generation robots are said to be more affordable to OEMs (White, 2021). Currently at the VW plants, both globally and in South Africa, the majority of the vehicle production is taking place by means of robotics. This process automation first started at the production plants from the level of the body shop, then the paint shop and currently, the assembly line is the only semi-automated level that is operated by manual labour.

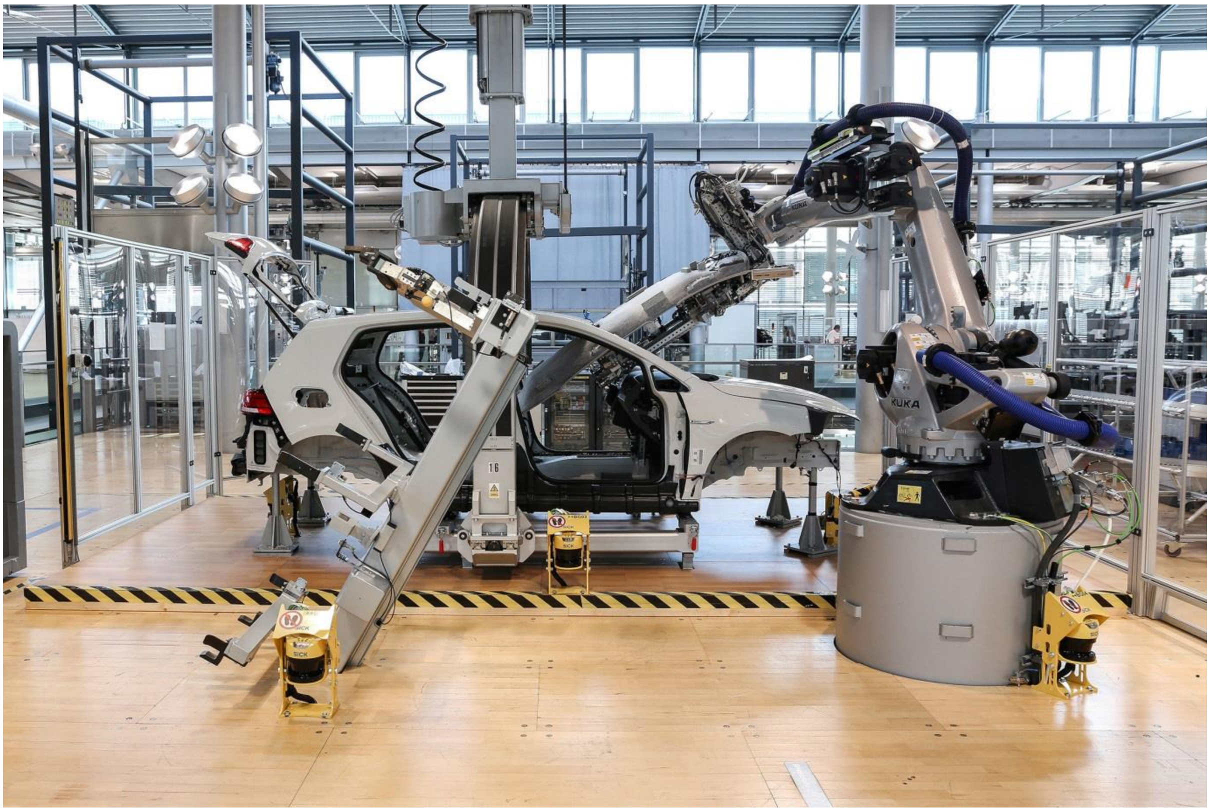

Figure 2.12: Automation at Volkswagen Production line

Source: Volkswagen (2021).

### *2.7.6 Supplier company, Lear Corporation*

Lear Corporation is one of the largest suppliers of automotive components and internal systems which also utilises Cassioli for the deployment and design of the car seat assembly line, located in Melfi. Operationally, the plant consists of an automated warehouse that is inter-operable and allows for manufacturing flows to be synchronised with two tack lines for the assembly of the front and rear car seats. The entire system used in the manufacture of seats includes a high level of automation and integration amongst different plants in the automated warehouse using anthropomorphic robots (Cassioli, 2015). Lear Corporation also utilises a company called Automation Alley as a corporate partner for Industry 4.0 Accelerator, which focuses on technological operations in manufacturing.

According to Duddy (2018), the Lear warehouse makes use of an automated storage and retrieval system (ASRS) that enables the Lear Corporation factory at Coventry to triple the output of car seats to over 300,000 sets a year in hundreds of different specifications and to meet its customers' just-in-time delivery schedules (Duddy, 2018). Lear employs 174,000 employees globally, with 257 facilities in 38 countries. Lear also specialises in electrification, in terms of vehicle network architecture that allows for connected mobility and software for vehicles. Lear processes include electrical distribution and connection systems, route networks and electrical signals, as well as managing electrical power within the vehicle for all types of powertrains, including traditional ICE architectures and the full range of hybrid, plug-in hybrid, and battery electric architectures, supporting the current industry trend toward electrification (Duddy, 2018). The current engineering and development activities for electronics are in the United States (Southfield, Michigan), Germany, Spain, China, and India. The assembly of these modules use capital-intensive, high-speed surface mount placement equipment and assembly processes in Mexico, Europe, Northern Africa, and China, as well as electronic system products and their applications (Duddy, 2018). Currently, Lear Corporation is aligned to trends as per their design processes and manufacture products across their entire E-Systems portfolios that are aligned with the trends toward electrification, connectivity, autonomy and shared mobility (Lear Corporation, 2020).

### *2.7.7 Supplier company: Schnellecke Logistics*

Schnellecke Logistics is a warehousing, component assembly, production supply, distribution logistics and transportation company, which covers the entire value chain of logistics with coverage globally, and IT processing is one of Schnellecke core competences (Lambert, Stock and Ellram, 1998). Schnellecke Logistics has branches in South Africa, based in the following towns/ cities - East London, Johannesburg, Pretoria, and Uitenhage. Other tasks of the logistics company include supply logistics which include material supply of production with vendor parts and modules, warehouse management and order picking, sequencing, line feeding, container and empties management, and the entire material flow management.

Caridade, Pereira, Ferreira and Silva (2017: 1096-1103) analyses the logistics warehouse in the automotive industry as one of the leading industries that contribute significantly to its agile nature whereby warehouse activities are optimised. As such, due to the changing nature of technology, these warehouses for the purpose of development, were restructured to optimise various company warehouse functions and Schnellecke Logistics was one such company using digitisation in the form of a warehouse management system (WMS) to automate its warehouse functions.

Bartholdi and Hackman (2008:18) describe their warehouse logistics as a warehousing, component assembly, production supply, distribution logistics and transportation company, which covers the entire value chain of logistics with global coverage, and IT processing is one of Schnellecke core competences. Schnellecke Logistics has branches in South Africa, based in the following towns/ cities - East London, Johannesburg, Pretoria, and Uitenhage. Other tasks of the logistics company include supply logistics embracing material supply of production with vendor parts and modules, warehouse management and order picking, sequencing, line feeding, container and empties management, and the entire material flow management.

Pandian (2019:63-72) describes artificial intelligence applications in smart warehousing environments for automated logistics, such as the tasks carried out in Schnellecke of packaging logistics, which entails the packaging of parts in shipment sizes for transport to foreign production plants and the complex spare parts logistics, including the complete shipping organisation and the necessary sequencing and picking of parts and assemblies for numerous global brands at multi-centres located close to the plants, and delivery to the point of assembly on the production line. Schnellecke also undertakes an array of tasks in the module assembly for many major manufacturers in the development of the assembly and delivery process, assembling components worldwide, and delivering them just in sequence to the production lines, as per the automotive requirements of the major OEMs.

Hermansson and Möller (2016) add the digitalisation of supply chains adds value, as seen in Schnellecke which handles the responsibility of the distribution logistics that includes managing the warehouse, whether with or without a refrigerated section, handling the goods receiving, storage and picking of goods, based on customers' orders, and delivery. Schnellecke uses the most modern equipment, the latest information technology, numerous innovations, and a high degree of standardisation in its operations (Schnellecke, 2021). Schnellecke is currently exercising a wide variety of digitalisation that has become an important value-adding factor in the logistics sector. However, current studies show that although logistics companies now frequently use technologies such as warehouse management software, tablets, or Google Glass, these are mostly locally isolated solutions. Lagorio, Zenezini, Mangano and Pinto (2022:1043-1066) discuss innovative technologies currently being adopted in the management of logistics in various logistic companies in order to increase its productivity, allow for better communication and the scaling down of costs, as the current technology in the logistics sector is fragmented.

Hence, Schnellecke, has developed a comprehensive framework called Schnellecke iX+ that combines many individual measures into an integrated whole. The “i” stands for intelligent, the “X” for transparency (x-ray) and the plus sign for the next stage of development. “In the future, the focus will be on increasing productivity and ensuring transparency and flexibility along the supply chain” (Schnellecke, 2021:1).

## 2.8 The theoretical framework

This chapter considers the theory behind the problem by examining the theoretical framework that is a structure used to detail how the study, philosophically and methodologically, approached the whole study (Grant & Osanloo, 2016). This chapter discusses theoretical frameworks, theories and models that guided this study. The chapter is organised in the following manner: the first section, discusses the social cognitive career theory, this theory is relevant and was utilised to understand the factors influencing individuals’ decisions to pursue or abstain from new occupations and emerging industries as part of industrialisation, as well as to devise strategies and is therefore relevant for workers. The next section discusses the career construction theory and practice (CCTP) and this theory assists in analysing workers’ identities, and linking these with current and prospective work encounters that can bring about a sense of significance and provide guidance and intentionality in workers’ occupational responsibilities when faced with problems in their workplace. Section 2.2.3 discusses the theory of the psychology of working and this theory suggests that there is an increasing significance in highlighting the occupation experiences of workers who diverge from traditional career paths which is relevant in this study where we see the problems experienced by workers as a result of job changes.

In section 2.8.4, the (PWT) assists our understanding in light of the continued divide observed in the OEMs and supplier companies’ job roles and it is relevant in explaining the context of the study in that it assists in understanding how workers encounter a limited range of job alternatives and experience intensified problems in securing adequate employment, based on their skills and capabilities and competence for new job roles. Hence, the following theories were chosen is because they coincide with this study and the application of theoretical models in the context of the Fourth Industrial Revolution is important in shaping discussion around problems and prospects.

Therefore, this section, the (SCCT), and the (CCTP), the theory of psychology of working and the (PWT) are discussed as linked to the conceptual framework to succinctly relate to the

Fourth Industrial Revolution and the future of Jobs: Problems and prospects in the South African Automotive Industry rationale.

### *2.8.1 Self-career Construction Theory.*

The (SCCT), as proposed by Lent and Brown (2013) and previously discussed by Lent, Brown, and Hackett (1994), appears to be a suitable framework for comprehensively elucidating the concept of career self-management throughout an individual's lifespan. This framework can also be utilised to understand the factors influencing individuals' decisions to pursue or abstain from new occupations and emerging industries, as well as to devise strategies for supporting individuals in making informed career choices in these domains. According to previous studies conducted by Sheu et al. (2010) and Sheu and Bordon (2017), the level of self-efficacy beliefs and outcome expectations significantly influence an individual's inclination towards new occupations or industries.

The high self-efficacy expectations regarding the tasks associated with these new job opportunities, along with the perceived desirability of job characteristics and work outcomes, are key factors in shaping one's interest in pursuing a career. It is therefore crucial to consider the influences and obstacles originating from the perspective of economic factors, such as work-related factors and environments. These factors play a significant role in comprehending the circumstances under which individuals decide to pursue and eventually engage in new occupations and industries that arise as a result of digitisation and automation.

Further, the extension of the social cognitive career model to encompass career self-management, as proposed by Lent and Brown (2013), appears to be well-suited for elucidating career development concerns within the context of a technologically advanced and automated economy. With the growing prevalence of self-employment and the perpetual requirement to continuously enhance one's skills and knowledge to adapt to technological advancements, the significance of career self-management is anticipated to become increasingly prominent.

The utilisation of the social cognitive framework can serve as a valuable tool for elucidating, examining, and intervening about the determinants that facilitate and drive individuals to proactively engage in career management through diverse self-directed career behaviours. For instance, the establishment of robust networks across professional and organisational boundaries may become progressively more crucial in ensuring ongoing employment stability. One additional crucial self-directed career behaviour within this particular context involves the continuous enhancement of one's professional skills. This phenomenon can be observed through the pursuit of formal education, as well as the engagement in lifelong learning activities. Moreover, it is relevant to the enhancement of job-related competencies through the process of adapting to and collaborating with dynamic systems and evolving technologies (Curran, Gustafson, Simmons, Lannon, Wang, Garmsiri, Fleet, & Wetsch, 2019:74-93).

The expectation for ongoing education and the cultivation of skills imposes a significant responsibility on individuals, and it is important to acknowledge that not all individuals will possess the ability or inclination to meet this demand. The social cognitive model provides a valuable framework for comprehending the factors that facilitate and drive individuals to engage in self-directed career behaviours, including networking and upskilling (Mullins, 2019). Additionally, it offers insights for developing interventions aimed at supporting individuals in these endeavours. According to the (SCCT) and recent studies conducted by Lent, Ezeofor, Morrison, Penn, and Ireland (2016), individuals with high levels of self-efficacy and positive outcome expectations regarding career-related activities, such as networking and learning, are more likely to establish goals associated with these behaviours. The implementation of these goals and subsequent career outcomes are influenced by factors such as personality traits, contextual supports, and barriers.

### *2.8.2 Career Construction Theory and Practice (CCTP)*

The advent of the fourth industrial revolution presents a growing challenge for individuals in establishing a coherent professional identity and deriving personal fulfilment from their work. The utilisation of the Career Construction Theory and Practice (Savickas, 2013) provides counsellors with a valuable framework to aid individuals in establishing a sense of coherence and purpose throughout their varied professional endeavours.

According to the Career Construction Theory and Practice approach, based on the escalating automation of work as part of 4IR, this will significantly influence work job experiences and therefore, this theory bring to light the issues of career and skills development, as well as the current models of career growth during which the models are analysed to identify the most suitable model for the enhancement of careers, which is relevant in this study context (Hirschi, 2018: 192-204).

The concept of life design, as proposed by Savickas et al. (2009), is central to the framework of CCTP. This approach emphasises the development of a comprehensive professional identity that considers various aspects of one's life beyond work, including leisure activities, family relationships, and community involvement. The diminishing significance of work roles for certain individuals, coupled with the growing integration of digitisation and automation in both work and non-work domains, underscores the rising necessity of cultivating a comprehensive sense of identity that encompasses both professional and personal spheres. Career construction and life design are effective approaches that can assist individuals in discovering significance and a sense of purpose that encompasses their professional endeavours, as well as other aspects of their lives. It is also a focus on organising existing knowledge and generating new knowledge on work that will assist in promoting work and life outcomes (Lent, 2004:101).

Career adaptability is a significant aspect of CCTP and life design that has garnered substantial research focus in recent years (Rudolph, Lavigne, & Zacher, 2017: 17-34). Career adaptability refers to a psychosocial concept that encompasses an individual's abilities to effectively handle career-related problems and successfully integrate their identities within a professional context (Savickas, 1997; Savickas & Porfeli, 2012). In light of the escalating pace of technological advancements, the realm of career development has witnessed heightened dynamism. Consequently, the ability to effectively navigate shifting circumstances and procure employment that imbues individuals with a profound sense of significance and direction is poised to assume greater significance for a substantial portion of the population. The concept of career adaptability can provide insight into the psychosocial resources individuals require to effectively navigate the demands of an evolving work environment characterised by digitalisation and automation. Nevertheless, it is imperative to acknowledge that career adaptability resources constitute merely one aspect of a more comprehensive array of career resources that individuals require to effectively cultivate a career (Hirschi, 2012). It is imperative to additionally contemplate the role of human capital resources, social capital resources, and environmental resources (such as organisational and labour market resources) in facilitating the individuals' ability to manage and adjust to the ongoing transformations in the workplace.

#### *2.8.3 The theory of psychology of working*

The evolving landscape of employment suggests a growing prevalence of individuals who lack permanent employment with a single employer and instead engage in a sequence of autonomous tasks and projects (Brynjolfsson & McAfee, 2014; De Stefano, 2016). This presents significant problems in terms of how work can effectively meet fundamental human needs related to security, survival, social interaction, and individual autonomy. This implies that there is an increasing significance in emphasising the career experiences of individuals who deviate from conventional career trajectories, as suggested by Blustein (2006). Nevertheless, a common criticism directed towards numerous career development theories and frameworks is that they were originally formulated to elucidate and are primarily applicable to the career decisions and professional growth of individuals with higher levels of education, predominantly men engaged in white-collar occupations.

In contrast, the career experiences of individuals from low socio-economic backgrounds and those engaged in lower-qualification or blue-collar occupations have received limited attention in the current discourse on careers (Blustein, 2006; Richardson, 1993). Hence, career research must expand its purview and employ theoretical frameworks capable of encompassing career trajectories. These frameworks should possess the capacity to apply to individuals who lack permanent employment, engage in multiple jobs, or face limited prospects for career advancement. The Potential Work Trauma framework, as proposed by Blustein (2006) and further discussed by Duffy, Blustein, Diemer, and Autin (2016), offers a valuable approach to tackling the aforementioned concern. This is due to its specific origins in addressing the work experiences of marginalised individuals and those from lower socio-economic backgrounds who possess limited financial and social capital.

### *2.8.4 Psychological Well-Being Theory (PWT)*

The Psychological Well-Being Theory (PWT) acknowledges the significance of work as a fundamental component of human existence, emphasising its crucial role in promoting mental well-being. This is attributed to its ability to satisfy key psychological needs, namely, competence, relatedness, and autonomy. The concept of (PWT) is founded upon an expansive interpretation of work, encompassing caregiving activities that occur beyond the realm of the marketplace. Moreover, it recognises the interconnectedness of work and non-work domains in the lives of individuals. Further, the theoretical framework emphasises the importance of considering social, political, economic, and historical factors to comprehensively understand work experiences. In light of the ongoing polarisation observed in the job market, as discussed by Autor (2015), it is anticipated that a growing proportion of individuals may encounter a restricted range of career options and encounter heightened problems in obtaining satisfactory employment.

The concept of decent work, encompassing aspects, such as physically and interpersonally secure working conditions, reasonable hours that allow for leisure time and sufficient rest, organisational values that align with familial and societal values, fair remuneration, and access to adequate healthcare, has been defined and emphasised by the International Labour Organisation (2012) and by Duffy et al. (2016). Although the origins of (PWT) do not stem from a deliberate analysis of the growing digitisation and automation in the labour market, its emphasis on marginalised individuals, work volition, and decent work offers a valuable foundation for tackling significant obstacles in career development within a digitised and automated economy.

There is a consensus among various sectors of society, including politics, education, and business, that the process of digitisation and automation will bring about significant transformations in work in the coming decades (Frey & Osborne, 2013; Brynjolfsson & McAfee, 2014; De Stefano, 2016). Nevertheless, the existing body of literature on professional career development and vocational psychology has yet to comprehensively address the systematic implications of these changes within the field. This discussion presents an overview of significant trends about which career researchers and practitioners should be cognizant in order to tackle this matter. Consequently, this analysis was conducted to evaluate the degree to which existing prominent theories and frameworks of career development are appropriate for addressing the emerging issues. It is important to recognise that there may be additional frameworks and approaches that have not been discussed in this analysis, which could provide valuable perspectives on the topic of digitisation and automation of work. The choice of the models and frameworks presented in this study is inherently subjective and constrained by the limitations of available space and time.

## 2.9 Conceptual framework

There is consensus that better job prospects can only increase as economic transformation proceeds and the term "economic transformation" is used to describe a pair of interrelated development processes: (i) the relocation of labour and capital from low-productivity, low-earning sectors like traditional agriculture to higher-productivity sectors through the increased entry and growth of firms in the higher-productivity sectors; and (ii) the improvement of productivity within sectors, particularly the lower-productivity ones (Fox & Thomas, 2016). New technology (e.g., mechanical, digital, and management technology) and better resource allocation (physical resources, including land, human, and financial resources) have contributed to economic transformation by lowering production costs and increasing the variety and sophistication of what is produced (in economic terms, the value added).

McMillan et al. (2017) argue that economic transformation is a necessary condition for sustained economic growth and development. The following indicators indicate how far economic transformation has progressed: (i) increases in labour productivity within sectors; (ii) employment and output shifting to higher labour productivity sectors; (iii) export diversification, increased domestic value addition in exports, and value chain upgrading; and (iv) convergence in labour productivity across the economy (McMillan et al., 2017).

The process of economic transformation facilitates the expansion of labour earnings within the economy, along with a corresponding shift in employment patterns. This shift entails a change in the proportion of individuals engaged in self-employment and family-based enterprises in households, firms and microbusinesses, towards wage-based employment in private firms or the public sector (Fox & Thomas, 2016).

This phenomenon arises when the rate of growth in wage/salary employment surpasses that of the labour force. The majority of individuals in the labour force tend to favour formal wage/salary jobs due to their comparatively lower income risk when compared to self-employment and family employment in the informal sector (ILO, 2021a). According to previous studies (Fox et al., 2016; PfPC, 2018; Lorenceau, et al., 2021), the aforementioned occupations are commonly sought after by African youth upon their completion of formal education. Historically, the predominant focus of economic transformation analysis revolved around structural change, with particular emphasis on the expansion of manufacturing output and employment. This sector has traditionally played a significant role in generating a substantial portion of new wage-based employment opportunities (McMillan et al., 2017). In recent times, there has been a notable shift in the attention of authors towards various other sectors (Gollin, 2018).

The process of economic transformation in developing countries has been observed to have a positive impact on employment opportunities and poverty reduction (Fox & Gandhi, 2021). However, it is important to note that this desired outcome is not guaranteed and can vary depending on various factors.

It is important to acknowledge that the mere presence of labour productivity gains facilitated by novel technology does not inherently result in the creation of additional employment opportunities. The creation of new employment opportunities can be attributed to two main factors. Firstly, when productivity gains are achieved, resulting in a reduction in production costs, the demand for goods and services increases. Consequently, firms can expand their output by recruiting additional workers. Secondly, the entry of new firms into the market leads to the production of novel items, thereby generating fresh employment opportunities. In the automotive field of, it is observed that productivity improvements within the sector, known as sectoral transformation, have resulted in increased incomes but a decrease in employment growth. However, these gains have had a positive impact on employment growth in non-automotive sectors through multiplier effects. This phenomenon, referred to as structural transformation, has been discussed by Jayne et al. (2020).

The process of transformation generally leads to an overall improvement in employment opportunities. However, it is important to note that this process often involves both the acquisition and loss of jobs and occupations. The acquired employment opportunities may not inherently possess a higher level of desirability compared to the employment opportunities that have been relinquished. Hence, it is necessary to thoroughly analyse the potential impact of integrating the new Fourth Industrial Revolution (4IR) technologies in Africa, not only in terms of their capacity to facilitate economic transformation, but also regarding the nature of employment opportunities that may arise, the potential job losses, and the specific societal groups that may be affected.

Ideally, the newly created employment opportunities will be designed to enhance development. This implies, as articulated by Sen, that these jobs should contribute to the improvement of individuals' capabilities to lead lives that they have valid reasons to value (Sen, 2001:53). Within the realm of employment, Sen's notion of ethical development outcomes has been commonly referred to as "decent work." The International Labour Organisation (ILO) defines decent work as the provision of comprehensive employment opportunities that encompass both productivity and rights at work, accompanied by social protection measures and the facilitation of social dialogue (ILO, 2021b). The dimensions of decent work are influenced by a nation's social policies, such as the structure for employee collective action, social dialogue, and bargaining, the body of labour laws and the overseeing institutions, as well as social protection policies and institutions.

The aforementioned factors are largely unaffected by the pace of technological advancement, except in cases where technological progress facilitates economic growth and transformation.

This, in turn, aids in the generation of resources necessary for the implementation of social policies that promote decent work.

The additional aspects of decent work pertain to the attributes associated with a particular form of employment, and it is these aspects that can be influenced by the implementation of new technology (which will be the primary focus of this examination). These factors encompass preferred job classification: preferably a position that adheres to formal employment norms, including a contractual agreement and compliance with national labour laws; desired income: preferably a full-time salary that surpasses the poverty threshold.

The ideal work arrangement entails full-time employment without any instances of involuntary part-time work or excessive overtime. Additionally, it is crucial to ensure equal access to employment opportunities without any form of discrimination. Also, it is important to maintain a safe working environment with a low likelihood of occupational injuries (ILO, 2021b).

Among the various dimensions, the distinction between formal and informal employment holds the greatest significance. This is because other elements of decent work, such as social protection, rights at work, freedom from injury, and social dialogue, are predominantly upheld through government regulations imposed on employers. This enforcement is considerably simpler when firms are officially registered with the government, provide employment reports, enrol employees in public social protection programmes, collect employee contributions for social protection systems, and adhere to certain standards.

One proposed solution is the implementation of a formalised system designed to resolve worker complaints and workplace disputes. In contrast, it is important to note that self-employment and family employment typically lack coverage under labour and social protection laws and institutions, regardless of whether they are situated in developing or developed nations. Self-employed individuals, along with their families, lack a formal labour contract between themselves. The determination of self-employment income is challenging, making it difficult to collect contributions for social protection systems. Further, self-employment earnings are not insurable due to the presence of moral hazard.

Employees who are classified as informal typically experience a lack of social protection, resulting in a lack of social insurance coverage. Consequently, they may encounter heightened vulnerabilities, such as increased exposure to hazardous and unhealthy working conditions, as well as potential mistreatment or exploitation.

The income generated from the informal sector is characterised by increased levels of risk and volatility. Consequently, households reliant on informal income exhibit a greater proportion of individuals classified as the working poor (Fox et al., 2020).

Self-employed individuals, who exclusively work with members of their household, or operate a microbusiness with a limited number of casual employees face a significant level of risk as they lack a guaranteed minimum income.

Instability is a prevalent issue due to the transient nature of work activities in various sectors, such as agriculture, informal businesses, and formal employment. These activities are often subject to temporary or seasonal fluctuations, including casual daily labour tasks, such as temporary wageworkers or unskilled construction workers. This phenomenon gives rise to under-employment, which refers to the inability to secure sufficient working hours throughout the year, consequently resulting in a diminished level of income (Fox & Thomas, 2016).

The literature on the Luddites, assist us by displaying the inter-relatedness between the implementation of technologies and the state, for example despite the Luddites experienced the technology as destroying their jobs and thus they resorted to removing the technology, the British State then sent in soldiers to disperse them. The current revolution however which operated in a modern setting might see a different form of impact on technology such as a skills bias approach O'Rourke, K.H., Rahman, A.S. and Taylor, A.M., (2013: 18-23).

The proportion of informal employment within the overall employment framework typically diminishes as nations undergo transformation and progress. The growth of 'gig' employment has contributed to a recent deceleration of this trend in upper-income countries (ILO, 2016). Although 'gig' employment may be considered formal in certain instances, it is predominantly characterised by heightened income instability, increased risk, and a lack of adequate protection. In this study, our primary objective is to examine the potential impact of adopting Fourth Industrial Revolution (4IR) technology in Africa. Specifically, we aim to assess whether this adoption can lead to a reduction in the proportion of informal employment by promoting the growth of formal jobs through the establishment of new firms and an increase in the prevalence of formal, wage-paying positions within the overall employment landscape. Additionally, we seek to investigate whether the implementation of 4IR technology can contribute to higher earnings for individuals employed in various job sectors, regardless of the nature of their employment. However, before evaluating the future, it is important to acquire knowledge about the African continent.

## 2.10 Chapter summary

This chapter provided insight into the various studies that have been done in the area of technological changes and their impact on jobs. The chapter then continues with relevant literature attributed to fourth industrial technological changes and the automation of jobs. It further includes literature that discusses the impact of 4IR technological changes on workers' jobs, the impact of 4IR technologies, specifically on jobs in the automotive industry, the problems of 4IR for workers, the potential impact of the 4IR technologies on workers and jobs in South Africa, as well as skills development in preparing the current workforce for new technologies, the reshaping of the industry using new technology implemented in companies.

The literature is then sharpened and narrowed to include the automotive industry specifically; its operating structure which contextualises the impact of 4IR in South Africa in the automotive companies, specific for this study, in which workers operate and that have implemented the same type of unified production operations and changes in their plants, both in SA and globally. The relevance of the conceptual and theoretical framework shows how technological advances' implementation impacts on workers. Further literature included in this chapter discusses, in detail, the theory of each article and gaps in the various research that exists, which the research question and objectives of this study is intended to bridge such gaps. The next chapter of this study consists of the research methodology that was adopted in this study.

# CHAPTER 3: RESEARCH METHODOLOGY

## 3.1 Introduction

The previous chapter outlined the literature review. This brought to light some of the theories, such as the social cognitive theory as well as the (PWT) that emphasise self-management, which bases its views on new occupations and industries. These theories set the scene and are relevant for this chapter on the research methodology, of which the focus and approach is on workers' experiences as they are the ones impacted by new technologies, as outlined by the research questions and objectives of this study. Some of the research questions were on how the new 4IR technologies impacted job roles and responsibilities within the automotive industry, specifically at OEMs, and supplier companies, as well as the specific organisational problems faced by workers during the implementation of 4IR technologies and how these problems affected workers' employment conditions. Further, the research objectives were to explain how new 4IR technologies are impacting workers' jobs by means of actual job changes that analyse some of the worker organisational problems as well as to close some of the gaps in previous literature, by identifying automotive worker specific problems, and to design a participatory model for workers and automotive industry employers, thereby addressing the research problem under investigation which was to identify how the introduction and implementation of 4IR technologies on workers' jobs in the production plants in OEMs and supplier companies are impacting workers. Hence, this chapter presents the research methodology that was adopted to conduct this study.

The research methodology adopted, focused on a qualitative approach. This approach was appropriate, as it analysed the problems experienced by workers as a result of technological advances introduced at the various companies due to the 4IR that is impacting workers and was able to assist in defining the kinds of problems faced by workers. With this in mind, the design and plan of the data collection using interviews was appropriate to obtain the participatory input of workers' experiences, which contributed significantly to the study findings, conducted via email and Microsoft Teams virtual platform throughout the study. Workers participating in this study were from the automotive industry, currently employed at various OEM plants, as well as supplier companies that are concurrently implementing automation in their production lines of motor vehicle manufacturing. Worker participants were drawn from the (OEMs), and two supplier companies that were used in the study, hence the methodology was centred on this approach.

## 3.2 The research design

The research design used for this research study was a qualitative research design. According to Houghton, Casey, Shaw, and Murphy (2013:4), "qualitative research is a process of naturalistic inquiry that seeks in-depth understanding of social phenomena within their natural setting. It focuses on the 'why' rather than the 'what' of social phenomena and relies on the direct experiences of human beings as meaning-making agents in their everyday lives"; qualitative research aims to understand, from within, the subjective reality of the study participants. This study adopts this rationale of "social phenomena within their natural setting" to explain how the controlling principles of technological processes and change like work are impacting workers in their everyday lives. Therefore, these "social phenomena" are based on workers' experiences at their vehicle production plants as their "natural setting," as described by Houghton et al. (2013).

This study utilised Flick's (2013) method of a combination of descriptive and explanatory methods, which describe the impacts of the 4IR experienced by workers, as well as explaining some of the problems. The purpose of descriptive research is to describe the state of affairs, describing the current situation faced by workers on the shop floor (Kothari, 2004). As such, the research design for this study is a logical progression of stages or tasks, from problem formulation (impacts of the 4IR) to the generation of conclusions or theory (possible solutions), which are necessary for planning and carrying out the study (Creswell, 2019; Marshall & Rossman, 1999). The concept of research methodology is defined by Schwardt (2007) as being a theory of how an inquiry should proceed and involves analysis of the assumptions, principles, and procedures in a particular approach to such an inquiry.

According to Schwardt (2007), and Creswell et al. (2009), methodologies explicate and define the kinds of problems that are worth investigating, and how to frame a problem in such a way that it can be investigated using particular designs and procedures. In addition, it guides the research on how to select and develop appropriate means of collecting data. This type of study design is necessary to describe this research topic and is a plan of implementation on how the research process is undertaken, together with the required instruments to achieve the desired research objectives (Flick, 2013). Ultimately, the overview of the study area focuses on a qualitative approach, based on a case study, using a sample size of four automotive plants (shop floor) consisting of a total of 13 participants in the respective plants impacted by digitalisation.

This was followed by using methods of data sources (interviews) to develop a comprehensive understanding and by testing the validity through the convergence of information from different sources, of the phenomenon of the Fourth Industrial Revolution. The chosen research design therefore constituted the principles of qualitative research approach, which shaped the research to interpret it to assess the impact of the Fourth Industrial Revolution on workers using interviews to bolster the findings of the study.

## 3.3 Research population and sampling

### *3.3.1 Research Population*

The research population is described as the population as an aggregate or totality of all the objects, subjects, or members that conform to a set of specifications (Polit & Hungler, 1999). The research population and unit of analysis in this research study were both male and female workers in the automotive industry working for the OEMs, as well as from the vehicle supplier companies in South Africa. This particular population was selected to give expression to different kinds of impacts of 4IR on job roles in the industry. The research population were 13 workers in total, shop steward representative of OEMs, supplier companies and skills development institutions, as well as a trade union automotive co-ordinator. The majority of the respondents population were shop stewards and the rationale for this majority population was because shop stewards have the intricate knowledge of the various job changes taking place in their companies from a technical and practical point of view. Other respondents (union official) provide an operational view and the strategic policy views are provided by the SETA respondents.

### *3.3.2 Sampling Type*

Purposive sampling is widely used in qualitative research for the identification and selection of information-rich cases related to the phenomenon of interest (Palinkas et al., 2015). The choice of purposive sampling for this study was based on the aim of the research (Ritchie, Lewis, Nicholls & Ormston, 2014). In this case, to explore the impact of digitalization on jobs, shop stewards of automotive companies, both OEM and supplier companies, as well as skills development stakeholders and a trade union official were selected in the sample type. The differentiation between a shop steward and an official is that a shop steward works in the OEM and Supplier Companies and has practical and technical production experience as compared to a trade union official who has a more operational experience of the automotive industry. Hence both participants contributed different perspectives. Purposive sampling that included choosing individuals who have certain qualities or experiences that are pertinent to the study, was used (Creswell, 2019). This was chosen as the researcher was interested in the experiences of persons who have been impacted by these technologies. The sampling selection was based purely on who was available and on which case studies would serve the purpose of this research (Ritchie et al., 2014). The rationale behind the use of purposeful sampling in this study was to acquire a sub-set of the workers' population in the automotive industry who would contribute to a good representation of the industry to avoid bias (Economic Times, 2020).

### *3.3.3 Sampling Size*

Sampling is a process, act, or technique employed in research to systematically select a relatively smaller number of population-representative from a pre-defined population to serve as subjects in the study (Sharma, 2017). The following table depicts the sample size and the number of respondents, as well as the number of interviews conducted for the research study. This research sample size was determined using a total of 13 participants. Each participant selected, contributed to the research in terms of addressing the research questions, objectives and the research problem at hand, hence participants selected were representative of the automotive industry both from OEM and supplier companies and relevant participants representing the current skills development landscape, that is, the SETA (sector education training authority) and the SAQA (The South African Qualifications authority). The selection of the combination of participants add value to the study as each participant shares different perspectives and experiences as a result of technological advances in the automotive industry. The sample size was also largely determined during the time which the study was conducted which was during the Covid pandemic. This also contributed to how the study was conducted, however all ethical processes were followed.

**Table 3.1: Table of sample size and the number of respondents**

| | | | |
|---|---|---|---|
| OEM plants | BMW SA<br>Shop steward | 5 Interviews | = 5 |
| | VWSA<br>Shop steward | 3 Interviews | = 3 |
| Supplier Company | Lear Corporation SA Shop steward | 1 Interview | = 1 |

| | | | |
|---|---|---|---|
| Logistics Company | Schnellecke SA<br>Shop steward | 1 Interview | = 1 |
| Trade union Official in the Automotive Sector NUMSA (1 Interview) | | | = 1 |
| Stakeholder interviews (SETA & SAQA) (2 Interviews) | | | = 2 |
| **Total Sample Size** | | | **13** |

## 3.4 Data gathering procedure and methods

### *3.4.1 Interviews*

As a preferred and ethical method of data collection during a Covid pandemic, interviews, as described by Gill, Stewart, Treasure and Chadwick (2008), was used to explore the views, experiences, beliefs, and motivations of individual participants. The selection of interviews as the data-collecting instrument in this study is because interviews would better assist in explaining the experiences of workers at their various companies from their point of view. According to Fontana and Frey (2005), unstructured interviews, as a qualitative research method for data collection, are an effective tool to access people's experiences and participants' inner perceptions, attitudes, and feelings of their reality. Further, unstructured open-ended interviews assisted in obtaining in-depth information from workers without limiting their views, which could be the case using another method of data collection. Such interviews contributed to the study, as the workers' views were unfiltered and they were free to express themselves without fear or favour (Weller, Vickers, Bernard, Blackburn, Borgatti, Gravlee, & Johnson, 2018).

The participants interviewed in this study were all South Africans, adults working in the OEMs and supplier companies, above the age of 18. The workers who were interviewed also chose to remain anonymous in the process. These interviews were an effective method of generating and interpreting workers' experiences and points of view (Ritchie et al., 2014). The study utilised interviews with a manager in the automotive industry to source input from an operational perspective in explaining how digitalisation has changed operations in the work plant. Interviews with various stakeholders were in the form of unstructured open-ended questions. Interviews with workers were undertaken, nationally, in South Africa and were conducted via an online platform. Different numbers of participants were selected for different institutions, as shown in the table of sample size ,and the number of respondents and the rational for using a combination of participants was because each participant presented different views, technical views by shop stewards, operational views by the trade union official and strategic policy views presented by institutions as a whole for e.g. the SETA as an organisation gives an holistic skills approach to 4IR for the entire automotive industry. The justification for using online interviews conducted in the study was due to the period in which the study was being conducted and the global shutdown during the Covid 19 pandemic as the country was in a state of disaster and online platforms were the only mandatory means of conducting the study and taking into account all ethical aspects of the research requirements that had to be adhered to. Participants also found this the most suitable and safe method at the time, due to the nature of the circumstances.

### *3.4.2 Nature of Data in the Interviews*

Unstructured interviews do not reflect any preconceived theories or ideas and need little or no organisation (Gill et al., 2020). The interviews were guided on the topic of digitalisation in the workplace. The practical experiences of workers were shared using a set of pre-determined open-ended questions. In-depth questions directed at workers included company dynamics, geographic footprint, production processes, market information, such as imports and exports, specific information from employees relating to the company, impacts of the introduction of technology in their specific plants, labour broking, skills development strategies or gaps, shop steward structure and collective bargaining agreements in place. Further questions regarding supplier companies were conducted to determine the level of implementation of technology and its impact along the value chain.

## 3.5 Data analysis strategy

Data collection and analysis tools are defined as a series of charts, maps and diagrams designed to collect, interpret, and present data for a wide range of applications and industries (ASQ, 2020). The NVivo tool of thematic analysis was used to analyse data in this study. It was important to transcribe the audio recordings of the interviews in a verbatim manner to guarantee precision and inclusiveness.

The following table summarises the approach undertaken using thematic analysis

**Table 3.2: Thematic analysis**

| Approach and steps | Description |
|---|---|
| Importation of transcribed data | The initial step involves importing the interview transcripts into the NVivo software. It is necessary to establish a systematic organisation of data, wherein the responses of each interviewee are meticulously categorised and stored in distinct compartments |
| Familiarisation with the Data | A thorough examination of the interview transcripts to gain a comprehensive understanding of the text facilitates the acquisition of a deep understanding of the data. |
| Data segmentation | Involved dividing a dataset into distinct and meaningful subsets based on specific criteria or characteristics |
| Generation of codes and coding | Generation of nodes (codes) within NVivo to symbolise the themes or concepts that pique your interest. The nodes serve as categorical entities that facilitate the organisation and analysis of data. |
| Code Refinement | Code Refinement involved improving the quality and efficiency of computer code. It aimed to enhance the code's readability, maintainability, and performance without altering its sense |
| Development of themes | After completing a substantial portion of data coding, the codes were analysed to identify any potential connections and patterns. Themes began to emerge in this context. |

Source: Nowell et al., (2017)

Using thematic analysis, was used as a methodological approach to distinguish and establish prominent themes and patterns within the dataset obtained from the interviews. This process entailed becoming acquainted with the data through repeated readings of the transcripts. The process of generating initial codes involved the identification of significant features or concepts within the data. The process involved organising codes into thematic categories that effectively encapsulate the underlying content of the data. The process of reviewing and refining the themes is undertaken to ensure that they possess a high degree of coherence and relevance. The data was interpreted by establishing connections between the identified themes and findings and aligning them with the research objectives and questions. This analysis aimed at establishing correlations between the prevailing themes and offered valuable perspectives on the impact of Fourth Industrial Revolution (4IR) technologies on job roles and responsibilities within the automotive industry.

Triangulation was also used which involved the use of multiple sources or methods to gather and analyse data to enhance the quality of the data generated from the interviews. It involved incorporating various sources of data, such as secondary data, company reports, and academic literature, to validate the findings and strengthen the reliability of the research.

### *3.5.1 Validity*

According to Heale (2015), validity relates to the consistency of measures. In addition, it is a method that measures the characteristic or trait of interest (Bolarinwa, 2020). The questions in the interview process were formulated to achieve validity in this study. This process was conducted by ensuring that questions were standardised and easily replicated. In so doing, the interview could be repeated through a test-retest procedure, which involved administering the same measurement instrument of an interview to the same individuals, under the same conditions, after a period. The same respondents from the selected sample size were used throughout this study. A consistent number of workers, as indicated in the sample size, were used to share their experiences. The South African case study method produced stable and consistent results due to the standardised format of the interviews completed by the respondents and the input that the research aimed to achieve.

### *3.5.2 Reliability*

Reliability, according to Bolarinwa (2020), is the extent to which an interview, a test, an observation, or any measurement procedure produces the same results on repeated trials. A specific measure is considered reliable if its application on the same object of measurement several times produces the same results (Research Methodology, 2020). Each question in the interview contained a value attached to it. On completion of the interview by respondents, the responses were analysed accordingly, to ensure reliability and stability. The reliability of this study included retesting the same number of participants on the same interview at a different time to compare their input with the previous interview responses. Hence, the reliability of the research lies in the input obtained from the interview results.

## 3.6 Ethical considerations

According to Connelly (2014), authors are required to report on the ethical considerations of their research to ensure participant consent in the areas of voluntary participation, safety, confidentiality, and anonymity. According to Orb, Eisenhauer and Wynaden (2001), ethics pertains to doing good and avoiding harm. Harm can be prevented or reduced through the application of appropriate ethical principles. Thus, the protection of human subjects or participants in any research study is important (Orb et al., 2001).

Data collection involved using interviews in the study and was appropriate to obtain the participatory input of workers' experiences, which contributed significantly to the research findings. All data collection methods were done on a virtual and electronic platform (Microsoft Teams as well as email), mindful of the COVID-19 pandemic.

**Before the Study:** Research involving human participants accompanied the consent documents that addressed the specific study. In this specific research, the consent of shop stewards, managers, and trade unions was enlisted. The informed consent of workers was obtained and a sufficient amount of information about the study was provided to the participants for them to make an informed decision and understand the implications and their contribution towards the study. This was also to ensure that information supplied by the workers would remain anonymous, as the study needed to protect the workers' identity, as well as their right to human dignity and autonomy in answering questions and providing further details. All company data and statistics comprised information that was already in the public domain and no confidential documents or data were sourced without the consent of participants. Research participants were informed of their right to abstain from participating in the study, or to withdraw from participating in the study by revoking their consent at any time, without suffering prejudice or reprisal. The study applied the principle of informed consent as an on-going process during the research.

**During the Study:** The researcher acknowledged all the sources used in the study accordingly. The interviews included information about the purpose of the study before being distributed to respondents. The identities of the respondents remained confidential during this period. All the sources were included in the list of references attached at the end of the study. The respondents were not given any token that could suggest the solicitation of bribery. Those who chose not to respond to certain questions were allowed to do so.

**After the Study:** No participants in the study were compromised in any way in terms of confidentiality of information, both personal and company-related. All information utilised in the research was public knowledge and the input of participants was consensual. The researcher analysed and reported the findings, according to the data collected from the respondents. The researcher conducting the study did not use any of the data to rubber stamp the researcher's pre-conceived conclusions. The research findings were shared with respondents before they were finalised for examination.

### 3.6.1 Limitations of the study

It is also important to note some of the limitations encountered in the study, which include workers wanting to stay anonymous during interviews, due to the nature of the information that they shared with regard to their work changes in their various roles, they wanted their views to be expressed, however on a no-name basis. Therefore, no worker's names were disclosed in this study, hence it was considered a limitation, however, workers were content to share information based on their job changes and experiences and requested that their views find expression in this dissertation nonetheless; hence this research study took into account all ethical practices in the process. Other limitations included workers' shared access to technology such as using a single laptop at their various plants to conduct the various online interviews for this study, also the challenge of them having to have access to a printer to scan and send input, however, resources were shared amongst workers to contribute to their experiences to this study and as the researcher of this study, I tried to assist where possible although there were limitations present, we managed to conduct the study with the required objectives successfully.

## 3.7 Chapter summary

This chapter discussed the research methodology and rationale of using this particular research methodology and the research design that was used in this research study which was a qualitative research design. Aspects of the research study in terms of the research population of the study was discussed.

The research population and sample size consisted of a combination of 13 participants that included shop steward representatives of OEMs, supplier companies and skills development institutions, as well as a trade union automotive official, all of which were part of the research population. The type of sampling used was purposive sampling and the justification of the data gathering procedure, conducted via an online platform, was due to the study being conducted during the period of the Covid pandemic. The data gathering procedure and methods were in the form of open-ended unstructured interviews.

Lastly, the data analysis strategy was performed by means of a thematic analysis approach in order to distinguish prominent themes and the data analysis also detailed the validity and reliability as part of the data analysis strategy. Pertinent aspects of ethical considerations were discussed, taking into account their adherence, before the study was conducted, during the study and after the study. The next chapter of this study consists of the research findings and discussions.

# CHAPTER 4: RESEARCH FINDINGS AND DISCUSSIONS

## 4.1 Introduction

The previous chapter of this study presented the research methodology used in this study. This chapter deliberates on the research findings and discussions. The aims of the research question and objectives of this research were to determine the impact of new technology on workers in production plants, the problems and prospects and the future of jobs for workers in the automotive industry. The findings of this research therefore indicate the following, based on various worker participants' input on their experiences, as well as their suggested input in the process of technological change at the workers' respective workplaces, both at an OEM and supplier level, as well as in the automotive industry as a whole. This study critically examined the literature and relevant theories as well, which served as the foundation for the development of these findings and recommendations.

The findings are systematically structured to answer the following research questions:

i. How do new 4IR technologies impact job roles and responsibilities within the automotive industry, specifically at OEMs, and supplier companies?
ii. What are the specific organisational problems faced by workers during the implementation of 4IR technologies at OEMs and supplier companies?
iii. In what ways do 4IR technologies lead to work changes in the automotive industry?

The findings from the interviews are presented according to anonymity as ***"participants 1 to 13"***. Responses that were similar have been omitted to avoid duplication of findings

## 4.2 Data presentation

The presentation of data collected is based on the three critical research questions raised in the study, which should answer the following three aspects namely:

1. Whether technology has impact on the roles and responsibilities of workers in the automotive industry?
2. Whether there are specific organisational problems faced by workers in the automotive industry?
3. Whether the introduction of 4IR technologies leads to work changes?

Based on data collected from the participants in the study, the results are presented as follows:

### *4.2.1 The impact of the 4IR technologies on job roles and responsibilities within the automotive industry*

In this research that sought to evaluate the available evidence relating to the impact of technological innovation on workers, occupations, jobs, and skill needs, the starting point for the evaluation was an assessment of how technological innovations and robotics have intersected with work organisation and the production of motor vehicles in OEMs and supplier companies in terms of the implementation of new technology and robotics. The findings of the research emanate from the analysis and results by using the applied research methodologies of online interviews that were electronically circulated to participants as well as relevant literature reviews carried out concerning the following OEMs, VWSA, BMW and in the supplier companies of Lear Corporation and Schnellecke logistics. In terms of the skills development methodology utilised, the interview sessions with the relevant skills and education training authority (SETA), were conducted based on the skills development strategy and the changing nature of jobs, taking into account the necessary problems being faced by workers and further, the development of a suggested 4IR training model as a possible prospect into the transition and integration of the new technologies in the era of the fourth industrial revolution trajectory in the automotive industry, and in practice, the OEMs and supplier companies, in this research study.

The results of the interviews, as well as the literature, show a strong indication that OEMs are automating at a rapid pace through data contained in the financial statements of OEMs and supplier companies, as well as these multinationals' level of investments in industrial robots, as seen in the South African automotive industry and globally, shown in data presented in the literature review section of this research.

Participant 1 suggested that:

> *Robotics are widely being used in production plants, almost at a rate of 90%,*

Participant 3 noted that:

> *with a fully automated body shop, paint shop and with time, increasingly workers being moved to the assembly line*

Participant 4 observed that*:*

*Job titles, such as spot welders and spray painters, as well as toolmakers, were completely replaced by robotics that now perform these tasks*

Participant 5, shared similar views that:

*The robotics are rapidly upgraded to perform even more sophisticated tasks than the previous version, to perform the few tasks originally performed by workers via manual labour.*

Participant 5, 7, 9, 12 seem to suggest that:

*the line speed of robotics places enormous physical pressure ergonomically on workers to maintain the line speed with insufficient time to have a break.*

As was observed across the interviews, prior, only certain aspects were performed robotically but now they are fully automated by using sealer robots and sucking robots and the robotics are rapidly upgraded to perform even more sophisticated tasks than the previous version, to perform the few tasks originally performed by workers via manual labour.

In the assembly line of OEMs, workers are faced with unprecedented problems with the replacement of operators by robotics and these operators moved to the assembly line, as the line speed of robotics places enormous physical pressure ergonomically, on workers to maintain the line speed with insufficient time to have a break.

Participants across seem to agree that: *the break consists of a 15-minute tea break and a 30-minute lunch break.*

Participant 2 shared that: *older workers like me were offered voluntary separation packages when certain robots were introduced, and younger workers find themselves in the assembly section of the plant also under pressure to produce and keep up with the very fast pace of the line speed initiated by the robotics at the start of production at the level of body shop down to the level of the assembly line.*

Such responses mean that once a worker leaves the organisation, either using retirement or work pressure due to line speed expectations, no replacements are being done by the OEMs, as well as supplier companies, the process of natural attrition applies. The OEMs utilise productivity concepts such as the “worker innovation” concept, basing productivity in the assembly line process on this concept. This concept is based on the premise of keeping up and maintaining line speed in conjunction with production by industrial robots, making its way down to the assembly line level.

### *4.2.2 The organisational problems faced by workers during the implementation of 4IR technologies*

In conducting the various online interviews with workers from OEMs and supplier companies and thoroughly evaluating the results systematically, core areas of problems emerged, based on workers' input in the context of worker organisational problems. The following table is a summary of problems for most workers in the core areas, as identified by the 13 worker participants in the study from the OEMs, as well as the workers at supplier companies. In the interview process, participants indicated the following factors to be critical problems faced by them at their respective production plants and supplier companies. On further data analysis of the various interviews, the following key topics were referred to and emphasis was placed on these particular factors.

**Table 4.1: Summary of the types of worker problems as a result of the implementation of robotics**

| | |
|---|---|
| • Robotics Implementation and job replacement<br>• Line Speed problems (ergonomics)<br>• Short time (fewer hours of work), lower pay<br>• Health and safety problems<br>• Productivity concept in terms of line speed<br>• Skills development problems, lack of skills strategy, investment in technologies for simulation learning<br>• Employment and placement problems - Job opportunities are limited for a particular race group | • Lack of worker involvement and consultation, rather just implementation of strategy<br>• Lack of skills accreditation<br>• No recognition of prior learning<br>• No dual training<br>• Work reorganisation<br>• Gender problems<br>• Job losses<br>• Insufficient manpower in the assembly line (natural attrition problems)<br>• Lack of investment in skills and development training and acquisition |

| | |
|---|---|
| | of new technologies for simulation learning |

Source: Author (2023)

Here, the evidence focuses on a group of technological innovation problems in the automotive plants that appear to have increasingly disruptive effects on the workers themselves and their job roles, as well. By contrast, estimates indicate a significantly stronger effect on job and occupational transformation, as tasks that make up jobs and the skills required to do them are reconfigured to accommodate technological change.

In examining the patterns of job destruction, this analysis makes known that other factors are likely to play a meaningful role in shaping patterns of net employment growth and this includes the impacts of trade and investment in shaping new productive capacity, which involves shifting employment opportunities from one location to another within global value chains. This research, after data analysis, indicates that the more profound consequences of technological innovations are likely to be apparent in the patterns of job creation and destruction. This is seen by new emerging jobs and job titles, this is broadly known as the polarisation or 'hollowing-out' hypothesis, with net job creation most concentrated in highly-skilled (and higher paying) and low-skilled occupational categories. In understanding these patterns, it was important to be cautious not to presume that the trends would be the same across countries.

### *4.2.3 Work changes in the automotive Industry*

Based on input shared from worker interviews with shop stewards at various companies, it indicated the impact of the new technological changes, both in the introduction of new technology, as well as new technological processes that took place and are still taking place at their plants, that is affecting them in terms of job roles, remuneration, and their respective conditions of employment, as contained in the bargaining agreement.

Participant 4 specifically emphasised that:

> *As an example, one illustration included the shared experience of a changing job role in the company from a storeman to being moved to a more general work area.*

In the workers' main agreement, signed between the employer and the employees, as agreed by and gazetted by the relevant bargaining council,

Participants 1-8 share similar sentiments that:

> *the agreement included providing legally binding and comprehensive conditions of employment, including minimum wage structures for all employees whose jobs are defined in the agreement*.

These include separate technical schedules, each one applicable to a particular sub-sector of the industry value chain contained in the agreement. These technical schedules detail the specific jobs, tasks and technical activities which are undertaken by employees participating in the direct production process in those sectors, based on the industry definitions applied to the OEM or supplier company.

Most participants suggest that:

> *As part of the job analysis process, some companies consult SMEs (subject matter experts), to provide insight and feedback on specific role requirements in a specific job. After analysis, some operations like "store operations" do not fit within the main agreement and therefore, the storeman position does not meet the definition requirements under the main agreement classifications, thus falling outside the companies' definition of stores*.

Such findings from the interviews with workers indicate the grey areas of changing job roles and tasks associated with a role and position changing, as a result, older workers who do not have the future requirements of the transitioned role are now at a disadvantage. Further conditions of employment changed from wages to salary with a new grade structure and new hours of work, as well as a change in operations affect how the worker is protected in the agreement, as a result of the job role becoming redundant and no longer accommodated in the newer job roles, grading structures and protectionist clauses in the guiding regulations.

Many participants suggested that *the main agreement is also no longer applicable*.

This leads to the entire change of the job profile as job roles change hence the duties and responsibilities supersede the old job titles. It has therefore become clear from the analysis of the storeman role, that the complexity and role requirements of the position had changed and could not be accommodated within the parameters, as set out in the main agreement with workers. Hence, workers' job roles performed in previous roles from the automotive body shop to the paint shop are partially, if not entirely, under-utilised in the assembly where most workers were moved to as a result of the robotics replacing their job functions. The various job roles, such as spray painter and spot welders, have transitioned from a purely manual process to a more complex process with the adoption of new technology which requires the job roles to operate in a system-driven environment now purely operated by robotics and not by a manual worker.

Based on the data analysis of the workers' interviews, there are disruptive effects of emerging information and communication technologies. This was evident when examining the numbers and types of jobs affected by developments in technology, based on the sample size and worker input, that led to significant worker dislocation to the assembly line. All of these findings relate to the future of jobs for workers as a result of the new technologies and while it is unable to predict the future, it is clear from the input shared by workers that they see their jobs requiring new forms of skills development and training and their readiness in terms of the upskilling and reskilling would impact the future of their jobs.

#### *4.2.4 The technological changes at individual OEMs and supplier companies*

These are some of the changes in the various OEMs and supplier companies, based on individual company findings.

Since most automotive production plants are similar in terms of their production and functional layout, most changes experienced by workers are technically similar for the OEMs, however, these are some of the findings experienced by workers in these specific OEMs and supplier companies with the implementation of new technologies and their impact on workers' jobs.

#### *4.2.5 The workers' experiences with technological advancements at VWSA*

Participant 9 quoted his experience with technology as follows:

> *when they bring in new robots, I get overwhelmed to think of the speed that I must keep up with and I am only human and I am not young to work fast to keep up the speed of a robotic instrumen*t"

In the OEM VW, the company has implemented various technological changes by introducing approximately 320 robots as per the workers' insight into the company production line transitions. These new laser robots and sealer robots are located in the body shop of the production plant and replace the job roles and responsibilities originally performed manually by a human worker in the job role of an operator.

Participants 1, 2, 3, 4, 6 and 9 share similar sentiments;

> *in the paint shop section of the production plant at VWSA, before technological advancements, the entire paint shop tasks were carried out manually by spray painter workers as well as the paint shop sealer workers and general workers in the paint shop, currently, the entire paint shop is automated by laser and sealer robotics that perform the complete paint shop tasks that go into the spray painting of a vehicle irrespective of the various model specification of the vehicle to be spray painted.*

For Participant 11;

> *the press shop section of the production plant that was responsible for the tasks of "end of line stacking "used to be operated by a press operator and is now operated by "Kuka stacking robotics" responsible for the various tasks associated with stacking and picking up objects.*

**Figure 4.1: A representation of a stacking Kuka Robotic used at VW that is referred to by the participant.**

Source: KUKA (2015)

In the Assembly line of the production plant in VWSA, there is also the replacement of operators, these operators are specialised in a specific work area of the assembly line but have been replaced by robotics whilst others have been placed in areas of the production plant within VW and other workers who leave or retire at the OEM, are not replaced, as the company applies the concept of natural attrition. The result of this approach for workers at VW is that workers are faced with issues of health and safety problems associated with having to keep up with the speed of robots used in the assembly line of the production plant. This impacts the workers ergonomically, including challenging the physical and mental capabilities of workers. *Further work reorganisation of workers moved from one section of the plant to another, due to change of jobs tasks as new robots are introduced, sees skilled workers, as well as semi-skilled, placed in positions that they were not originally employed to do as in the case of the operator workers, toolmakers and mechanics who had retrenchment notices.*

Participants 1, 11, 12 and 13 shared similar sentiments;

> *Workers have reiterated that the company does not consult with them about these unilateral technological changes before their implementation in the production processes and further, there is very little substantial recourse in their current conditions of employment to protect them as automotive workers in the OEMs.*

Participants 1, 4, 3, and 7, with close views, note that:

*in terms of worker skills development, when new technologies are introduced at the production plants, workers in the plant are not able to receive dual training i.e., training whilst being employed in the OEM in other skills, for example, in mechatronics or other electrical qualifications that could assist their career paths*.

Most participants agree that;

> *the current training academies contain outdated machine technology that is irrelevant to the current forms of production robotics in practice.*

Most participants reiterated that;

> *there is a need for accredited training that is relevant and up-to-date with the industry's technological changes and use of robotics.*

Most participants have described this experience as follows:

> *these new robots are too sophisticated for us because they require computer programming, which we don't have and it is challenging for us to do a job we don't have the skills to perform*.

Participants 1, 2, 5, and 9, noted that:

> *some workers do not have clear job specifications when they are reorganised in other job roles, hence they are placed where they are needed and moved when their job tasks are replaced with a robot, hence this impacts them negatively as it creates a level of uncertainty in terms of roles and responsibilities, as outlined in their original job descriptions when they were employed.*

Such sentiments confirm information that was captured in the triangulation as demonstrated in Table 4.2.

**Table 4.2: Job changes at the OEM, VWSA**

| **Production area of the OEM** | **Worker Job description *before* technological implementation at the Plant** | **Worker Job description *after* technological implementation at the Plant** | **Worker Outcome of technological change implemented** | **Job/Workload changes** |
|---|---|---|---|---|
| Body shop | Operators | If the workers are still employed, they transition to general workers, whether skilled or semi-skilled | Job task **replaced +-90%** by new laser robots and sealer robots | If still employed, workload increases, if another worker leaves or there is the element of natural attrition. Workload is increased |
| Paint shop | Spray painters | | Job task **replaced -**+ 90% by new laser robots and sealer robots | Some workers who do remain are moved to the assembly line for general tasks and provide complementary work |
| Paint shop | Paint shop sealer | | Job task **replaced -**+ 90% by new laser robots and sealer robots | Some workers who do remain are moved to the Assembly line for general tasks and provide complementary work |
| Assembly line | Operators | | Job task **replaced -**+ 90% by new laser robots and sealer robots | |
| Press shop | Press operator | | Job task **replaced** by "Kuka" stacking Robotics | |
| Body shop | Skilled operator (workers that remained) | General worker | The worker moved to the assembly line | Job/ Workload |

| **Production area of the OEM** | **Worker Job description *before* technological implementation at the Plant** | **Worker Job description *after* technological implementation at the Plant** | **Worker Outcome of technological change implemented** | **Job/Workload changes** |
|---|---|---|---|---|
| | Spray-painter and welder (workers that remained) | General workers | The worker moved to the assembly line | |
| | Artisans | Technician skill demands | Lack of skills to meet new work demands | |

Source: VW Interview data (2021)

The above employment data extracted from the annual financial statement of VW indicate consistent employment, however, the disaggregation of employment data is not known, and hence, one is unable to see the types of employment and the sustainability, as well as the nature of positions in these figures. To have these figures would have shown the movement of workers in various positions, as well as the permanent and seasonal staff. Therefore, even though the employment number remains constant, the actual details, as explained by workers, do not show staff turnover rate or types of employment like seasonal employment and "gig work." 'Gig work', as it is termed, is the process of work created as and when the need arises that equates to a job linked to a period with not much or no sustainability attached to it. Hence from the input of workers, this employment data shows an increase in employment, however, it is because the nature of the jobs that are contract work, adds to the numbers but in terms of actual permanent employment, the percentage is reducing.

#### *4.2.6 The workers' experience technological advancements at the BMW SA OEM*

Participants 1, 5, 6 and 7 mentioned that:

> *their production processes are also transitioning due to the implementation of new technologies by the rapid demand for different vehicle models and the shift of the automotive industry to the manufacture of new electric vehicles.*

In terms of the production line in BMW, the process includes stages of vehicle manufacture from the body shop to the paint shop and then to the assembly line.

According to Participants 1, 5, 6, 8, 12;

> *100% of the body shop is now automated, with approximately 80 to 90% of the paint shop automated and operated by robotics performing tasks previously carried out by manual workers.*

Most participants observed that;

> *the assembly line is the only area of the production plant that has the use of workers to perform manual labour tasks and responsibilities. These include technicians fixing or adjusting robots to work according to the specifications set out and this type of job function is a specialised skill that most workers in the assembly line do not have. Hence, on a skills development challenge, the skill of mechatronics in the automotive industry skills training is largely lacking.*

Participants 1 and 10 mention that:

> *in the production plants, the manufacturing in the body shop was previously done by manual workers and now the entire body shop is automated and solely operated by robotics.*

Participants 7 and 9 noted that:

> *Job titles, such as arc welders, have been replaced by robotics in the body shop and in the paint shop of the production line, workers employed as spray painters were also replaced, as well as the replacement of operators.*

When it comes to training, most participants describe the training they receive on how to operate new robotics that takes place in a short period (a day or two). To most of them; *this is not adequate time to learn a skill and secondly, it is training that is not accredited by any formal institution.*

This impacts workers because if they were to leave the automotive industry and OEM companies, they would not have the necessary qualifications required to be employed in other jobs, even though they have practical experience.

Most participants agreed with the:

> *training academies located on-site at the BMW OEMs do not adequately accommodate workers' needs in that workers describe the training centres as outdated and that have no academic influence on their career paths beyond the OEM use.*

Some also noted that *the company does not consider employing workers trained in the academy instead they employ outside candidates without giving preference to internal workers who have operated the robotics and have years of experience*. This, for workers, is a major challenge, as the element of recognition of prior learning is not taken into account.

Furthermore, most participants observed that; *new workers are brought in to do specialised tasks because they have the specialised qualifications with no experience as workers do. Hence, it is a big challenge and discouragement to workers in terms of the ethical conduct of the OEM selection process in not giving workers first preference in better employment opportunities in the OEM.*

Another quoted on his experience with technology and digitalisation as saying,

> " *This new technology is causing me to perform other job tasks and functions that were not on my job description when the OEM employed me and I am afraid of asking because I don't want to lose my job, especially in this poor economic position"* Participant 10.

As triangulated from secondary data, the table below depicts the changes workers have experienced over a period due to the technological implementation of robotics in the production plants and the various job roles that have changed and roles completely lost and not replaced, resulting in job losses. For workers who are fortunate to have remained, they are placed into job roles that are general and are subjected to natural attrition, as well as having to work in challenging conditions, keeping up to the speed of robotics at the assembly line.

Ultimately, workers' job roles that remain after automation, only do so in theory as the majority of tasks and roles that remain are automated (+- 90%) and workers are replaced by robotics. Workers' job roles after the implementation of robotics, are roles that are more supplementary to the robotics rather than complete job roles as workers are only responsible for +- 10% of their original job description.

**Table 4.3: Schedule of Job changes at BMW OEM**

| **Production area of the OEM** | **Worker Job description *before* technological implementation at the Plant** | **Worker Job description *after* technological implementation at the Plant** | **Worker Outcome of technological change implemented** |
|---|---|---|---|
| Body shop | Operators | If the workers are still employed, they transition to general workers whether skilled or semi-skilled | Job tasks were **replaced** by new laser robots and sealer robots |
| Paint shop | Spray painters | | Job tasks were **replaced** by new laser robots and sealer robots |
| Paint shop | Paint shop sealer | | Job tasks were **replaced** by new laser robots and sealer robots |
| Assembly line | Technician | Technician | Job task **requires specific mechatronic skills largely lacking** |
| Press shop | Press operator | | Job task **replaced** by "Kuka" Robotics |
| Body shop | Skilled operator (workers who remained) | General worker | The worker moved to the assembly line |
| Paint shop | Spray-painter and welder (workers who remained) | General workers | The worker moved to the assembly line |
| Paint shop | Arc welders | General workers | The worker moved to the assembly line |

*Source: BMW Group Interview data (2020)*

The above table shows the decline in employment figures from the period 2017 to 2020, which is a clear indication that there is a reduction in the number of jobs, as explained by workers.

### *4.2.7 The workers' experiences at Lear Corporation SA*

At the supplier company, Lear Corporation, workers shared their experiences in terms of how automation processes, robotics and their work conditions have been impacted. For most participants, even *though the work processes are now easier ergonomically, most work in the seat company has been automated which requires a new set of skills that the majority of workers lack.*

Participant 8 observed that;

> *Since Lear corporation has adopted the seating and E-Systems design, engineering and manufacturing of the seats in vehicles, various job processes that used to be done manually, are now done electronically and the expertise needed for the new electronic systems is complicated, according to workers' experience and require engineering, IT and technical qualifications.*

Participant 5 shared that:

> *workers who were required as sewers are now replaced by advanced automation that is responsible for 90% of the work processes.*

Most participants shared views that:

> *our work has evolved and therefore jobs in the supplier company require skilled workers, the majority of whom are located in the engineering field. Most of the jobs have been reducing drastically over the years as more jobs are being shed due to the sophistication of technology that does not require much manual labour.*

The work that does require manual labour is more on a management level. Workers get put on short time, which means that they receive less pay for work since there is less work available due to mechanisation processes.

Another challenge observed by most participants is that *when these robots break down, it causes work stoppage at Lear at the expense of workers and specialists and engineers have often to be sought in Europe to repair machines as the skills and replacement parts are not available in South Africa.*

Participant 9 reiterated that;

> *for unskilled workers, many are contracted by labour brokers and called only when they are required which creates job instability and also a much lower rate of pay; these workers have also claimed to have been exposed to various harmful substances when they are placed from one position to another in the supply chain*

Participant 13 shared that;

*we are moved along the supply chain when work tasks become automated; eventually, are retrenched. In fact, employment numbers are on a rapid decline as many workers are said to have received retrenchment notices due to new technology and the company no longer requires manual workers due to the introduction of robotics used in the manufacturing processes, such as the electrification advanced network architecture and connected mobility systems.*

From the table above, it is indicative that technological changes are reducing the need for manual workers and the manual workers who are required for the new forms of work are at a skill level for which workers are not prepared. This impacts workers at Lear because new workers with less experience, but more qualifications, are brought in and the older workers are outsourced, as per workers' input.

Participant 9 mentioned that;

"*I don't have the necessary skills for these new forms of technology and I am afraid that it will cost me my job because I will end up doing a task I don't like because the work I used to do is not there anymore and the new tasks allocated to me, I am not skilled to perform*"

Another participant 4 described his experience as;

**"***when they bring in new robots, I get overwhelmed to think of the speed that I must keep up with and I am only human and I am not young to work fast to keep up the speed of a robotic instrument"*

As seen from the above, workers' job roles that remain after automation, only do so in theory as the majority of tasks and roles that remain are automated (+- 90%) and workers are replaced by robots. Workers' job roles after the implementation of robotics, are roles that are more supplementary to the robotics rather than complete job roles as workers are only responsible for +- 10% of their original job description.

The company also practises the concept of natural attrition, hence when a worker leaves the organisation, they are not replaced and this places pressure on the workers to carry tasks out with limited manpower, jobs are reduced due to technology reducing the need to employ manual and semi-skilled work at the seat company. As triangulated from the secondary data, the table below demonstrates how significant has been the impact of technologies on the work schedule.

**Table 4.4: Schedule of changes at Lear Corporation Supplier Company**

| **Worker Job description *before* technological implementation at the Plant** | **New forms of Jobs at Lear corporation *after* technological advancements** | **Worker Outcome of technological change implemented** |
|---|---|---|
| Cutting | Workers that do remain offer supplementary roles to robotics | Job tasks **replaced** 90% by automotive seating and electrical distribution systems technology |
| Sewing | | Job tasks **replaced** 90% by automotive seating and electrical distribution systems technology |
| Assembling | | Job tasks **replaced** 90 % by automotive seating and electrical distribution systems technology |
| | Auto – Electrical engineering jobs | New forms of skills are required that some workers currently do not have. Need for upskilling |
| | Industrial Engineer | New forms of skills are required that some workers currently do not have. Need for upskilling |
| | Process Engineer: Quality specialist | New forms of skills are required that some workers currently do not have. Need for upskilling |
| | Supplier quality engineer | New forms of skills are required that some workers currently do not have. Need for upskilling |

Source: Nowell et al., (2017)

#### *4.2.8 The worker's experiences at Schnellecke SA*

In Schnellecke Logistics, workers have identified that the majority of work systems in the company are using autonomous systems and robots to perform tasks associated with supply logistics, warehouse logistics, module assemblies, sequences, as well as, packaging logistics, spare part logistics and transport logistics. The company, according to most of the participants, implements *the "just-in-sequence delivery" of individual parts to the place of installation. The majority of the work within the warehouse is automated as the "Picking Robots" carry out tasks related to the material call-offs about size.*

Specifically, Participant 8 noted that:

> *the customised components are picked up and packaged into customer specific containers and transported to the production line. The only manual work at this stage is that of a driver operating the forklift.*

Participants, 3 and 5 shared that;

> *the rest of the process that entails parts of about 200 different kinds are sequenced by robotics and delivered to their point of origin and the entire production line process and the production-sequenced deliveries are all automated by controlling the process electronically*.

The supply of production also utilises container/empties management, of which the company utilises a form of customised software to determine the container's number and location as well as processing containers before they are put back into circulation to repeat the process of filling the containers with parts again. The only job tasks undertaken by workers are the scanning and driving processes.

Participant 11 noted that;

> s*ince my job role changes, I am required to perform less hours of work and as a result I struggle financially since I don't receive the same pay scale as I used to because the robots are doing most of the job tasks that we used to perform.*

Most participants pointed out that the problems faced include - *working fewer hours due to robotic breakdowns and maintenance processes associated with mechanical breakdowns. Less work for workers translates to lower pay and less work hours*. This has a negative effect on the net pay of workers.

In terms of the Schnellecke sustainability report for the period of 2018-2019, there is a significant reduction in the number of employees from 19000 employees in 2018 to 17000 employees in 2019, as well as a reduction in in the number of countries from 14 countries to 12 countries in which Schnellecke is currently operating. Currently, there is no available data for 2020. This table shows us the decline in employment figures, which is a result of the implementation of new technology, as per workers' input.

**Table 4.5: Schedule of changes at Schnellecke Supplier Company**

| **Worker Job description *before* technological implementation at the Plant** | **New forms of jobs at Schnellecke due to technological advancements** | **Worker outcome of technological change implemented** |
|---|---|---|
| Supply logistics | | Job task **replaced** by "Picking Robotics" |
| Warehouse Logistics | | Job task **replaced** by "Picking Robotics" |
| Module Assembling | | Job task **replaced** by "Picking Robotics" |
| Packaging Logistics | | Job task **replaced** by "Picking Robotics" |
| Spare part logistics | | Job task **replaced** by "Picking Robotics" |
| Transport logistics | | Job task **replaced** by "Picking Robotics" |
| Forklift driver | | The only manual form of work still available |
| | Remote working from a Tablet | New forms of skills are required that some workers currently do not have. Others can upskill whilst the majority of older workers find it a challenge and remain as drivers. |

Source: Schnellecke Interviews (2021)

Based on the figure above, the impact of technological changes in the above plant is visible. These changes have impacted the quality of the skills in that there is a skills deficit in terms of the required skill level. Current workers only have the basic on-the-job training to carry out their tasks, however, the skill quality required is to be at the skills identified in the table below. The various initiatives and skills processes are underway, however, based on the findings of the interviews, workers are faced with various problems in attaining the required skill level.

Findings of interviews with stakeholders at the respective Sector education and training authorities about worker skills development to address technological changes brought about by 4IR technological advancements and the new forms of jobs indicate the various dynamics and skills requirements at the various OEM and supplier company in terms of skilling, upskilling and reskilling for the new forms of jobs, as well as organisational problems in implementing the changes as noted in Table 4.5.

The findings from the relevant sector education and training authorities (SETAs) indicate that there is no "blueprint" or ideal base level skills currently, as each sector is diverse and the automotive industry is no exception. The SETAs do, however, implement training for retrenched workers so that they may be reintegrated into other sectors of the economy. Further input from this stakeholder indicates that further research and development in the automotive sector is required to identify scarce and critical skills needed for the new forms of work and the information technology skills (IT) for the operation of the new digital technology used, especially in the automotive industry. Currently skills development programmes are underway, but the major focus should be on institutions of higher learning and universities to provide such needed skills and qualifications.

The current approach of the SETAs is that of a demand-driven approach in terms of relying on OEMs and supplier companies to provide a workplace skills programme to facilitate training needs which is largely lacking at the moment.

In the automotive industry, there is a need for skilling and reskilling, but the challenge is that the culture of older workers and the educational capabilities to reskill is often a challenge as most workers do not have the necessary computer skills to begin the reskilling process. In addition, the time it takes to retrain a worker for the job they currently do has evolved and therefore, it is a moving target, as described by training authorities. The findings also indicate that what assists the process of training and skills development for workers in the automotive industry in general, is the need for worker-initiated training.

This is encouraged because it is workers who are experts in their fields and who can identify the necessary training programmes that will benefit their sectors in collaboration with trade unions. Currently in the training authorities are various interventions about sector skills and training, some of which include training along the supply chains included in the various skills development strategies and workplace skills plan training (WSP) that include partnership with all stakeholders, including government, business and labour in the development of training programmes and therefore the increase in access to occupationally directed programmes.

This is what some of the input from stakeholders said;

*the new occupational qualifications require some work experience for certification, even though there might be some flexibility in the design of different qualifications, there is no doubt that the system requires better and more systemic arrangements for workplace-based learning in order for the programmes to inspire confidence among employers and to improve employment outcomes for students*

Table 4.6 illustrates identification of the scarce skills needed, according to the interviews with training authorities and worker interviews in VWSA, BMW, as well as supplier companies, Lear Corporation and Schnellecke. New and emerging skills requirements, such as financial management and general management have emerged since workers have also identified a need for more skilled jobs in management positions and hence have identified the following skills to assist in bridging the current skills gap.

**Table 4.6: Schedule of Skills requirements from the Sector education and training authorities**

| **Category** | **Current & Future Skills Need Identified** |
|---|---|
| Automotive Industry value chain | Mechatronics |
| VW & BMW | Electrical engineering |
| VW & BMW | Engineering |
| VW & BMW | Information technology (IT) |
| VW & BMW | Financial Management |
| Schnellecke & Lear | Coding |
| Schnellecke & Lear | Data Science |
| Schnellecke & Lear | Programming |
| Schnellecke & Lear | Management Skills |

Source: Author (2022)

Ultimately, workers' job roles that remain after automation, only do so in theory as the majority of tasks and roles that remain are automated (+- 90%) and workers are replaced by robotics. Workers' job roles after the implementation of robotics, are roles that are more supplementary to the robotics rather than complete job roles as workers are only responsible for +- 10% of their original job description.

In essence, the new technologies implemented at the various OEMs and supplier companies might be making work easier, but they are also replacing the various job roles of manual work as carried out traditionally by workers and new technologies are replacing existing workers skills by the new and future skills requirements that current workers do not have.

The process of skilling taking place at the moment has various problems, as explained in the individual companies' findings.

In summary, the findings are based on workers' experiences at the respective OEM and supplier companies, as well as the stakeholder input from the sector education and training authorities. This input shows that various problems exist for workers emanating from the implementation of the new technological changes and these problems were described, including the changing job roles that pose a huge challenge for the workers. These changes result in workers being given supplementary roles to their original job description as a result of their job tasks being 90% automated.

The new forms of work that emerge, as well as the changing conditions of employment, are also discussed. The current skills development landscape does not have sufficient mechanisms in place that are automotive context specific to adequately remedy the challenge through creating opportunities, as the current skills development frameworks, as well as the technical qualifications used at the various sector education and skills development authority (SETAs) for skills development, do not adequately address specific worker problems in the automotive industry, as the current version of the skills development plans are broad-based and not automotive context-specific. The findings of this research indicate that technological changes are impacting workers and their jobs negatively, however, the strong need for updated skills was also identified as part of the findings.

## 4.3 Chapter summary

This chapter returns to the research question and discusses the finding results extensively, i.e., how the new technology is impacting workers, detailing their problems as well as the changing job roles at the OEMs and supplier companies with a large concentration of the problem being as a result of new technology implemented in the form of robotics, as seen in the findings of problems. Existing literature during the period of when this research study was conducted , did not address the automotive industry specific OEM's or specific supplier companies, neither were there any analysis made to the specific type of job changes impacting workers using the new forms of technology. The next chapter of this study will focus on the contributions, recommendations and the conclusion of the study.

# CHAPTER 5: CONTRIBUTIONS, RECOMMENDATIONS AND CONCLUSIONS

## 5.1 Introduction

The previous chapter of this study analysed and presented the research findings of this study, which included the impact of the fourth industrial revolution on job roles, various work changes in the automotive industry and then more specifically, the technological changes in the OEMs and supplier companies and lastly, the chapter presented the experiences of workers in these various companies. This chapter then concludes the dissertation. The research aimed to show the problems and prospects in the automotive industry and the future of jobs in the context of the fourth industrial revolution. The rest of the chapter provides the summary of the study, contributions of the study, as well as recommendations of the study and ultimately, the conclusion of the study.

## 5.2 Summary of the study

The summary of this study in this chapter is based on five chapters which forms the basis of the study. The researcher developed the five chapters as follows:

Chapter 1 contextualised the study by means of its research questions, the chapter then gave a background to the research problem and the study rationale where it contextualised the South African environment and the impacts of digitisation on workers in the automotive industry.

Chapter 2 contained the literature review of previous studies that was conducted in the context of the fourth industrial revolution and the technological change's impact on jobs. This chapter literature, found that there is an impact of new technology on jobs due to technological implementation, especially where there are a lack of skills to operate these new forms of technology in the workplace.

Chapter 3 discussed the research methodology of the study including the research design, research population, sampling types and size, the data gathering procedure by means of interviews, the data analysis in terms of validity and reliability and lastly, the ethical considerations and limitations of the study was detailed. The conclusion of the research methodology used, is that it was appropriate for the purpose of this study as its methodology assisted in achieving the objectives of the research study.

Chapter 4 articulated the research findings and discussions of the research, which identifies the problems workers experience in their job roles as a result of the implementation of the new technology and robotics at the respective companies with various participants' comments from the interviews included. The study's main findings indicated that as a result of new technology implemented in the various companies, workers jobs are being changed and some jobs lost. The reasons for these included the use of new technology and the lack of skills required for the new (4IR) technology.

Chapter 5 discussed the conclusion, contributions and recommendation of the study. Theoretical and empirical objectives of the study are addressed, as well as the gaps in prior research and how this research study has addressed these gaps, that is, by prioritising workers and their jobs, specifically in the automotive industry. The research continued to identify various opportunities for workers in addressing challenges in the form of skills development strategies and by the design of an inclusive model to manage the change process brought about by the fourth industrial revolution. This model aims to assist the process of change in the automotive industry.

The chapter also notes some of the limitations encountered in the study, which include workers requesting to stay anonymous during interviews, due to the nature of the information that they shared with regard to their work changes in their various roles. Therefore, no workers' names were disclosed in this study, hence it was considered a limitation, however, workers were content to share information based on their job changes and experiences and requested that their views find expression in this dissertation nonetheless, hence this research study took into account all ethical practices in the process. In conclusion, this research study articulated best practices and opportunities for workers in the South African automotive industry.

## 5.3 Contributions of the study

This section discusses the contributions and recommendations of this research study to the theoretical body of knowledge and practical contributions to the subject matter. The contributions and recommendations are discussed under the relevant headings.

Based on the findings of this research and the changes, the effects of which are being examined, the following contributions and recommendations are articulated after factual information obtained in the findings from this research, based on workers' experiences and scientific data from companies, such as employments data in the OEM and supplier companies, as well as the sector education and training authorities. This study also notes the changes before technological changes to workers' jobs and the after effects, as a result of the implementation of new technology in the production processes within the various plants, noting the current and future skill requirements for workers.

When examining previous research studies on the impact of new technology, what was largely missing was that the prior research was broad-based and did not adequately address what the specific worker problems are within specific major OEMs and supplier companies, as well as identifying what the exact work changes are, as identified in this research findings, such as the new job roles, etc., hence this research objective was to bridge that gap and also identify areas of further research, such as a deeper dive into the skills development landscape as a tool in bringing both current and future workforce in line with the necessary skills required for the new world of work requirements, both in the automotive industry, as well as other sectors of the economy, which is articulated in this discussion section of the research, based on areas of further research.

The research undertook to bridge some of the gaps in previous research studies that explain how technology causes work changes broadly, however, it did not address "worker-specific problems," specifically in the context of the automotive industry OEMs and supplier companies. Hence, one of this research study objectives was to identify these worker-specific problems in more detail and to recommend potential prospects for workers in the form of a clear and inclusive suggestive participatory model for a "Just 4IR technological transition" that takes into account elements of workers' skills development as well.

With the automotive industry in transformation as a result of the disruptive changes and developing technologies, the nature of the current automotive business model is transitioning, concurrently moving towards the business term of a "circular car", as OEMs aim to maximise material efficiently. This strategy translates to zero waste and zero pollution during the manufacturing process. Hence, industry is moving toward a circular economy approach, as well as a 'gig' economy approach, changing the employment landscape. What this translates to for workers and their jobs, is that, as we have seen in the findings of the research, workers are affected by having less manual work available, as well as shift work and short time experienced, primarily by the implementation of robotics in plants that replace manual work originally carried out by workers.  This means workers are employed on a 'gig' basis when there is work available, almost equivalent to a form of seasonal income, which is unsustainable for workers from a socio-economic point of view.

The starting point for our evaluation was an assessment of how technological innovations and robotics have intersected with workers and work organisations and the production of motor vehicles in OEMs and supplier companies. The findings of the available evidence related to the impact of technological innovation on workers sampled in the various OEM's occupations, jobs and skill needs and what emerged is the observation of central and recurring concern, that workers have no control over policy-making and the technology that is introduced in the automotive industry and specifically, in OEMs, i.e., OEMs have choices in terms of the manner of implementation of technology and how fast technological processes and robotics are implemented, however, with little input from workers. Workers are also facing unprecedented problems in both their job titles, their job tasks and responsibilities. While the pace of change can be confronting technological progress, it should not be something forced on workers, but rather a process "with" workers' collaboration, to harness the potential of new technology and skills for good and with the possibility of minimising and transforming the harmful impacts of technological implementation on jobs, that it creates opportunities rather than problems and job losses, as we have seen in the findings.

In such instances, there is a rapidly evolving employment landscape and based on the findings, there are elements of job displacement from heightened labour productivity (line speed) to the widening skills gap and there are job creation opportunities in other sectors as well.

## 5.4 Recommendations of the Study

Based on the findings of the study, the study recommended the following interventions:

### *5.4.1 Inclusive model of transformation*

For the smooth and equitable transition of workers into an automated working environment in the advancement of the fourth industrial revolution implementation of technology in the automotive industry, where workers are affected daily, both positively and negatively, an inclusive model of transformation is required to manage the change process, hence a suitable and mutually beneficial just and suitable model of transitioning of the automotive industry is needed. Most importantly, the element of skilling, reskilling, recognition of prior learning, dual skills and lifelong skills development is needed to maintain jobs in the automotive industry but concurrently, to create jobs in other areas of the economy as well, hence workers replaced by automation, are skilled and retained in a form of employment whether it be in the same industry or other industries that evolve as a result of the transformative nature of the current automotive industry.

Transformation, in this case, the recognition of prior learning should be used to secure future employment opportunities for workers, as well as skills allowing for job placement as the industry transitions in meeting its future demand for electric vehicles where jobs in the automotive industry will transition, based on the new skills demand required by the automotive industry and its supplier companies along the value chain, but going further to use skills as part of the lifelong learning concept to take job security to the next level by creating job opportunities in other industries and sectors outside of the automotive industry. An example of this would be job opportunities in the engineering of batteries throughout the manufacturing lifecycle as well as opportunities in project management, supplier capability programmes and localisation programmes that can empower even previously displaced workers.

### *5.4.2 Secured policy support for systemic change*

The ability should be developed to have multi-faceted skills with dual use in all other sectors of the economy, as the duality of skills equates to job suitability and advancement in career paths. With this in mind, coupled with the elements of skills development, training and equitable transformation of the industry, there should be secured policy support for systemic change. As much as we are seeing changing job roles, based on the findings of this research, we are also seeing the new and emerging roles as well as job categories and functions that are expected to become important in the industry and what is largely lacking is the element of skills duality. The opportunity exists with the move from combustion engines toward the production of electric vehicles and jobs and skills in these emerging industries create opportunities for new forms of employment and a greater chance of a decent and skilled occupation that has dual uses. The training and development of new and existing workers are needed, especially in the fields of information technology, engineering, mechatronics, coding, change management, project management and various entrepreneurial skills for a sustainable and growth-led job market, that includes the benefit of the optimum use of robotics for human development in other areas of society, whether in a service industry or not, but with the opportunity of growth in all areas, in the socio-economic context of the economy, all of which is identified and articulated in the findings section of this research.

### *5.4.3 Remedies and innovative strategies*

Further, it is evident that there are required remedies and innovative strategies that are vital to be put in place and fully implemented with a process of evaluation. It is important to note that South Africa operates under the guidance of its current automotive masterplan (SAAM 2035). The future global trends in the masterplan report by Barnes (2019), forecast an upward demand trend to 2035; this shows that there is an upward positive trend. This is indicative that the automotive industry is and will be sustainable in the near future and therefore, the investment in the improvement of conditions both for workers and on a policy level, is vital. There are current policy interventions in place and this is located within the policy fora of the automotive masterplan (SAAM 2035), specifically the "key industry development objectives by 2035" and the objectives relating to doubling employment in the automotive value chain, as well as the emphasis placed on the implementation of the six pillars of the automotive masterplan, with particular areas relating to pillar five of "Transformation" that entails transforming the current trajectory of the automotive industry to have more inclusiveness in the policy by allowing principles of broad-based black economic empowerment (BBBEE) to be central to the transformation process. It is projected that this employee group will be representative of the South African demographic profile (in terms of, gender, race, and physical abilities), being present across the complete range of the automotive industry categories. In the $6^{th}$ pillar of the automotive masterplan "Technology and associated skills development", currently, on writing this report, what is lacking and is a critical outstanding activity encapsulated in the South African masterplan objectives (SAAM 2035), is the development of a technology and associated skills development roadmap to support the evolution of the industry in line with SAAM 2035 elements, as the new electric vehicle market using new technology (EEV), must allow workers to be brought on board with these developments, hence allowing workers to prepare and to respond to the emerging technology, as it is clear in the masterplan that there will be emerging technology with both active and passive technology that will feature in these technological developments and workers will have to be realigned through capacitating workers in skilling, reskilling and lifelong learning, as well as for the recognition of prior leaning in the technological evolution.

### *5.4.4 Revised technological transitional model*

Hence, there is a need for a new revised technological transitional model that is suggested in this study, based on the findings of the research. The OEMs, as employers of the workers, do recognise come core labour standards, such as those contained in the various global framework agreements and works councils, however further improvement and collaborative interventions of strategies exist, such as skills development. What remains vague in the journey through technological changes is the current workplace skills plan in adequately allowing for plans to transition workers with the aim of job sustainability. Further, it is unclear about the new career paths emerging and the kinds of skills that will be required; also, the level of participatory approach that is required from all stakeholders is currently inadequate, due to the power dynamics at play between employers and employees. Therefore, establishing a clear set of strengths, weaknesses, opportunities, and threats is what is needed for better transitions into new technology, also identified as some of the areas of further research.

In terms of gaining a clearer insight on what are some of the worker organisational problems being experienced with the implementation of 4IR technologies at the respective OEMs and supplier companies that are affecting workers' conditions of employment, we have seen in the various figures presented in the findings section of this research, that shows the job roles of workers before the implementation of technology at their plants and the impacts after the new technology implementation, takes into account the level of new skill requirements and job changes moving from one job role to another. Hence, in line with one of these research objectives of identifying various organisational problems, these are described.

#### *5.4.5 Skills development and training systems*

The current skills level in the assembly line of the automotive industry and the OEM and supplier companies in this study consists of skilled, semi-skilled and general/unskilled workers. Further, the work reorganisation of operators, welders and general workers to the assembly line creates a challenge of under-utilisation of skills with the OEMs having a blanket approach to placing workers in the assembly line regardless of their existing skill level. Skills development and training systems and mechanisms must be put in place that will be reactive to the current and emerging needs of the labour market as a result of the transitioning nature of work by increasing workers’ capabilities and level of skills for decent work and job suitability.

Using existing tools and interventions contained in the national skills development legislation and the South African automotive masterplan pillars in terms of skills development, should recognise prior skills of operators, welders, toolmakers, technicians and other general work and capacitate such workers in customised training programmes to train as electric vehicles (EVs) specialists as the trend and increasing future demand in the automotive industry is towards the manufacture of electric vehicles. This would ensure the use of existing skills of workers, without having to retrench workers due to a skills deficit but rather use the existing skills as a base line education and further build on those skills to a level suitable and academically recognised in terms of the education qualification authorities' standards. These interventions will allow for job retention, expansion, as well as growth and sustainability both for the OEMs and supplier companies, all envisaged in the skills development plans of the relevant SETAs and the pillars in the automotive masterplan.

### *5.4.6 Worker inclusion in the design and implementation of equipment*

To harness the complete benefits of technological advances and productivity growth, this can only be done effectively by collaboration efforts, as well as a high level of social dialogue for an equitable and successful transition that benefits all stakeholders, both workers and employers alike. This includes worker inclusion in the design and implementation of equipment, as well as work re-organisation and skills development strategies before its implementation process, hence allowing workers to be part of the process in identifying various bottlenecks before implementation and a cost-saving measure for both employers and employee in the automotive industry. For the workers, it allows for a well-planned work schedule with no stoppage or wastage, as well as a cost-saving and profitability strategy for the employers as this will entail continuous vehicle production and supply with minimum to no interruption in the process at the respective companies in OEMs and supplier companies, all equated to increased productivity with positive domino effects along the value chain with the added benefit of job satisfaction and the retention for workers.

The following opportunities were identified, based on findings, to allow for a pro-worker technological transition.

- Companies' involvement in training academies situated on-site (VW & BMW)
- Need for skilling and reskilling in other sectors
- Rework of the workplace skills plan
- Rework of the automotive sector skills plan
- Address the existing and the anticipated future skills gap
- Upskilling, reskilling, and lifelong learning

- Recognition of prior learning
- Qualification accreditation
- New career paths
- AI and machine learning programmes
- Using assistance systems for improved working conditions and addressing health and safety problems
- Training programmes to capacitate and train electric vehicles (EV's) specialists

#### *5.4.7 A Suggested Worker Inclusion Skills Development Model and pathway*

As we have observed the limiting barrier to technological transition and the majority challenge for workers, is that it is essential that skilling, reskilling up-skilling, as well as lifelong learning be embedded in the transitional plans of OEMs and supplier companies, as well as a unified participatory approach in the implementation of strategies and technological changes, to ensure a just technological transition with sustainability when responding to these changes, often termed as a digital disruption.

The skills development model, as suggested, includes a combination of existing model information but includes addressing gaps in the current skills development pathway. This model is based primarily on the premise of worker inclusion in the planning, design, and implementation of these strategies with combined and inclusive stakeholder engagement on an ongoing basis with an element of monitoring and evaluation of the entire process.

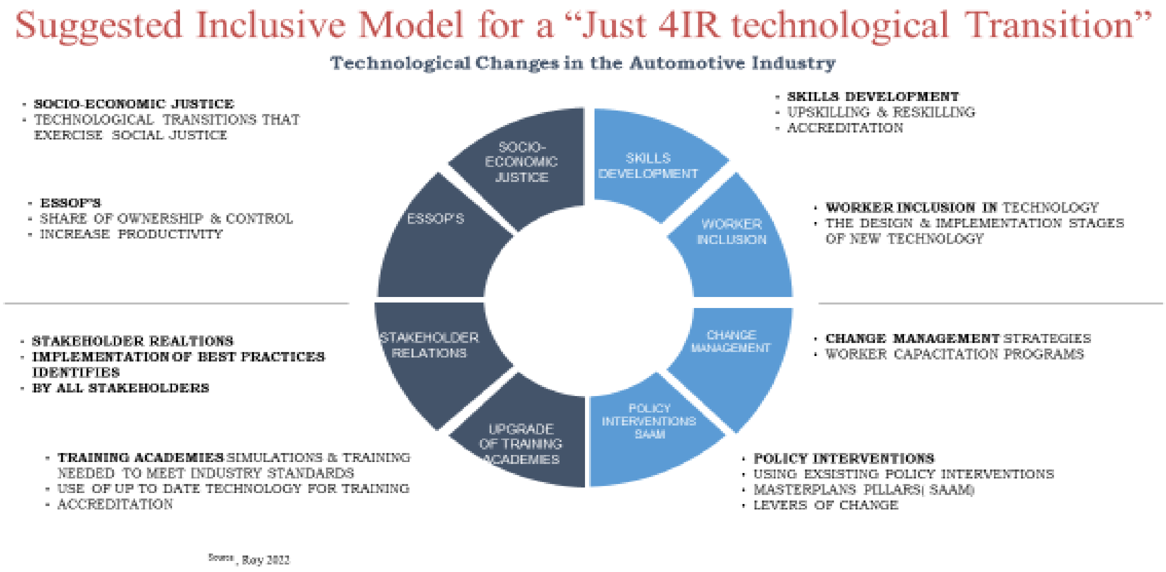


**Figure 5.1: Suggested Inclusive Model for a" "Just 4IR technological transition"**

Source: Author (2021)

It is clear that transformation in the automotive industry is happening at an accelerated pace, workers can therefore not stop the automation and robotics implementation process but rather should become instrumental in the way the transformation process takes place. This includes training academies in the various plants, training workers using up-to-date technology that is used in the production lines of manufacturing vehicles, together with the skill set of mechatronics and engineering as a base line skill that is accredited, to allow workers to use these skills in other sectors of the economy as well, which allows for workers to sustain their employability.

Workers are those impacted the most in terms of being directly affected by robotics, especially in the OEMs and supplier companies. The opportunities that exist, are to harness skills and development to accommodate the transition from combustion engines to electric vehicles. This can be done by an assessment of where the automotive industry currently is and where it is headed, based on our current capabilities as a country, as well as infrastructurally, coupled with the current skill set of workers in the automotive industry, to establish a strategic skills ready pathway for workers that will have dual benefits on a socio-economic level. Hence, one of the core elements in the suggested model above is skilling, reskilling and upskilling. What this entails is identifying gaps in the current workers' skills level and filling these gaps by training workers for the new forms of work in the industry, for example, for the development and manufacture of batteries as a new form of energy and a core component in the manufacture of the new electric vehicle to meet the demand in the automotive industry but to also create opportunities for workers to use their existing industry knowledge, allowing them to be retrained for other skills and job roles within the industry or in other areas of the economy. Having base line skills allows a worker to be accredited in a particular qualification, which then allows them to become multi-skilled and highly employable, staying economically active and maintaining a form of employment in the future demand of the world of work in the fourth and other revolutions to come.

Another element in the model and most importantly, is the inclusion of workers in the design of the change processes before strategies are implemented by employers. This allows for the input of workers and their inclusion in the design and decision-making process that can assist in having a successful, practically implementable model, as all stakeholders are involved in the process. Incorporating the element of change management before the transformation takes place in the workplace is important in getting workers to understand the change, manage the change and most importantly, be part of the change. It is having a proactive rather than reactive approach to new technology within the automotive industry when workers understand the growth pathway and benefits for all stakeholders in reaching productivity standards where workers are incentivised and are part of the change management process.

By OEMs and supplier companies implementing Employee Share Ownership Plans (ESOPs) in their respective company structures and global framework agreements, this will allow workers to further be directly involved in the success of the company as they are now shareholders of the company and have a stake in the profit sharing ratio of the companies, aligning employees with the business owner’s interests even if, through the process of training workers to become local suppliers of components to the automotive industry, such as the black supplier programmes already being implemented in the Automotive Supply Chain Competitiveness Initiative (Ascci) platforms contained in the automotive masterplan transformation pillar policy document.

#### *5.4.8 The South African Automotive Masterplan as a Policy instrument for change*

By using the element of existing policy in the automotive industry, that is, the automotive masterplan (SAAM 2035) policy document and implementing the various pillars of skills development and transformation, initiatives, such as local market optimisation to full capacity, this can harness worker opportunities within the automotive industry.

The use of the SAAM 2035 eight focus areas consisting of Local market optimisation (to 1.2m units), Regional Market Development (to over 1m units), Localisation (to 60% local content), Infrastructure development (to leading international competitor standards), Industry transformation (in identified areas of opportunity), Technology and associated skills development (focusing on future industry needs), one can identify opportunities in all of these pillars that will assist workers and the industry at large.

Ultimately, after taking into consideration the research question, objectives and literature, as well as the findings of this research, there is a need for further research to be conducted in the areas of skills development, specifically at institutions of higher learning, workers' readiness programmes, as well as opportunities in identifying the new forms of work that can emerge to empower workers to move into different parts of the manufacturing sector and the broader economic sectors, based on the various upgraded skills that are technologically ready for this revolution and the next. Further research is also required as it is unclear on the new career paths emerging and the kinds of skills that will be required, also the level of participatory approach that is required from all stakeholders is not currently adequate. Therefore, a further area of research identified is to establish a clear set of strengths, weaknesses, opportunities, and threats in what is needed for equitable transitions for the implementation of new technology in the automotive industry.

In summarising the discussion and recommendations obtained from the study, corresponding recommendations obtained are clearly articulated and explained in addressing issues, such as workers' inclusion, the skills gap, and a suggested model for transformation. Lastly, the areas of further research were explained, based on the findings, with skills development as an opportunity taking centre stage for workers to remain economically active and sustain and create jobs in various sectors of the economy.

#### *5.4.8.1 Practical implications*

The evolving landscape of employment presents numerous prospects for the advancement of career counselling practices. With the rapid pace at which occupations are evolving, individuals are increasingly faced with the need to acquaint themselves with unfamiliar job roles and industries that may present novel employment prospects and career trajectories. Career professionals have the potential to assume a progressively significant role in assisting individuals in comprehending these transformations and acquiring, assessing, and implementing career-related information to facilitate their career decision-making and career planning endeavours. Furthermore, individuals can seek guidance from career experts to effectively navigate the ever-evolving nature of their present occupations and enhance their employability by engaging in on-going education and skill development. Career counsellors play a crucial role in aiding clients in the identification of their learning and training requirements. Additionally, they provide valuable support in locating and effectively completing relevant educational programmes and training. This includes leveraging the growing availability of online resources in this domain.

To provide such assistance, counsellors and career centres can employ innovative methods to expand their reach to previously untapped clientele by implementing online support services. The recognition of the potential of computer-assisted assessment via the Internet (Tracey, 2010), virtual counselling centres (Horan, 2010), and web-based self-help and interventions (Gati & Asulin-Peretz, 2011) has been acknowledged for a considerable period. However, Whiston, Li, Goodrich Mitts, and Wright (2017) found that among the intervention studies conducted in the past two decades, only four out of 57 interventions were found to be computer-guided. Practitioners are encouraged to perceive this as an imperative to proactively cultivate and incorporate online- and computer-assisted career interventions into their professional endeavours, while also collaborating with researchers to assess the efficacy of these methodologies.

The utilisation of computer-assisted interventions holds promise in expanding the scope and inclusivity of individuals who can benefit from these services. This is particularly relevant in light of the ongoing digitisation and automation of work, which presents problems to traditional career support methods. However, it is important to note that these individuals are typically not reached by conventional career support approaches (Nota, Santilli, & Soresi, 2016). Digital career support can be provided through various means, such as online self-assessment tools, the dissemination of career information via video or virtual reality platforms, and the provision of online counselling services through video-based platforms.

Nevertheless, there exists a significant opportunity to develop online career guidance systems that leverage the advances in artificial intelligence and the growing abundance of data about individuals' professional trajectories. These systems have the potential to provide a personalised assessment of an individual's career concerns through the use of customised, automated interview questions and assessments. Subsequently, they can offer tailored recommendations for activities that facilitate self-directed career management.

#### *5.4.8.2 Implications – Research and practice*

In light of the imminent transformative shifts in the realm of employment, career research must encompass a range of pivotal concerns. Drawing on the theoretical frameworks of (PWT) (Blustein, 2006; Duffy et al., 2016) and the career construction and life design perspectives (Savickas, 2013; Savickas et al., 2009), an initial area of inquiry for future scholarly investigation involves exploring how individuals can attain intangible advantages from employment within a digitised economic context. These intangible benefits encompass elements, such as, social interconnectedness, a sense of meaning and direction, and a feeling of proficiency. The conventional understanding of a professional identity centred on a relatively consistent occupation and its corresponding responsibilities will require re-evaluation for numerous individuals. The aforementioned phenomenon will be particularly evident among individuals who are compelled to transition from their original occupation to engage in relatively unrelated and routine duties as a result of the growing trend of job polarisation. For certain individuals, the allocation of time may no longer be predominantly dedicated to work, but rather, work may constitute merely one facet among various spheres of engagement.

Furthermore, it is anticipated that there will be a growing integration between professional and personal spheres. The analysis of these matters could be influenced by the protean career model, which emphasises a comprehensive view of career management (DiRenzo, Greenhaus, & Weer, 2015). Additionally, the career construction and life design approaches, which concentrate on the integration of various identities into a significant personal narrative, can also provide valuable insights (Savickas et al., 2009). One aspect to consider pertains to the inquiry of how individuals can effectively navigate the boundaries between their professional and personal spheres in situations where these domains are no longer physically segregated as a result of the heightened adoption of telework (Diaz, Chiaburu, Zimmerman, & Boswell, 2012). An essential matter to investigate pertains to the process by which individuals develop professional identities in connection with their non-work roles, as well as how they incorporate these non-work roles into their career decisions and career development strategies (Greenhaus & Kossek, 2014). Researchers can investigate the potential changes in the subjective significance of work in light of these circumstances, as well as the impact of emerging vocational identities on career commitment, job satisfaction, and overall well-being.

Drawing upon the theoretical foundations of the social cognitive model of career self-management proposed by Lent and Brown (2013), as well as the protean and boundary-less career frameworks outlined by Arthur (2014) and Hall (2004) respectively, an additional significant concern to be examined pertains to the requisite career behaviours, attitudes, and potentially novel career competencies that individuals must possess to flourish within the contemporary economic landscape. Lent and Brown (2013) provide a comprehensive examination of adaptive career behaviours that hold significance across various career stages, such as the cultivation of work readiness and employability skills during the exploratory phase in adolescence. Given the historical and present economic conditions, it is anticipated that these behaviours will persist as significant factors in the future.

However, it is also probable that the evolving economic landscape will necessitate the adoption of novel behaviours, attitudes, and competencies. In contemporary times, the ability to obtain employment opportunities from diverse employers through the utilisation of digital matchmaking platforms has become notably significant. It is important for individuals to effectively showcase their abilities and establish a commendable online reputation that reflects the superior calibre and dependability of their work on such platforms.

Furthermore, the necessity to continuously and expeditiously develop and enhance one's professional competencies through the utilisation of digitised resources such as online training programmes, online courses, and online communities, alongside the establishment, sustenance, and utilisation of digital networks with fellow professionals and prospective employers, appears to be progressively paramount. Potential areas for future investigation could encompass an exploration of the novel career behaviours, attitudes, and competencies that hold significance in attaining success within the emerging economy. Additionally, it would be valuable to ascertain the individuals who are more or less inclined to demonstrate and cultivate these attributes under specific circumstances.

The utilisation of SCCT can offer valuable frameworks for addressing the problems associated with emerging career tasks that individuals must navigate, as well as identifying the essential personal and environmental resources required to effectively manage these tasks. One prominent professional obligation for individuals is the perpetual need to adapt to and effectively collaborate with rapidly evolving technological advancements. The acquisition of career-relevant experiences and skills has traditionally been recognised as a significant factor in the early stages of one's career and during the exploration phase of one's career (Super, 1990). However, due to the continuous changes in the economy, individuals at various stages of their careers and lives will be compelled to enhance their skills and knowledge. Obtaining and successfully juggling multiple jobs from multiple employers at any given time in one's career, such as by providing services or completing tasks and projects via multiple digital platforms, is another emerging career task for many people across all career stages. To attain favourable levels of job security and income, it will be increasingly important to implement such work arrangements.

One primary obstacle in career research is the identification of key career tasks that individuals are increasingly encountering. Further, research must ascertain the effective strategies that individuals can employ to effectively manage these tasks. An essential aspect to consider is the comprehensive analysis of various individual factors, such as knowledge, motivation, and traits, as well as environmental factors, such as social support and organisational support, about career resources. This examination is crucial in understanding how these resources, as discussed by Hirschi (2012), can effectively aid individuals in navigating and overcoming career-related obstacles.

One potential recommendation for future research is to leverage the expanding array of data sources and methodologies resulting from growing digitisation, which could enhance the investigation of emerging research inquiries. One illustrative instance involves the utilisation of social network platforms like LinkedIn, which present an extensive array of data on educational backgrounds and professional trajectories of individuals across the globe. These datasets can be subjected to analysis to extract novel understandings regarding career patterns, specifically the sequential progression of employment and educational experiences that commonly culminate in specific positions (Biemann, Fasang, & Grunow, 2011).

In addition, organisations are employing tools, like Cornerstone, to gather and oversee escalating volumes of digital data on various facets of employee conduct and productivity. This includes assessment outcomes, fulfilled job tasks, training activities, and professional background. This data has the potential to offer novel perspectives on factors that influence career success, workplace well-being, and diverse career paths. Researchers also have the option of forming partnerships with platforms that provide on-demand work to investigate the working conditions of workers who are employed in the ‘gig’ economy. This can be done by combining the data collected from these platforms with additional survey questions. The extensive adoption of smartphones and smartwatches has facilitated the acquisition of real-time data by researchers, encompassing visual and auditory recordings, as well as physiological measurements. Research utilising these technologies has the potential to provide novel insights into the daily behaviours and experiences of individuals employed in various work arrangements (Ilies, Liu, Liu, & Zheng, 2017).

## 5.5 Conclusion

This chapter brings the research study to conclusion. To realise the goal of the study, the following theoretical and empirical objectives were addressed. The study contributed to the identification of gaps in prior research that have not adequately covered the impact of technology in the context of workers' jobs, specifically in the automotive industry and this study addressed this gap by interviewing workers in the automotive industry in specific OEMs and supplier companies and getting specific worker input on their problems being experienced with the new technology introduced at the various production plants as a result of the fourth industrial revolution implementation of new technologies. These results saw how the technology impacted workers' daily tasks and operations, income, workers' health and safety, as well as the overall impact of loss of jobs, as a result of workers being replaced by robotics to replace previous manual tasks and workers not replaced to maintain workflow, as a result of natural attrition. We have further seen how the use of industrial robots has increased, which is a clear indication that the automotive industry is one of the major industries that is highly automated and will continue to automate production processes in the future.

In further reaching the research objectives of this study, the research proceeded to identify opportunities for workers that were not already covered in the existing body of literature; this included identifying opportunities for workers in the production process, such as upskilling and reskilling, amongst others, as well the design of an inclusive model of transformation to manage the change process more adequately, further creating an environment of job creation, both in the current automotive sector in different job roles, as well as opportunities in other sectors of the economy, using skills development as a lever for equitable transformation.

Ultimately, the research paper as part of the recommendations, articulated best practices and opportunities for workers' problems and the automotive industry, using a suggested transformative and inclusive skills development model that includes the incorporation of objectives set out in the automotive masterplan 2030 by including the elements in the suggested model such as skills development, worker inclusion in the design process of technology, change management, using policy interventions, such as the SAAM 2035, as well as ESOPS. All of these interventions allow workers to become shareholders in companies and therefore better enablers of change in the transformation process.

In conclusion, we have seen that various opportunities and problems exist within the automotive industry in implementing technological changes as a result of the fourth industry revolution interventions, however, we have also noted and identified mechanisms to manage the change process for workers, as articulated in the suggested transformative model for workers in figure 5.1. This ensures the success of all stakeholders but most pertinent is that workers are not displaced or left behind in this fourth industrial revolution and future revolutions, by adopting a human-centred approach that takes into account technological impacts on workers and creates both manual and digital opportunities for workers in all sectors of the economy.  This knowledge and suggested model for best practice will assist workers and employers as they offer possible solutions for workers' job sustainability and opportunities that can be used in other sectors of the economy and reduce the current unemployment level in South Africa.

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