A quantitative analysis of public attitudes towards the fourth industrial revolution: an integrated technology adoption model in South Africa

Zama Mabel Mthombeni

Student Number: 210533654

Thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

In the Discipline of Development Studies

School of Built Environment and Development Studies, University of KwaZulu-Natal, Durban, South Africa.

January 2024

Supervisor: Professor Oliver Mtapuri

DECLARATION

I, **Zama Mthombeni (**Student Number 210533654), declare that:

1. “The research reported in this thesis, except where otherwise indicated, is my original work.
2. This thesis has not been submitted for any degree or examination at any other University.
3. This thesis does not contain other persons’ data, pictures, graphs or other information, unless specifically acknowledged as being sourced from such persons.
4. This thesis does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:
   a. Their words have been rewritten, but the general information attributed to them has been referenced.
   b. Where their exact words have been used, then their writing has been placed in italics and inside quotation marks and referenced.
5. This thesis does not contain text, graphics or tables copied and pasted from the Internet, unless specifically acknowledged, and the source being detailed in the thesis and reference section”.

Student name

Zama Mabel Mthombeni

[redacted]

Supervisor

Prof Oliver Mtapuri

ABSTRACT

The impact of technology on society is a multifaceted and intricate issue in a rapidly changing world of constant technological advancements. The emergence of the Fourth Industrial Revolution (4IR) has sparked a growing debate regarding its potential opportunities and challenges for various societies. While robots have been utilized for over 50 years in previous industrial revolutions, their recent integration into domestic and different work environments through the 4IR is a modern development. Social robots are now deployed to perform tasks that were previously performed by humans and are used in scenarios where they must interact with people. Despite the significance of these changes for human development, there has been limited research on public attitudes towards such advancements of the 4IR in South Africa. This study investigated the relationship between micro-level sociological characteristics and attitudes towards the 4IR using survey data from the South African Social Attitudes Survey (SASAS) among a sample of adult respondents (n=2736) in South Africa. The study adopted a positivist paradigm and a quantitative approach and sought to contribute to the understanding of public perceptions of the 4IR in South Africa. Existing attitudinal adoption models were reviewed, and the study used these to develop an integrated framework that harmonized these theories. This framework incorporated a dimension of micro-sociological indicators and categorized attitudes into two distinct categories. The use of micro-sociological indicators in the technology adoption model was an important approach that allowed for a more comprehensive understanding of public attitudes towards the Fourth Industrial Revolution (4IR) in South Africa at the micro-level. Unlike traditional adoption models that focus solely on macro-level factors such as economic and institutional conditions, micro-sociological indicators consider individual-level characteristics such as race, social class, knowledge, age, and gender. . The study findings revealed a distinct social class effect, highlighting heightened scepticism toward the Fourth Industrial Revolution (4IR) among individuals in lower social classes, those with worker vulnerability, and those lacking internet access. A crucial recommendation is to challenge the prevailing narrative of elitism linked to technological progress and emphasizes targeted investments in historically marginalized communities. South Africa can learn from the experiences of other nations and consider implementing comprehensive strategies involving policy interventions, public-private partnerships, and social initiatives. Exploring the

feasibility of universal basic income as a social safety net would be prudent, aligning with global trends in addressing the socio-economic impact of automation and technological advancements.

.

Keywords: Fourth industrial revolution (4IR), , public opinion, social shaping of technology , techno-sceptic, South African Social Attitudes Survey (SASAS)

ACKNOWLEDGEMENTS

This thesis represents the culmination of an academic endeavor that has been greatly enriched by the support and assistance of numerous individuals and organizations. I am deeply grateful to each person who has played a role in shaping my academic journey.

First and foremost, I extend my heartfelt thanks to my Lord Jesus Christ for providing me with health and resilience throughout my studies. I am indebted to Prof. Oliver Mtapuri, my supervisor, whose time, expertise, and constructive criticism were instrumental in making this thesis possible. His guidance and inspiration have been invaluable throughout the entirety of my study period.

I would like to express my gratitude to Dr. Benjamin Roberts of the Human Sciences Research Council for his unwavering patience and support. The South African Social Attitudes Survey (SASAS), coordinated by Dr. Roberts, provided the dataset crucial to this thesis, and I am thankful for the opportunity to utilize this valuable information. Special thanks also go to Dr. Steven Gordon and Dr. Ngqapheli Mchunu for their outstanding assistance and patience in addressing my inquiries regarding the SASAS data and my overall study.

In academia, I am fortunate to have received support from Dr. Thobeka Zondi, Dr. Marole Moloi, Londiwe Jali, Sibusiso Ntshiza, Nothando Ntshayintshayi, Nokhetho Mhlanga, Selelo Matimolane Dr. Shanaaz Dunn, Dr Fidel Udo, Prof Benjamin Maiangwa, Dr Wilfred Lunga and Dr. Sakhiseni Yende. I am deeply grateful for their guidance and encouragement. My mentors, Prof. Thierry Luescher and Dr. Samuel Fongwa, have played integral roles in my academic growth at the HSRC, motivating me to excel in my PhD studies.

I extend my appreciation to Ms. Shirin Motala for her passionate support and encouragement in maintaining a balance between work and my PhD pursuits. Colleagues at the Human Sciences Research Council have been invaluable, providing advice and assistance that significantly contributed to the completion of this thesis.

To my family, whose love and support have been my anchor, I am profoundly grateful. Special thanks to my nieces, Sisipho and Siphokazi Mbebeza, for their unwavering love and assistance throughout this journey. Many individuals have contributed significantly to the success of my PhD study, and I extend my sincere thanks to all. May God bless each one of you abundantly.

DEDICATION

"This work is dedicated to the Almighty Jesus Christ who guided me with the wisdom and strength to complete this thesis".

In loving memory

I also dedicate this thesis to my late mother, Zodwa Agnes Mthombeni, who eagerly waited to see the fruit of this work, but unfortunately did not live to see it.

LIST OF ABBREVIATIONS

3D	Three-dimensional
1IR	First Industrial Revolution
2IR	Second Industrial Revolution
3IR	Third Industrial Revolution
4IR	Fourth Industrial Revolution
5IR	Fifth Industrial Revolution
AI	Artificial Intelligence
ANC	African National Congress
ANOVA	Analysis of Variance
AU	African Union
DA	Democratic Alliance
DCDT	Department of Communications and Digital Technologies
DOI	Diffusion of Innovations Theory
DRC	Democratic Republic of Congo
DTPS	Department for Telecommunications and Postal Services
EFF	Economic Freedom Fighters
ETAM	Extension of the Technology Acceptance Model
EU	European Union
GDP	Gross Domestic Product
GHS	General Household Survey
GM	Genetically Modified
HSRC	Human Sciences Research Council
ICT	Information and Communication Technology
IFP	Inkatha Freedom Party
ILO	International Labour Organization
IMF	International Monetary Fund
IoT	Internet of Things
IR	Industrial Revolution
IT	Information Technology
OECD	Organisation for Economic Co-operation and Development

PATT	Pupils' Attitudes Towards Technology
PBC	Perceived Behavioural Control
PC	Personal Computer
PMG	Parliamentary Monitoring Group
S&T	Science and Technology
SAL	Small Area Layers
SASAS	South African Social Attitudes Survey
SCOT	Social Construction of Technology
SCT	Social Cognitive Theory
SES	Socio-economic Status
SONA	State of the Nation Address
SST	Social Shaping of Technology
StatsSA	Statistics South Africa
STEM	Science, Technology, Engineering, and Mathematics
TAM	Technology Acceptance Model
TD	Technology Determinism
TIB	Theory of Interpersonal Behaviour
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UK	United Kingdom
USA	United States of America
UTAUT	Unified Theory of Acceptance and Use of Technology
WEF	World Economic Forum

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: INTRODUCTION

1.1 Background on Technology Advancements and Economic Influence

Industrialization and technological development are essential for the global economy's growth (Serumaga-Zake & Van der Poll, 2021). The Fourth Industrial Revolution (4IR), as with all previous industrial revolutions (IRs), has a crucial characteristic in that it leads to changes in economic and social structures (Serumaga-Zake & Van der Poll, 2021; Shaturaev, 2022). In his book '*The fourth industrial revolution*', the executive chairman of the World Economic Forum (WEF), Klaus Schwab, introduced the phrase "4IR" to describe technological advancement. This phrase describes the current collapsing borders between the physical, digital, and biological domains (Schwab, 2017). These technologies are spreading progressively throughout society and changing how our cities, economies, and political systems operate. Despite what its appellation might imply, the 4IR's effects will be felt throughout a much wider spectrum of society (Vicente & Dias-Trindade, 2021).

To better understand the 4IR, it is worthwhile to look back on the first three industrial revolutions. The first three IRs generated a large body of literature with a variety of cause-and-effect theories. I will not discuss this literature here, as an assessment of the existing literature is provided in Chapters four and five. Instead, I will present an interpretation of the stylized facts from the big historical picture. Mhlanga (2021) claims that the past IRs forced society to undergo extensive and frequently painful version changes. One such version change was having to overcome the lack of traditional industries and job sources, for instance, as countries transitioned from rural, mostly agricultural cultures to urban business societies, and finally to post-business societies (Mhlanga, 2021).

Technological advancements have consistently evolved at a rapid pace across the first three Industrial Revolutions, although not as swiftly as the current rate. In recent years, the speed of technological progress, deployment, and implementation has notably increased for various reasons (Kayembe & Nel, 2019).Human life now includes a significant amount of technology and society is gaining new skills and capabilities thanks to technology transforming lives. Society is therefore currently advancing toward the 4IR, which calls for a society in which people have more freedom

and can move between digital realms. They interact with one another by using technology to manage and assist their lives (Xu, David & Kim, 2018, p. 90). In addition to the social and economic penalties of the loss of many cutting-edge jobs, the 4IR is anticipated to have a great influence on how public and enterprise choices may also be furnished. These changes will likely be profound and increasingly chaotic (Anakpo & Kollamparambi, 2022; Feldmann, 2013).

The Organisation for Economic Co-operation and Development (OECD) estimates that 57 per cent of employment is at risk of automation, per a report published by Oxford University in 2018. Over 85 per cent of all employment losses in the United States of America (USA) between 2000 and 2010 were attributed to new technology (World Bank, 2018). These statistics underscore the tangible and historical economic implications of the Fourth Industrial Revolution, where technological advancements significantly shape and reshape the employment landscape. According to the Bank of England, two-thirds of all occupations might be automated within the next 20 years (Mohajan, 2019; World Bank, 2018). Brynjolfsson and McAfee, among other economists, have noted that the revolution may result in increased inequality because of its propensity to destabilize the labour markets (Brynjolfsson, McAfee & Manyika, 2014). Robots and computers will replace humans in a wide range of industries as automation increases. Low-skill/low-paying occupations will go so the poor will have more difficulties, and this will create increased social tensions (Taiwo & Vezi-Magigaba, 2021).

1.1.1 The fourth industrial revolution in the context of South Africa

Understanding the impact of the Fourth Industrial Revolution (4IR) in South Africa is imperative due to two pivotal elements that underscore the country's socio-economic landscape.. Firstly, South Africa grapples with one of the world's most unequal economies, rooted in its history of colonization and racial segregation (World Bank, 2018; Orthofer, 2016). Secondly, the nation faces a significant challenge of high unemployment, with approximately eight million people jobless as of 2022(Statistics South Africa [StatsSA], 2022). South Africa is a developing nation but when compared to other developing nations on the continent of Africa, it possesses several technologically advanced industries (Le Roux, 2018). In the 2018 WEF Global Competitiveness Survey of 140 nations, South Africa came in at number 60 (Le Roux, 2018). However, the job growth in these advanced industries does not align with the increasing number of young people

entering the labor force, creating a structural disparity in labor supply and demand (Reddy, Bhorat, Powell, Visser & Arends, 2016). This paradox suggests that even though most workers and job seekers have low skill levels, economic growth benefits workers with advanced degrees (Reddy et al., 2016; Rogan, 2018). This disparity disproportionately affects the African demographic group, constituting 75% of the employed and 90% of the jobless (StatsSA, 2021). The youth (15 to 34 years old) face notably high unemployment rates, a challenge exacerbated by the growing difficulty for young individuals to enter the job market (Bhorat, Oosthuizen, Lilenstein & Steenkamp, 2017). This socio-economic backdrop sets the stage for understanding how the availability of digital tools and internet access further entrenches these disparities.

The availability of digital tools and the Internet in South Africa closely mirrors the economic inequalities of the nation. According to StatsSA (2018, p.4) from the General Household Survey (GHS) "64.7% of South African households had one member who had access to the Internet at home, at work, while studying, or in Internet cafés". The highest rates of Internet connection were found in the "Western Cape (72.4%), Mpumalanga (70.2%), Gauteng (74.6%), and Mpumalanga, while the lowest rates were found in Limpopo (46.2%) and the Eastern Cape (55.3%)" (StatsSA, 2018). The percentage of South African households with access to the Internet at home was just over a tenth (10.4%). In contrast to 17.3 per cent of families in urban areas, only 1.7 per cent of rural households countrywide and less than 1 per cent in the Northwest (0.8%) and Limpopo (0.6%) have access to the Internet at home. This underscores a challenge wherein individuals without Internet connectivity face barriers to taking advantage of opportunities associated with the Fourth Industrial Revolution (4IR), particularly in the context of online remote work, which requires a dependable Internet connection.

Historically, only 17 per cent of the world's population, or 1.3 billion people, participated in the first, second, and third industrial revolutions because they had access to electricity. The remaining 1.3 billion people were unable to do so. In sub-Saharan Africa, 600 million people lack access to electricity, so technology advances leave the underprivileged behind (International Energy Agency, 2019). A cursory examination of prior IRs reveals that, despite the greater social advantages brought about by the invention of steam, electricity, and digitization, theses advantages have not been linked to the interests of the underclasses (International Energy Agency, 2019).

Instead, they are linked to the development of big capital through current "big" technology. This 4IR is expected to be no different.

The cutting-edge technology of the 4IR deterministically promises to improve life for everyone, so there is an urgent need for a critical inquiry to understand the consequences that the 4IR has and will continue to have on the most underprivileged and marginalized elements of our population (Adams, 2021). While the elitist discussion around 4IR negotiations and their potential impact on employment market disparity has garnered some attention in South Africa (Adams 2021; Gillward, 2019), little has been done to examine the attitudes of its citizens toward this IR. This is despite the fact that they are already being affected by and will continue to be affected by the growing prevalence of artificial and related 4IR technologies. 4IR has widespread societal implications, so it is important that social scientist's study public attitudes toward the technology.

1.2 The Fourth Industrial Revolution and Public Opinion in South Africa

A new wave of technological convergence is currently creating the groundwork to prepare for the 4IR. This includes, among many others, three-dimensional (3D) printing, artificial intelligence (AI), and robotics (Luz Tortorella, Cauchik-Miguel, Staines & McFarlane, 2022; Makridakis, 2017; WEF, 2017). The thrust of the 4IR is the usage of smart systems to tackle global challenges, unlike the previous means of revolution which used mass production, transportation, and rapid adoption of electricity (Makridakis, 2017; Naudé, 2017; Vicente & Dias-Trindade, 2021). Ayentimi and Burgess (2019) claim that the rise of the 4IR will present serious risks, modify patterns of consumption, employment, and production, as well as establish more general geopolitical and socio-economic change agents in both developed and emerging nations. Even though technology has a tremendous deal of potential to spur social and economic advancement, individuals, governments, and businesses all over the world may need to make proactive adaptations in response to these changes brought on by the 4IR (Roberts, Gordon, Struwig, Bohler-Muller & Gastrow, 2021; Runde, 2016).

According to some scholars , the 4IR will have extreme effects on society because it will disrupt labour markets, increase income inequality, and increase unemployment. For more information on this, see Millington (2017); Peters (2017); and the Department of Economic and Social Affairs

(2017). While certain professions and jobs are expanding swiftly and changing the capabilities and skill sets required, many have already undergone substantial modifications because of the present technology revolution, while others are already threatened by redundancies, significant job displacements, and skills disruptions (Naudé, 2017; Peters, 2017; Roberts et al., 2021; WEF, 2017b). It is thus crucial to examine the 4IR within the South African socio-economic situation.

Concerns about South Africa's ability to adapt to the revolution effectively have been voiced by the Industrial Development Think Tank (Bell, Goga, Mondliwa & Roberts, 2018). National evaluation studies and cross-national comparisons frequently give the nation's technological capacity and level of digitalization low ratings (see, for instance, Roberts et al., 2021). There are also concerns that the 4IR will worsen inequality and unemployment (Chakravorti, Tunnard & Chaturvedi, 2015; Fagerberg & Srholec, 2017; Schofield & Dwolatzky, 2019). The McKinsey Global Institute (2017) evaluated the number and types of jobs that could be created or eliminated by 2030 using several 4IR scenarios and reported that it is potentially possible to automate many of the human jobs utilizing 4IR technologies. This has already been shown (Manyika, Lund, Chui, Bughin, Woetzel, Batra, Ko & Sanghvi, 2017), and it will cause a huge disruption in the labour market. According to the Mckinsey study, automation may replace up to 13 per cent of the current labour activities in South Africa by 2030 (Mckinsey Global Institute, 2017). In a society that already faces a serious dearth of suitable employment opportunities, this will result in a tremendously disruptive change in the employment environment.

Citizens in a modern democratic society must have enough access to trustworthy information to form informed opinions regarding important societal developments. Science communication and people's resistance to scientific and technical improvements is mostly caused by a lack of comprehension of these developments (Sturgis & Allum, 2004). The adage "to know science is to love it" captures this idea of the knowledge deficit model well (Allum, Sturgis, Tabourazi & Brunton-Smith, 2008). Roberts et al. (2021) found that there is a lack of research on public awareness of specific examples of 4IR technology, such as biotechnology, and a significant portion of the population lacks basic knowledge of these technologies. South Africans appear to have disturbingly little knowledge of science (Roberts et al., 2021). This shows that the general public

might have a poor comprehension of and misconceptions about the 4IR, and that further knowledge of it might not change those things (Roberts et al., 2021; Struwig & Roberts, 2012).

Despite the possibility that the 4IR will produce many new jobs and raise demand for those that already exist, not everyone will be able to benefit from this revolution (Sutherland, 2020; Roberts et al., 2021). Routine, hazardous jobs can be handled by automation, and this may lighten the load on both workers and customers. Societies must make ready for difficult labour changes if they are to reap the rewards of automation. Individual workers will need to upskill continuously, learn new skills, and adopt an entrepreneurial mindset to adapt to a more socio-technical future (Yang, 2018; Roberts et al., 2021). The assumption is that younger generations will find this type of shift simpler because they are sometimes seen as having a greater passion for technological advancement (Roberts et al., 2021). We do not know how open the younger generation is to robotics and automation because the research evidence that implies a connection between age and a preference for technology is flimsy at best (Roberts et al., 2021; Vicente & Dias-Trindade, 2021).

Given the potential for the 4IR to have a disruptive effect on society, increased awareness of it may result in more people fearing it than being optimistic about it. There is currently a large gap in national representative statistics regarding how the 4IR is perceived by the public in South Africa. Due to this mismatch, it is challenging to anticipate the viability of a model for technology adoption that could be appropriate for South Africa's socio-economic environment. The South African government is creating new policy frameworks to welcome the 4IR and to exploit its promise while minimizing its negative effects. However, societal opposition, which is often referred to as Neo-Luddism, means that 4IR programs are less likely to be successful. Neo-Luddites are people who disapprove of modern technology; this term was coined in relation to textile workers who opposed the introduction of technological devices that diminished the need for skilled workers (Vincent, Nadelhoffer & McCay, 2020). Little is known regarding societal positions' effects on people's views about automation and robotics, and given the absence of empirical data on this we have to analyze the public’s responses to new technological developments, otherwise policymaking may be hampered and be rendered ineffective. The current study aims to close this gap by providing a nationwide representative sample that will help to generalize the findings and establish a national perspective on the 4IR.

1.3 Research Problem

The research problem this study confronts is the lack of a comprehensive understanding of public perceptions and attitudes towards the fourth industrial revolution (4IR). Such an understanding is necessary to implement effective policies that will maximize its potential while minimizing its negative effects, and this is especially important for marginalized and impoverished people living in townships and rural areas. The study aims to fill the gap in existing research on public opinions on 4IR, especially in South Africa, and to identify the demographic characteristics that impact the public's opinions. When reviewing the literature on the subject it became evident that the study of attitudes towards technology advancements have mostly been derived from a small amount of public opinion research to date, and most of this research has been conducted in the global north (See Nomura, Kanda, Suzuki and Kato, 2009). This study aims to fill this gap by utilizing a nationally representative sample that intentionally includes underrepresented groups in the technology sector. The research not only quantifies the impact of various demographic characteristics on South African opinions but also highlights areas where the government should devise new policy frameworks to optimize 4IR's potential while mitigating its negative effects.

The exclusion of underrepresented groups from technology adoption policies, if not addressed, poses a substantial hindrance to South Africa's adoption of 4IR technologies. Neglecting public opinion may result in disagreements that thwart adaptation to new technological realities, widening existing inequalities and leaving marginalized communities further behind in accessing and benefiting from technological advancements. This potential exacerbation of social tensions and economic disparities could lead to resistance and backlash against policies that do not align with public preferences. Without a nuanced understanding of public attitudes towards technological advancements, policymakers may inadvertently implement measures that spark opposition, limiting the potential for innovation and economic growth driven by 4IR (Uhunamure, Nethengwe & Tinarwo, 2021).

Furthermore, the study acknowledges the global context by drawing attention to countries, like South Korea, Japan, and China, that have experienced protests related to technological development and robotics (see Nomura, Kanda, Suzuki & Kato, 2009). This international perspective emphasizes the importance of understanding individual views to prevent potential protests and conflicts arising from concerns about job placements.

Another significant gap addressed by this study is the scarcity of technology adoption models that incorporate society's attitude toward technology. Conventional models often overlook the influence of socio-economic status (SES) and other social factors on technology adoption, particularly in less developed countries with slow economic growth. Recognizing and addressing these structural issues, such as perceptions of financial limitations, is crucial to avoid worsening existing digital imbalances and negative socio-economic impacts on society. This study contends that South Africa must gain a thorough understanding of public perceptions and propensities toward the societal changes brought about by evolving technology. Effective public policy discussions and oversight are necessary, given the diverse policy views on 4IR. By addressing these gaps, the research aims to contribute valuable insights that can inform policies aligning with public preferences, fostering societal harmony, innovation, and sustainable economic growth.

1.4 Rationale for the Study

The discourse surrounding the Fourth Industrial Revolution (4IR) in South Africa has primarily focused on assessing the readiness of educational institutions, businesses, and the workforce, and the associated risks and benefits (Parker, Morin & Horowitz, 2019; Roberts et al., 2021). Despite the significance of these aspects for societal growth, there exists a noticeable gap in understanding public opinion on these matters in South Africa. This research addresses this gap by delving into the sentiments of the adult population (16 years and above) across diverse demographics, recognizing the universal impact of the 4IR. Conducting this study within South Africa ensures the relevance of findings to the socio-economic realities of sub-Saharan African countries, providing insights distinct from studies conducted outside the continent. The study not only aims to impact the current situation in South Africa but also seeks to propose hypotheses applicable to other geographical contexts, particularly in Africa.

To comprehensively capture public sentiments this study utilizes the Human Sciences Research Council's (HSRC) annual South African Social Attitudes Survey (SASAS), a cross-sectional survey that is nationally representative and repeated.The SASAS is gradually capturing the rate and direction of change in fundamental public perceptions, values, and the social fabric of contemporary South Africa, and the data is presented in a single, comprehensive record (Roberts, 2013). Contributing to this survey, which stands out as a critical tool for tracking changes in South Africans' social, economic, and political values, is of utmost importance given the potential of SASAS as an anticipatory or predictive mechanism that can guide decision- and policy-making processes (Roberts, 2013). It must be noted that the analysis does not directly address the stated policies of the Presidential Commission on the Fourth Industrial Revolution in South Africa, however, the results can be used to assess the success of present policies and to direct the development of new ones.

This research not only aims to impact the current situation in South Africa but also seeks to propose hypotheses applicable to other geographical contexts particularly in Africa. Conducting this study within South Africa ensures the relevance of findings to the socio-economic realities of sub-Saharan African countries, providing insights distinct from studies conducted outside the continent. The study not only aims to impact the current situation in South Africa but also seeks to propose hypotheses applicable to other geographical contexts, particularly in Africa. The insights gained from this research have broader implications, serving as a guide for the government in formulating policies and strategies related to the Fourth Industrial Revolution (4IR) and technology adoption. By leveraging the quantitative findings, policymakers can make informed decisions that resonate with the sentiments of the broader public. This aspect is particularly crucial in the dynamic landscape of 4IR policy development, where understanding public attitudes becomes integral to crafting effective and inclusive strategies for technological advancements.

1.5 Research Questions

In this study, the 4IR is investigated utilizing survey data on popular opinion. This study aims to investigate how perceptions of the 4IR in South Africa relate to important micro-level sociological characteristics. This dissertation's objective is to evaluate the reliability of these micro-sociological variables. The investigation considers both attitude-based (such as perceptions of recent technological advances) and non-attitudinal (such as educational achievement) drivers. The discussion centres on the following micro-level sociological indicators: SES, generational differences (age), and general knowledge of the first two.

The study offers the following research question to accomplish the aims of this thesis:

Main research question: What are the determinants of public opinion towards the 4IR in South Africa?

Specific research questions are as follows:

- What is the relationship between micro-level sociological indicators and attitudes towards the 4IR in South Africa?
- What are the salient factors that impact the cultural acceptance of 4IR automation?
- Which model is most appropriate to determine the adoption and utilisation of the 4IR technologies in South Africa?

1.6 Research Objectives

Main objective: To investigate the determinants of public opinion towards the 4IR in South Africa.

Specific objectives:

- To determine the relationship between micro-level sociological indicators and attitudes towards the 4IR in South Africa.
- To determine salient factors that impact the cultural acceptance of 4IR automation. And

- To develop an appropriate model for adoption and utilisation of 4IR technologies in South Africa.

1.7 Hypotheses

This study has seven hypotheses, and the results of the tests in terms of these are presented in Chapter Eight. The interest of the study is to determine varying attitudes by different socio-economic indicators, such as age, income, and employment status. The hypotheses are therefore framed to capture the varying attitudes as per the mentioned socio-economic indicators. This study utilizes bivariate statistical tests as this is the most efficient for testing two variables. Where there are three or more variables, repeated measures of analysis of variance (ANOVAs) are employed.

H1: Younger people will be more accepting of robots than older people.

H2: Confidence in South African government intervention will produce more favourable attitudes towards the 4IR.

H3: Employed people will be more opposed to automation than the unemployed.

H4: People will not support a private company introducing computer technologies that risk people losing their jobs.

H5: Workers who will be displaced by automation will be more hostile towards technology change in society.

H6: People will believe that schools have not prepared young people to work with technology.

H7: Familiarity with science and technology will predict favourable attitudes towards the 4IR.

1.8 Definition of Key Terms

Artificial intelligence (AI) and automation "is a rapidly progressing technology that has a significant impact on humans' daily lives through the artificial creation of human intelligence capable of reading, thinking, planning, perceiving, and manipulating natural language" (Internet Society, 2017, p. 2). AI has an impact on highly skilled graduate occupations and what it means to be marketable, whereas automation refers to the human replacement of robots in previously

performed tasks (Neufeind, Ranft & O`Reilly, 2018). AI is drastically changing the workplace by automating many tasks as well as changing the tasks themselves, and these are tasks which require specialized abilities to complete them (Corfe, 2018). However, in the future, AI is probably going to increase the prospects for using general skills, leading to transdisciplinary robotic labour and more human-conscious software solutions (WEF, 2017).

Black African: In the South African context, "Black" refers to individuals who are part of the indigenous African populations of the country. This category includes various ethnic groups such as Zulu, Xhosa, Sotho, Tswana, and others. Historically, during the apartheid era (1948-1994), racial classification was used to enforce discriminatory policies. "Black" was a broad category that encompassed various ethnic groups who were subjected to systemic oppression and segregation (De Klerk, & Gough, 2002).

Coloured: The term "Coloured" in the South African context historically referred to individuals of mixed race. large parts of the Coloured population are distant descendants of ‘interracial relations’ between the Black, White and indigenous population. They are an extremely diverse group of people with root in many different parts of the world but their collective experience of social and spatial separation from the White and Black population has nevertheless generated a sense of community that continues to operate in post-apartheid South Africa (Nilsson, 2016).

Industrialization is the term used to describe the economic transformation resulting from technology that is powered by inanimate sources and can advance continuously as a result of applied scientific study (Lopes & te Velde, 2021). Structures alter because of industrialization. Agriculture is losing its dominance as a source of employment as other activities, particularly manufacturing, take its place (Lopes & te Velde, 2021). The primary forces behind economic growth and rising national and per capita incomes have been improvements in industrial productivity and production, which in turn create an ever-expanding market for consumer goods and industrial items used in the construction of social infrastructure (Grubler, 1995).

The first industrial revolution (1IR) is defined as the age of mechanical production through the advent of the steam engine, which moved human activity from agriculture to textile manufacturing

(Kayembe & Nel, 2019). The 1IR covers the period between the 18th and 19th centuries. During this time human communities evolved from agricultural practices to the usage of mechanisation. The invention of the steam engine in the 1IR altered the production tools that were available. New methods of conducting business and addressing social issues were established by communities across the world, but especially in Europe and North America (Kayembe & Nel, 2019). These adjustments opened up fresh opportunities, duties, and skills. Many nations were able to grow, diversify, increase, and build their economy because to the 1IR. The 1IR primarily focused on infrastructural development. The development of urbanization, new skills, and improved living standards are only a few of the factors that are credited to the 1IR globally (Kayembe & Nel, 2019).

The second industrial revolution (2IR) "is known as the age of science and mass production, as this marks a period where scientific principles were brought into factories. Beginning in the early 19th century, the second era (2IR) was a continuation of the first. The 2IR witnessed significant scientific advancements in several industries, including steel, chemicals, and electricity" (Agarwal & Agarwal, 2017, p. 1063). Electricity's invention was a significant development because it made it possible for many businesses to run and develop. This technological advancement also made it possible to conduct mineral exploration. One characteristic of the 2IR was the use of machinery, which was frequently powered by electricity.

The third industrial revolution (3IR) started in the mid-1900s. "The 3IR was propelled by technological developments in production, distribution, and energy"(Roberts, 2015, p. 2). The advent of nuclear power and the widespread usage of electronics were two of the largest developments during the 3IR. Many regions of the world caught up with Europe during the 3IR.

The fourth industrial revolution (4IR) represents a profound change in how we communicate, live, and conduct business. Technology has made incredible advancements on par with those of the 1IR, 2IR, and 3IR, beginning a new chapter in the advancement of mankind. These modifications are connecting the physical, digital, and biological worlds together in ways that carry both considerable risk and enormous potential for benefit (Adams, 2021).

1.9 Structure of the Dissertation

Chapter One: The study is introduced in Chapter One of the thesis. It continues by describing the overarching research aims, the main research question and its supporting research goals, the importance of the study, and the description of key words.

Chapter Two: Attitudes are conceptualized and discussed, along with their significance to scholarship and how they develop. This chapter's purpose is to evaluate the key arguments made in support of these claims and to give a broad overview of the determinants of attitude formation. The future of quantitative attitudinal data is discussed, and the utility of examining attitudes in research on the 4IR in South Africa is questioned. Although attitude analysis is a well renowned academic field, its hidden benefits might not be immediately obvious. In fact, most researchers studying the 4IR internationally use data from public opinion surveys. Why analyzing public views in South Africa is important is a question that this chapter aims to address in detail.

Chapter Three: Provides an overview of the literature regarding industrialisation in the socio-economy in selected developed countries. It historicises the first three IRs and looks at significant differences, to locate the conversation on the 4IR in the context of a developed world, as the experience of industrialisation is not the same in developing countries.

Chapter Four. Reflects on literature regarding industrialisation in the socio-economic conditions of African countries and examines historical revolutions on the continent to provide context for this study. Although the study is grounded in understanding how South African society views the 4IR, it is crucial to look at the significant impacts that the first three IRs had. The chapter also has a focus on the 4IR in the socio-economic context of South Africa.

Chapter Five. This chapter provides the theoretical framework of the study. Existing theoretical frameworks are explored. They are categorized as technology adoption models, and include techno-optimist and techno-sceptic models which look at the interaction between technology and society. For this thesis, I propose the adoption of an integrated model that considers the complex interaction between technology and society, and not just the perceived ease of use of technology: It is sometimes about the setting in which technology is introduced and the effect that the technology has in different settings in society.

Chapter Six provides the research methodology and research paradigm chosen for the study. It offers the process followed by the researcher to perform secondary analysis as well as in preparing the data for analysis. The practical procedures and statistical analysis employed are discussed, and it closes with the ethical considerations of the study.

Chapter Seven provides empirical analyses through cross-tabulation and descriptive statistics to reflect on the varying attitudes towards the 4IR against the SES of the respondents. The chapter shows trends and patterns about the level of acceptance towards 4IR, and it reflects on the emerging attitudes as pertaining to literature and theory.

Chapter Eight is also a chapter of empirical analysis and shows the bivariate and multivariate testing. It is centered on the association between socio-economic profiles and the 4IR and discusses the relationship between micro-level sociological variables and attitudes toward the 4IR in South Africa. This includes the reasons that influence the attitudes held, and the chapter also addresses the respondents' perceptions of the 4IR. The information in this chapter's main sections relates to the relationships between the micro-sociological indicators and the results of the hypothesis testing.

Chapter Nine is the dissertation's last chapter, and it provides analyses of its arguments and conclusions and explores the consequences for scholarship and public policy. It also outlines the study's contribution to knowledge and points out areas that need more investigation.

1.10 Chapter Summary

The research problem, the study's context, and its background were all stated in this chapter's introduction. The discussion then moved on to cover the purpose and justification for the study. The study's aims and the research question it seeks to address were further outlined in this chapter, and these are to investigate how perceptions of the 4IR in South Africa relate to important micro-level sociological characteristics. This dissertation's objective is to evaluate the reliability of these micro-sociological variables. The investigation will consider both attitude-based (such as perceptions of recent technological advances) and non-attitudinal (such as educational

achievement) drivers. The basic organization of the entire dissertation was presented as the chapter ended. The next chapter will explore the conceptualization of attitudes.

CHAPTER TWO: CONCEPTUALISING ATTITUDES – THE 'WHY' AND THE 'HOW'

2.1 Introduction

The quantitative investigation of technological adoption has relied heavily on the notion of "attitudes." However, there are still significant misunderstandings about what an attitude is and how it forms in various groups. This is particularly true in South African academia where some scholars have critiqued attitude analysis as being excessively reductive (Gordon, 2017). This chapter explores the attitude literature concerning the issue of this dissertation to correct these misconceptions. The review's objectives are to assess the key defences of attitudinal analysis and to provide a general overview of the key elements that shape attitudes. The review presents general attitudes as well as the South African experience. The chapter is fairly selective in the works it reviews because there is a sizable amount of academic study on attitudes.

Although I acknowledge the drawbacks of a positivist approach, I concur with Turner (1993) that quantitative analysis can shed light on the social sciences. According to Turner (1993), having a thorough understanding of the analysis of attitudes is essential to doing significant quantitative research. This raises further questions, though, such as what an attitude is and why it is important to research attitudes. The purpose of analysing public views in South Africa is addressed in great length throughout this chapter.

I started looking for quantitative information from polls of the general population while participating in a virtual lecture on the potential of the 4IR in South Africa. I talked about the possibilities for quantitative attitudinal data and questioned the importance of attitudes in the study of 4IR in South Africa. Although attitude analysis is a well renowned academic field, its hidden benefits might not be immediately obvious. In fact, most researchers studying the 4IR internationally use data from public opinion surveys. The first topic covered in this chapter is attitudes and how they relate to behaviour and policy.

The chapter's next section looks at how public opinion affects policies and why democratic nations use it to determine the sentiments of their inhabitants. If we assume that attitudes are worthwhile

study subjects, we are left with the implicitly important topic of how attitudes develop. As evidenced by evaluations of the literature by McLean, Osei-Frimpong, Wilson and Pitardi (2020), this is a disputed topic that has generated a significant body of academic literature. The only straightforward response to this is that there are numerous elements at work.

2.2 Why Studying Attitudes is Important

Humans are social animals who embrace their culture and the values, attitudes, beliefs, and ideas that develop within it, and they use them to guide their behaviour (Durdukoca, 2019). In the context of this study, views toward advances like the 4IR must be studied because they elicit diverse responses in various nations with diverse internal economic circumstances. Studying attitudes has been deemed crucial due to the significant implications it has for interventional tactics (Cislaghi & Heise, 2020), particularly in the subject of social psychology. While attitudes are commonly associated with the object of study, the examination of attitudes extends beyond the realm of social psychology. It encompasses individuals and abstract concepts, providing a broader scope for analysis. Attitudes play a crucial role in a wide range of disciplines. Political behaviour (attitudes toward political candidates, parties, or voting), marketing (attitudes toward products), advertising (attitudes toward commercials), and health (attitudes toward protective behaviours, new medications, or the health care system) are among the examples of the disciplines that attitudes can be applied to (Albarracin & Shavitt, 2018; Masiya, Davids & Mangai, 2019; McLean et al,. 2020). In contrast to self-esteem, which is the study of attitudes toward the self, values are the study of attitudes toward impersonal concepts. Interpersonal liking is the study of attitudes toward other people. People can have specialized or generic opinions on a wide range of subjects, and their attitudes can either be typically positive or typically negative (Albarracin & Shavitt, 2018).

Allport (1935, p. 798) argues that historically, "the concept of attitudes is probably the most distinctive and indispensable concept" in social psychology. However, scholars currently consider the definition of attitudes as: "a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour" (Albarracin & Shavitt, 2018, p. 300; Masiya et al., 2019). Even while this definition is clear, it does not explain why investigating attitudes can be crucial to the research of the 4IR. I will attempt to answer that question in the subsections that follow.

2.2.1 What is attitude generally and in the South African context?

It makes no sense to study attitudes without taking the social context of the subjects into account. External socio-economic factors play a significant role in how people perceive the world. Although attitudes are perceived as being largely constant and stable over time and context, there is also recognition that attitudes are susceptible to change particularly when they are regarded as being built based on transient factors, like the perceiver's mood at a given time (Albarracin & Shavitt, 2018). Social and economic factors in South Africa have a significant impact on mental health: the negative impacts of injustice, poverty, and racism have not only failed to encourage good mental health but have also made it more difficult to achieve it (Carrion & Kaufman, 2018).

Even though apartheid and its effects on attitudes are not the main subject of this study, I believe it is important to emphasize its effects on the social and economic background because they affect general attitudinal orientation. Given how closely "white" has been linked to privilege, power, and wealth in South Africa, it is not surprising that any project focused on development, like the 4IR, would have a connection to these issues and might stir up feelings. The failure of attitude theorists to understand attitudes' essentially social origin has drawn criticism from social representation theorists (Albarracin & Shavitt, 2018; Fraser, 1994; Purkhardt, 1993).

Compared to theories of cognition, emotion, and behaviour, theories of social representation place more emphasis on the interactive and dynamic linkages between social knowledge, shared identities, and social practices (Purkhardt, 1993). Instead of seeing the concept as something "out there" that causes people to adopt certain attitudes, people are regarded as actively co-constructing the intersubjectively agreed realities that make up their environment (Purkhardt, 1993). This happens because of a procedure called "social re-presentation" (Purkhardt, 1993, p.32). Since social re-presentations "embody and define the perception of reality, deciding its borders, its meaning, and its relationships," they have a much larger impact than attitudes. Because they are shared by many people, social images "are social because they comprise a social reality that can affect individual behaviour" (Purkhardt, 1993, p. 32). This has important implications for the study of public attitudes towards the fourth industrial revolution as it suggests that people's attitudes towards the fourth industrial revolution may be influenced by their social and cultural

backgrounds. The way individuals interpret new technologies is likely to be shaped by their social and cultural experiences, which in turn will shape their attitudes towards the fourth industrial revolution. It highlights the importance of understanding the social and cultural context in which these attitudes are formed, as well as the role of the media and interpersonal communication in shaping these attitudes.

2.2.2 Attitudinal research in the South African context

Public opinion polls appeared destined to become a regular and significant component of South Africa's new democratic system when millions of South Africans queued up to cast their ballots in the country's historic foundational election in 1994 (Mattes, 2012). Although the state had set up a successful opinion research facility to track public attitudes toward political change and that a thriving private research sector had developed during apartheid, neither organization regularly surveyed the vast majority of black South Africans. This was due to several political and technical issues (Mattes, 2012).

Due to the country's history of apartheid, which was largely supported by racial injustice and segregation, most studies on views were carried out in racially separated settings. Social psychologists have been interested in studying attitudes in South Africa because of the history of the nation (colonial and apartheid), which has led to attitudes having a bearing on the race situation and being many people's obsession (Albarracin & Shavitt, 2018). In South Africa race is the underlying reason why particular groups feel and see things in a particular manner, not the attitude itself. In a study conducted in South Africa, Durrheim, Foster and Dixon (2011) sought to examine the issue of racial views in various historical eras and intergroup scenarios. Their research demonstrates that during the period, the systematic racial disparity was a result of racist sentiments, since there was prejudice directed at various races. This suggests that the historical context and intergroup dynamics play a pivotal role in shaping perspectives.

On the other hand, attitudes encompass a broader spectrum of beliefs, emotions, and behaviors that individuals hold towards a particular subject, extending beyond racial considerations. While racial views specifically focus on the influence of race on perceptions, attitudes encapsulate a more comprehensive range of inclinations that may be shaped by various factors, such as personal

experiences, cultural influences, and societal norms. Therefore, the distinction lies in the specificity of racial views, which concentrate on the role of race, compared to attitudes, which encompass a more diverse array of influences.

General population surveys were conducted in South Africa over the 20th century, which is like Durrheim et al.'s (2011) study. The majority were either household surveys or national censuses that were used to collect information about problems with sporadic production or consumption (Gordon, 2017). According to reports, white South African politicians and technocrats classified and divided the non-white population using surveys, particularly national censuses (Gordon, 2017). Christopher (2009) asserts that the racial prejudice of the time had an impact on these beliefs and that census numbers were frequently falsified to satisfy political needs at the time (Gordon, 2017; Maré, 2011).

Intergroup attitudinal studies were carried out recently in post-apartheid South Africa to gauge the attitudes of citizens towards immigrants (Gordon, 2017). The study was quantitative and used data from the 2013 HSRC South African Social Attitudes Survey (SASAS), a nationally representative opinion poll (N=2,739) of all adults in the country (Gordon, 2017). His study was also based on using micro-sociological factors to ascertain what shaped attitudes. The most influential group identity factors driving attitudes were: (i) social ties with neighbours; (ii) national identity; (iii) societal interest; and (iv) racial alienation (Gordon, 2017). The results of his study suggest that anti-immigrant sentiment in South Africa can be confronted by changing patterns of intergroup contact and group identifications. In addition, he found that South Africans favoured restrictive immigration policies and opposed granting foreigners the same rights as citizens.

Another study was conducted by Makhado and Tshisikhawe (2021) to examine the role of apartheid in planting tribalistic and xenophobic attitudes among South Africans. The authors analyzed existing literature and drew on their own observations and experiences to develop their arguments and present their findings. The study found that apartheid education encouraged and reinforced tribalism by promoting the idea that different African ethnic groups were fundamentally different and in competition with one another (Makhado & Tshisikhawe, 2021). Students were taught to identify themselves primarily by their ethnic group and to view members of other groups

as inferior (Makhado & Tshisikhawe, 2021). This led to the development of negative stereotypes and prejudices towards other groups, which has contributed to ongoing tribalistic attitudes in post-apartheid South Africa. Lastly, a study was conducted by Carrion and Kaufman (2018) to examine the attitudes of white people towards a political process that was designed to end prejudice. The study used the HSRC's South African Social Attitudes Survey (SASAS) and it was a quantitative study. The findings showed strong attachments to the National Party and de Klerk, low perceptions of threat, more tolerant racial attitudes, and the more socially and politically liberal values increased the likelihood of whites supporting policies consistent with the ending of apartheid (Carrion & Kaufman, 2018). It also find that assessments of the economy, both personal and national, had no influence on this attitude.

Although I have not seen all of the public opinion research studies that have been done to date, there is a growing consensus that they should be used for a variety of reasons. It is significant to emphasize the difficulties when attempting to influence public opinion in South Africa. The idea of modernization was alleged to have influenced survey research techniques, tainting the methodology (Seekings, 2001). At the time, most left-leaning academics in South Africa favoured historical and qualitative research techniques and were typically skeptical of "bourgeois social science" research techniques (Jubber, 2006). Surveying "attitudes" was seen as crass, culturally inauthentic, and unsophisticated at best, and as a foolish (but unsuccessful) attempt to copy physical scientists at worst (Mattes, 2013).

Hanf, Weiland and Vierdag (1981), a group of German sociologists and political scientists, suggested that the South African government's practice of racial segregation during the apartheid era should continue. This reduced the legitimacy of the opinion survey as a research technique even more among liberal academics in South Africa. Public opinion polls are being used to gauge citizens' opinions about political, social, and even economic issues that influence them in the country. It is for this reason that the HSRC administers a series of attitudinal research surveys termed the "South African Social Attitudes Survey (SASAS)" to gauge views on an array of topics from climate change to voting attitudes, xenophobia and currently the 4IR (HSRC, 2018).

Although studies on public opinion on scientific and technological advancements date back to the 1970s, they were motivated by the notion that innovation in science and technology (S&T) is largely responsible for national success and that innovation requires a supporting public (Besley, 2013). However, the main reason why research programmes were started was because scientists were concerned that growing public scepticism in Western nations would lead to funding reductions for scientific programs. Surveys of public opinion have become common in many nations as a result. The premise of this research area is that attitudes toward science are influenced by both interest in and knowledge of science (Raza, Singh & Shukla, 2009). These beliefs then have an impact on outcomes such as voter support for public funding. According to preliminary studies, South Africa's public attitudes about S&T have a distinct fingerprint that makes it stand out from other nations (Reddy, Gastrow, Juan & Roberts, 2013). Surveys carried out in various nations have shown that the public's attitude toward S&T is positively correlated with their level of scientific literacy (Sturgis & Allum, 2004). A meta-analysis found a weak but significant correlation between people's opinions of science and their support for public funding of it (Allum et al., 2008). Additionally, data appears that shows that socio-demographic characteristics such as gender (male), age (younger), and education level (higher) have an impact on positive perceptions about S&T and higher literacy (Munoz et al., 2012).

Long debated has been the connection between attitudes toward S&T and knowledge of science (Besley, 2013; Allum, Sibley, Sturgis & Stoneman, 2014). The so-called deficit hypothesis, which contends that if people were just more knowledgeable about science, their opinions toward it would improve and scepticism would vanish, has long been a tenet of research. Western nations have implemented numerous educational initiatives (Bauer, Allum & Miller, 2007) because of this. However, some have questioned both the general nomenclature and the effectiveness of such programs. Furthermore, a cross-cultural study in Europe has demonstrated that, in contrast to post-industrial countries, industrially developing countries have a lesser association between scientific literacy and attitudes toward S&T (Bauer et al., 2007). The argument is that only a small elite in industrial countries are knowledgeable (high socio-economic stratification), and that more information promotes a more optimistic outlook. Guenther and Weingart (2016) also examined the variables that affect people's views about S&T because their attitudes towards it are influenced by

their level of understanding of the 4IR. One of this study's goals is to determine how well-informed South Africans are about S&T.

Recently, studies trying to determine national views toward 4IR tended to focus on technology uptake in various fields; for instance, how educators and academics felt about cutting-edge teaching methods (Govender, 2012; Maisiri, 2020; Oke & Fernandes, 2020). Other research examined how people perceived 4IR technologies as affecting workplaces (Mhaka, 2020; Mille, 2019). However, the majority of studies on the 4IR focussed on its effects rather than the public's views, opinions, and perceptions. Other recent studies on the 4IR and public opinion in the South African context are mostly not generalisable because they utilized qualitative methods (Morathi, 2020). Some of the studies that were quantitative were district bound and cannot be generalised as they were not nationally representative (Lekhanya, 2019). Quantitative information on public perceptions toward 4IR in South Africa is thus still lacking, in part because most of the surveys conducted did not use a nationally representative sample.

2.3 The Attitude-Behaviour Relationship

Mattes (2013, p. 491) posed this question in his reflection on the significance of doing attitudinal research in South Africa: "What is public opinion research, if not the attempt to identify the values, beliefs and understandings that inform actions?" Mattes' (2013) usage of the word "inform" is telling because there is no real obvious linear relationship between attitude and behaviour.

The amount of study on how and when attitudes predict behaviour is significant and growing. The Theory of Planned Behaviour (TPB), which contends that attitudes are the primary determinants influencing behavioural intentions, is the foundation for a sizable portion of the literature (Ajzen, 2020; Ajzen & Fishbein, 2005). Consumer behaviour, safer sex, drug use, and technology adoption are just a few of the behavioural areas where the TPB has been successfully employed to explain and predict behaviour (see some of this research's meta-analytic syntheses for examples) (Albarracin, Fishbein, & Goldestein de Muchinik, 1997; Armitage & Conner, 1999).

Although the theory places a strong emphasis on attitudes, it also acknowledges the influence of contextual, normative, and individual qualities on behaviour (Ajzen, 2020). In other words, both

internal and external influences have a role in mediation of the relationship between attitudes and behaviour. The characteristics of the attitude itself, the person expressing the behaviour, and the environment in which it is expressed are thought to regulate the consistency of the attitude-behaviour link (Ajzen, 2020; Ajzen & Fishbein, 2005).The individual's knowledge about the "object" of the attitude and perception of it are mediated by cognitive processes are implicated in the influence of attitude (affect) on behaviour (Ajzen & Fishbein, 2000; Greenwald, 1989). Though sentiments about an object might influence behaviour, perceived ease of use is a causal factor in perceived usefulness. For instance, perceived utility and perceived usability are important as they form attitudes and act as a foundation for behavioural intention, which decides whether a sector would embrace and accept 4IR.

2.3.1 Attitude-behaviour relationship of Africans

The difficulties Western psychology has in understanding African behaviour, activities, and societal reality have been highlighted by African academics (Ratele, 2018; 2017; Holdstock, 2000). Holdstock (2000) went on to claim that long-standing Western psychological discoveries, worldviews, and ideologies "pathologize" rather than comprehend African people. Any psychological perspective must take the African people's worldviews, social realities, and economic realities into account in order to understand best how Africans perceive specific occurrences (Ratele et al., 2018). What then does a psychological perspective from Africa look like? African/black psychology is described by Baldwin (1976, p. 242) as a body of knowledge pertaining to the nature of the social cosmos from an African cosmological perspective; observing that "black psychology is nothing more or less than the uncovering, articulation, operationalization, and application of the principles of the African reality structure relative to psychological phenomena". Understanding how social representations vary between an African reality structure and a Western reality structure is crucial in order to comprehend events completely (Ratele et al., 2018).

The core beliefs of an African worldview are based on an African psychology approach that will provide conceptual models that organize, explain, and make it simpler to understand the psychosocial behaviour of Africans (Nwoye, 2015).This will make it possible for psychologists and other experts to develop initiatives that highlight the positive characteristics of African people (Nwoye, 2015). It is vital to investigate how 4IR developments maximize the benefits of new

technology because Africans will be among their most avid consumers. It is essential to recognize African roots and philosophy to build a clear and distinct perspective on the reality and lifestyles of African migrants in the diaspora.

The culture of Africa, which consists of a variety of ideas, values, attitudes, practices, and traditions, is what makes African social life concrete. This social life is portrayed through, among others, visuals that categorize situations, occurrences, and the people we interact with while condensing several meanings (Jodelet, 1991; Ratele, 2018). This reality is founded on patterns that influence how people respond to their environment in cognitive, emotional, and behavioural ways (Jodelet, 1991). Africans' ideas, practices, and values are therefore reflected in their actions, attitudes, sentiments, and values. This provides them with a framework with which to comprehend the world, interact with others, and lead generally fulfilling lives (Ratele, 2018).

2.3.2 The content of attitudes

As discussed thus far, attitudes can be viewed as a general assessment (for example, a like or dislike) of an attitude object. Several conceptual versions of the attitude notion have emerged because of this definitional approach. The multicomponent model of attitude has historically been one of the most significant (Albarracin & Shavitt, 2018; Haddock & Zanna, 1999). This viewpoint holds that attitudes are concise assessments of an object that include emotive, cognitive, and behavioural components (see Figure 2.1). Many academics have thought about how these three elements affect how views are formed and expressed.

The feelings or emotions connected to an attitude object are referred to as the affective component of attitudes (Gordon, 2017). Various influences on attitudes are produced via affective responses. Affective responses that a person has after being exposed to an attitude object are the main method through which feelings influence attitudes (Haddock & Maio, 2008). For instance, a lot of people say that they are afraid of spiders. A negative attitude toward spiders is likely to result from these negative emotional responses. There are various ways that feelings can start to be connected to attitude objects. Numerous scholars have investigated how coupling affective information with an attitude object using classical conditioning techniques might result in either a positive or negative attitude (Srivastava & Rojhe, 2021). For instance, Krosnick, Betz, Jussim and Lynn (1992); and

Srivastava & Rojhe's (2021) research participants were shown a succession of images of an unknown individual. Importantly, each image was preceded by an emotionally charged image that was exposed subliminally or exposed for a very brief period of time, below the threshold required for conscious encoding.

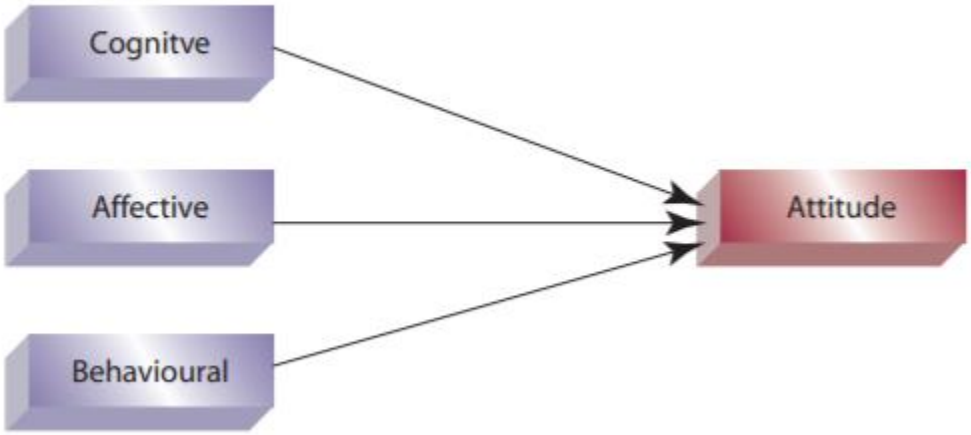


Figure 2.1: The multicomponent model of attitude

Source: Haddock & Maio (2008)

The beliefs, ideas, and characteristics we associate with a particular object are referred to as the cognitive component of attitudes (Srivastava & Rojhe, 2021). In many situations, a person's attitude may predominantly be determined by considering both the favourable and unfavourable characteristics of the attitude object (Fishbein & Ajzen, 1975). For instance, when an individual intends to purchase a new vehicle, he pays close attention to details like the various cars' safety records, fuel consumption rates, resale values, and repair expenses. In this case, attitudes toward the various cars are created through deliberate examination of both their good and negative traits. Many different sorts of attitudes are influenced by cognitions.

One theory of attitudes states that attitudes come from simpler cognitions regarding the attitude object, and that these simpler cognitions take the shape of beliefs. In the expectancy-value method of Fishbein and Ajzen (1975), an attitude toward an object is expressly defined as the sum of the "expectation value" products. Expectancies, which can range from 0 to 1, are the subjective probabilities or perceptions that a thing possesses a particular quality. Values are ratings of the

qualities, typically ranging from -3 to +3. If an attitude item is perceived to be related with or leading to positive things while avoiding negative things, it will be positively rated. Only salient beliefs, those that a person judges to be most pertinent, count towards overall attitudes.
The behavioural aspect of attitudes examines previous behaviours in relation to an attitude object. If someone remembers signing a petition against something previously, they might conclude that they are opposed to it. For example, a person might have signed a petition against nuclear power plants previously to prevent one from being built close to where they live. Bem (1972) claimed that this is more prevalent when a person has a weak or ambiguous attitude towards something. Numerous investigations have produced findings that support this theory.

For example, Chaiken and Baldwin (1981) asked participants to complete a survey with questions that were to serve as a reminder of their pro- or anti-environmental behaviours (e.g., picking up other people's trash, and leaving lights on in unattended rooms). Participants expressed their attitudes toward the surroundings after completing this assignment. The outcomes supported the self-perception theory: participants reported more positive attitudes after being reminded of their positive behaviours than after being reminded of their negative behaviours. Furthermore, only those people who had negative attitudes toward environmental issues before the experiment experienced this effect.

2.3.3 How do attitudes form?

After recognizing the importance of attitudes, we must think about how they change. For instance, the South African government frequently promotes the notion that the country's negative views of immigrants are a result of economic competition. The question of how attitudes develop is still up for discussion as scholars incorporate knowledge from allied fields (like social cognition) into their theoretical frameworks (Gordon, 2017). Theorists of public opinion who support hypotheses for the formation of viewpoints other than those of economic self-interest include (Sears 1993); Wilson 2013; and Zaller 1992). These researchers really do not deny that economic factors play a role in how people feel about particular things, but in recent years, the focus of scholarly inquiry has turned away from economic self-interest as the main driver of attitudes and moved toward non-economic ones (Sears, 1993; Wilson, 2013; Zaller, 1992). More and more emphasis is being

placed on societal interest and social identity. These patterns assist in reminding us of how challenging it can be to understand how attitudes are formed.

This section will present an assessment of the existing literature to identify a few major themes in the developing discussion. I will go over the relevant literature on the role of self-interest in determining attitudes, as well as potential substitutes, including knowledge, memory, and heuristics.

2.3.3.1 Information, memory and heuristics

According to Kruglanski (1989), attitudes are organized in the brain as associative networks of linked values and beliefs. Information that has been retained in memory is used to generate attitudes in the present. Therefore, attitudes should be influenced by how quickly information can be recalled from memory (Albarracin & Shavitt, 2018; Fazio, 1990). Laurian (2009), for example, claims in the attitudinal literature that people find it easier to learn and retain information that supports their preconceived notions than information that defies those attitudes (Albarracin & Shavitt, 2018; Eagly & Chaiken, 1993).

Take the following example of how knowledge can influence attitudes. Early in 2021 rumours began spreading about the new social media messaging application (app) (known as WhatsApp) requiring access to sensitive data, including banking data. This erroneous information that WhatsApp would have these new features heightened negative attitudes towards usage of the app and according to Dhawan (2021), citizens in South Africa started to resort to alternative apps such as Telegram.

Accepting memory as an important factor in shaping attitudes, we need to keep in mind that memory is socially structured in addition to being an individual issue. Moreover, memories may be collective and comprise of representations of group experiences, regardless of the "group" in question being subnational, national, or other (Ladwig, Vazou & Ekkekakis, 2018). Halbwachs (1992), the founder of collective memory analysis; Albarracin and Shavitt (2018); and Ladwig et al. (2018) have all shown how historical images are consciously made and used (though frequently not totally manufactured) to advance the goals of contemporary elites. An increasing body of public opinion research, however, demonstrates that the public and non-elites both reflect on the

shared histories of their respective groups favourably (De Houwer, Van Dessel & Moran, 2020; Hirst, Yamashiro & Coman 2018; Schwartz, Cacciatore, Scheufele & Corley, 2011).These investigations have demonstrated that common people's memories of their societies' collective past may differ noticeably from elite or even official versions. Furthermore, these results imply that people may assemble their current opinions using recollections of a group's collective past.

The psychological idea of "schema" has been appropriated by public opinion scholars to better understand how people utilize information to build attitudes. This completely altered the way in which we think about how information influences how people acquire attitudes (Davis, Altmann & Yee, 2020). Schemas are essentially mental models of attitudes and how they relate to other people. Schema theorists contend that knowledge of a particular group, event, person, or abstract notion (which comprises of knowledge of the concept and linkages to related concepts) forms the cognitive frameworks of opinions (Davis et al., 2020). Schema theorists contend that attitudes offer straightforward methods with which to address problems, organize memories of experiences and uphold a positive self-image (Sudman, Bradburn & Schwarz, 2010). In other words, attitudes are cognitive representations of assessments, which are crucial for people to understand their social environment. This social cognitive approach recognizes that people always have fresh stimuli flooding into their brains on a moment-by-moment basis.

Even though we utilise schemas to organise our attitudes effectively, people frequently lack knowledge on a particular topic. Sniderman, Brody and Tetlock (1993) discovered that humans use heuristics to make sense of the world through complex tests (or mental cues and shortcuts). Individuals classify the minimal information they have access to and speed up attitude construction by using cognitive heuristics, rather than intensive attention to and processing of information (Fiske & Taylor, 1991; Gordon, 2017; Katz, 2018; Petty, Wegener & Fabrigar, 1997). Cognitive heuristics are particularly useful when people are asked to formulate opinions on intricate policy matters. Common presumptions about human nature, political propensities, or even elite cues are examples of cognitive heuristics (Gordon, 2017; Kuklinski & Quirk, 2000). Individuals can develop ‘rational’ attitudes – attitudes that are internally consistent – by employing these cognitive heuristics.

2.4 Measuring Attitudes

Thurstone (1928) made his infamous claim that "attitudes may be quantified" in the first two decades of the 20th century. He added that attitudes can be evaluated using pre-designed questionnaires (Gordon, 2017). According to Gordon (2017), Likert's 1929 dissertation states that attitude surveys can be used to measure intelligence. For an overview of the first era of public opinion research, see Groves (2011).

Self-reporting questionnaires are the most popular way to measure attitudes. In these types of surveys, participants score the attitude object on two evaluative dimensions (such as agree versus disagree) (Gordon, 2017; Johnson, 2018). “The PATT (pupils' attitudes toward technology)” questionnaire is a self-reporting questionnaire that was used in the Van Rensburg et al. (1999) study to determine how South African schoolchildren felt about technology. The questionnaire was a 5-point Likert scale with several opinion statements assessed on a “five-point continuum: 1 = strongly agree, 2 = agree, 3 = undecided, 4 = disagree, and 5 = strongly disagree”. The questionnaire was administered to a group of individuals and the subjects rated how much they personally agreed or disagreed with each statement on a scale of 1 to 5. The methodology part of this dissertation explores alternative methods of assessing attitudes in addition to the Likert scale, which is just one of several tools available.

A group of academics conducted an experiment at the start of the 20th century that resulted in the first large-scale, systematic attitudinal surveys. This American study is credited with developing the "public opinion poll". When we use certain terms such as “public opinion”, we should be explicit about their meaning (Zaller, 1992). George Gallup and Elmo Roper, early public opinion researchers, recognized that the "public" was a group of people with varied opinions and views (Zaller, 1992). These researchers used a technique that involved systematic sampling from a predetermined group to get attitudinal data (Groves, 2011; Wilson, 2013). Along with this major innovation in sampling, Heath, Fisher and Smith’s (2005) approach also emphasizes the following important aspects: The use of standardized, "closed" questions to gauge respondents' subjective attitudes; (ii) in-person interviews with respondents; (iii) the use of trained interviewers; and (iv) the use of quantitative analysis to comprehend respondents' responses. The questionnaire and the SASAS questions were created using cognitive psychology theories of processing, memory, and

comprehension (Sudman et al., 2010). The public opinion poll has become a vital and effective research instrument for academics and scholars thanks to the ground-breaking work of Gallup, Roper, and others.

2.5 Public Opinion Research and Public Policy

Most normative and empirical theories of democracy nowadays focus on how responsive government policies are to the preferences of the people. Various social, political, and economic objectives are now served by public opinion research. Wysmulek (2019) utilized it to assess the level of corruption in Europe, and Roberts (2010; 2019) has used public opinion surveys in the South African context to gauge immigrant sentiments, voters' attitudes, climate change, and safety issues (Roberts, Struwig, Gordon, Zondi, Hannan & Gastrow, 2022). The premise of these studies, is that public opinion affects public policy, and this has been the subject of much historical discussion. Wilson (2013) argues that when you take the development of public opinion research into account, it is clear that the "orderly force" of public opinion has shaped social and political life for countless years. Gordon (2017) asserts that the concept of public opinion has its roots in the ancient Athenian idea of citizen participation in political decision-making. Public opinion and governmental action frequently coincide, which is morally correct and essential to democratic governance. When researchers in contemporary democracies fail to find a significant correlation between popular opinion and official policy, they become shocked and alarmed.

The relationship between policies and attitudes is not always straightforward, and it can occasionally be challenging to determine which factor causes which outcome. Studies acknowledge this reality, but they still maintain that in some democracies, public opinion and policy creation are linked. Public opinion's impact on public policy may not be as great in South Africa as it is in Western Europe or North America, but that does not decrease the importance of that influence. A coalition government is one in which political parties work together to form a government, and a coalition government has dominated the political landscape for the majority of the country's democratic period. We should consider that under this system, the policy platforms and guiding ideals of the political parties involved in the coalition are diametrically opposed to one another (Joshua, James & Titos, 2022). It is unclear whether the political parties pushing for coalitions are doing so primarily to undermine the African National Congress (ANC) as the

dominant party or to enhance service delivery should they decide to enter into a coalition government, however, these divergent party policy agendas and principles run the risk of impeding the delivery of services (Joshua et al., 2022).

President Cyril Ramaphosa emphasized the need for other civil society stakeholders, like academia, women, and the youth, to also have a significant role in response to the 4IR to ensure widespread buy-in by all role-players in society (Sutherland, 2020). The 4IR manifests itself through technological breakthroughs, and its impact cuts across all levels of society, demanding the employment of a broader lens and perspective, yet the debate of the 4IR is often dominated by the involvement of the government and the private sector. The example given here shows that there might be some correlation between public opinion and policy, even though it might not be entirely linear. In conclusion, I believe there is a particularly pressing need to examine mass public opinion in South Africa.

2.6 Chapter Summary

It has been suggested that the idea of 'attitudes' is crucial to the quantitative investigation of technological adoption. I clarified the misconceptions about what constitutes an attitude and how attitudes develop in each population. In South African academia, left-leaning academics have criticised attitudinal analysis as being simplistic. This chapter rectified these misconceptions by evaluating the research on attitudes as it relates to the issue of this dissertation. Additionally, it provided a summary of the main reasons for and against attitudinal analysis, as well as an examination of the main influences on attitude formation.

I did point out the drawbacks of the positivist approach as well as the potential benefits of the quantitative analysis for the social sciences. This chapter has argued that having a good knowledge of the subject matter being studied - in this instance, attitudes - is essential to performing meaningful quantitative research. The purpose of this chapter, therefore, was to address issues like what an attitude is and why it is important to understand them. Although attitude analysis is a well renowned academic field, its hidden benefits might not be immediately obvious. In fact, the majority of researchers studying the 4IR internationally use data from public opinion surveys.

The chapter also addressed in full and in detail why analysis of public views is important in South Africa. When facts are presented, views can (and should) have an impact on both individual behaviour and the policies of a democratic state. Determining attitudes toward the 4IR through national representative research is crucial because it will inform the government about the level of acceptance and the appropriate kinds of measures to implement. In the upcoming chapter, we will delve into an extensive literature on industrialisation in the socio-economies of selected developed countries.

CHAPTER THREE: LITERATURE ON INDUSTRIALISATION IN THE SOCIO-ECONOMIES OF SELECTED DEVELOPED COUNTRIES

3.1 Introduction

The preceding chapter provided a comprehensive exploration of what attitudes are and the importance of researching public opinions. This chapter focuses on the literature pertaining to industrial development in selected developed countries. They have generated a larger body of literature on this topic than developing countries since industrialization originated in these countries. The literature on the industrialization in developing countries will be presented in Chapter four. It is logical to separate the literature reviews as the developed and developing countries are at different stages of technology adoption. Developed countries tend to be further along in the adoption of 4IR technologies when compared to the developing countries. This is because developed countries often have more advanced infrastructure, greater access to capital, and more established educational and research institutions. The literature on the 4IR in developed countries will focus on the practical applications and impact of these technologies, while the literature on the 4IR in developing countries will focus more on the challenges and opportunities associated with technology adoption.

New technological advancements have boosted the world's economy since the beginning of the industrial revolution (Bhattacharyya, 2020). The 4IR is intricately entwined with technical progress and the past revolutions. When discussing the 4IR it is imperative to discuss technology change because it has always been a crucial component of the industrialization process. Every new technological wave affects economic development, productivity, and the potential for new kinds of work/companies/industries in both good and harmful ways. Researchers highlight how several aspects of the labour market, including employment, unemployment, labour demand, salary, and the related factors are impacted by innovation.

According to Feldmann (2013), increased unemployment may be a result of technological developments. Liso and Leoncini (2011) contend that the opportunity for better pay has been made possible by the increase in demand for skilled workers, but this is contrary to the findings of Piva, Santarelli and Vivarelli (2006). Piva et al. (2006) instead emphasize that the development of

technology has a negative impact on both skilled and unskilled workers. According to Alonso-Borrego & Collado (2002), technological innovation is one of the major forces behind job creation as well as job loss. Technology innovation, which is viewed as a methodical, ongoing, non-reflexive process, is one of the key drivers driving long-term productivity and economic growth (Matuzeviciute, Butkus & Karaliute, 2017). Businesses, governments, and academics are thus interested in innovation processes, as well as the results of the processes required to foster technological advancement.

Developed countries have access to a lot of skilled labour and adopt technologies that are appropriate for that labour, and Caselli and Coleman (2006) contend that the industrialized countries employ skilled labour more effectively than developing ones because of their adoption of technology. Contrary to this, developing nations tend to adopt technologies that are suitable for unskilled labour because they have limited access to skilled labour. Acemoglu and Autor (2011) assert that the need for regular tasks that can be automated reduces because of technological change based on skill. In this chapter, we examine how technological innovation and unemployment are related in European nations, as this is where the first IR started and spread to a significant extent. We do this by considering the varied impacts that innovations have on the labour market, as documented in scholarly literature, in addition to the paucity of empirical evidence at the macro level on how innovations affect unemployment (Matuzeviciute et al., 2017). The connection between technological innovation and the labour market is a hotly debated subject because it sheds light on the trends and issues that the labour market experiences as a result of technology growth.

This chapter seeks to contextualize the study by examining public opinions towards the 4IR in selected developed countries. During the search of the literature, I discovered that developed countries have more literature coverage on public opinion studies compared to African countries, and particularly South Africa (which will be discussed in Chapter Five). This was very much expected given that IRs emerged from the developed region. The purpose of this chapter is to form a global picture of the IRs as they occurred in developed countries, to reflect on lessons and possible similarities between the effects that industrialization has in the developed and developing regions.

This chapter is separated into four main sections, as follows:

1. The first section historicises the first three IRs and looks at the significant differences to locate the conversation on the 4IR.
2. The second section looks at the IRs and their socio-economic impact.
3. The third section looks at the 4IR and public opinion regarding its technologies and impact. And
4. The chapter summarises the main findings in the conclusion.

3.2 Historical Account of the First Three Industrialisations

Like any extensive process of economic or social change, industrialization is fuelled by the diffusion of multiple distinct but related inventions. These affect the entire social fabric of society and are not just of a technical nature; they are also organizational and institutional. The industrialization phenomena are primarily driven by technology, which also leads to dramatically increased output, enhanced factor productivity, and new modes of production, goods, and markets. However, social, and organizational developments are equally important (Mohajan, 2019). Nowadays, the term "industrial society" refers to a particular type of economic and social organization that includes everything from science and industrial management to the fine arts. An industrial civilization is built on the economics of standardized and specialized human activities to generate not only more finished products, but also a wider range of them.

To contextualize the study of the socio-economic effects on developing countries, it is important to look at the first three IRs and the lessons gained from them. Britain will be the case study for the first IR, because that is where it began.

3.2.1 The first industrial revolution: Lessons from Britain

The 1IR started in Britain and then extended progressively to other parts of the world over several centuries. The first region of the world to industrialize was Western Europe, which was then followed by North America, Eastern Europe, and Asia. The terms, "first industrial revolution" or "industrial revolution" are used to describe the enormous socio-economic changes that occurred in Britain between the years of 1760 and 1840 (Mohajan, 2019). During the 1IR, manual labour was

replaced by machinery, new processes for making chemicals and iron were developed, water-power efficiency was increased, steam power was expanded, and machine tools were created (Mohajan, 2019).

In the 1IR the iron and textile industries were crucial (Ashton, 1948). The 1IR moved rural industry into towns, where wage labourers replaced skilled workers. The principal source of supply of raw materials, including cotton, sugar, and tobacco, was the former British colonies. England sent slaves to obtain raw resources from Latin America and North America and they travelled to and from those destinations on English ships. The use of slaves for this came to an end, however, when the slave trade was outlawed in 1793 (Mohajan, 2019). The most significant technological advances of the time were the steam engine, which was developed in 1712 by English blacksmith Thomas Newcomen. The "atmospheric engine" is the historical name for his invention (Mohajan, 2019; Sinclair, 1907), and the steam engine's development drove the industrial revolution (IR). Iron was required to build the steam engine, which was primarily driven by coal, and coal was thus a major factor in the IR (Clark, 2007).

The steam engine burned coal to produce the motor power required to push water out of coal mine shafts. James Watt, a Scottish mechanical engineer, developed Newcomen's steam engine in 1776 while working in a Glaswegian university lab (Mohajan, 2019). This engine harnessed enormous volumes of coal-powered energy effectively and profitably. The globe entered the early modern industrial age due to this discovery, revolutionizing the manufacturing of steel, textiles, mining, railroads, and other forms of transportation using steam power. Cities, businesses, and all types of infrastructure all underwent significant expansion as a result (Sachs, 2005; William, 2012). Prior to the first industrial revolution, most people in Britain lived in small communities and commuted on foot or by horse over narrow roads. Disease was widespread due to poor nutrition, bad hygiene, tainted water, and the lack of a sewage system, and the average life expectancy was hence quite short. About 80 per cent of the population resided in small towns, and the remaining 20 per cent worked on small farms in rural areas (Dawley, 2000).

The mining, trading, and manufacturing sectors employed very few people as only small-scale and regional manufacturing existed. Aristocrats made up around 1 per cent of the population, and they

did not labour; instead, they invested a large portion of their riches in property (Clark, 2007; Mohajan, 2019). People only created textiles by hand before the IR, but production of items made by machines increased significantly after the IR. The 1IR was built on a glut of inexpensive labour and the production of high-quality goods for the wealthy landowners.

Basic hand tools were used to manipulate metal manually (Broadberry & Gupta, 2005; Gunderson, 2008). One of the first economists to explain how a modern economy works through the division of labour, specialization, and effectiveness of market transactions was a Scottish social philosopher named Smith (Smith, 1977; 2019). He promoted a free market and laissez-faire economics, or free trade without interference from the government as the foundation of the modern economy. This theory gave factory owners the freedom to choose how they wanted to set up the working environment, and society adopted mercantilism as a result (Ashton, 1948). Regular residents' average incomes did not increase and their standard of living did not improve throughout the first industrial revolution. Companies expanded in the cities and there was quick development, and this attracted more employees to the cities. The proportion of farmers in the population subsequently fell as more individuals entered industry (Berlanstein, 1992).

Ventura and Voth (2015) demonstrated how Britain's borrowing boom during the 1IR was advantageous for agricultural advancements as well as the growth of the textile and iron industries. This, in turn, sped up the structural transformation of companies and significant societal change occurred. Singh (2015) provided information on the 1IR's technological advancements using machines. According to Allen (1992), the 1IR began in Britain and the new discoveries and technology altered the course of human history. Britain had extraordinarily high incomes and inexpensive energy, and British living standards generally improved because of the economic progress that took place during this time (Allen, 1992). Agarwal and Agarwal (2017) observed that during the 1IR and 2IR, technology changed and banking and financial companies grew. They stressed that the power loom, stream engine, and improvements in iron-making methods were the main forces behind the 1IR (Agarwal & Agarwal, 2017). The network of joint and country banks expanded throughout the 1IR, and the introduction of wageworkers altered banking and firm financing (Agarwal & Agarwal, 2017). Male employees during the 1IR reportedly made two to three times more money than female employees (Burnette,1997). According to O'Brien (2017),

the success and adaptability of England's agricultural sector, its easy access to coal and other mineral resources utilized in international trade, and the substantial technological breakthroughs are all factors that contributed to the country's 1IR.

3.2.1.1 Consequences of the first industrial revolution

The first industrial revolution (1IR) brought about significant advancements in agriculture and transportation, leading to a large-scale production of goods, an uptick in international trade, an increase in employment opportunities, the creation of opportunities for women and children to earn a living, and changes in living conditions (O'Brien, 2017). European and North American countries saw significant increases in their per capita GDP (McNeil, 1990). Difficulties involving things like working conditions, pay, unemployment, accidents, and hiring women and children came up following the 1IR. According to Galbi (1994), women and children were hired for less money, and children made up nearly two-thirds of the workforce in some factories. Inhumane working conditions included 12- to 14-hour shifts. The children were spanked by mill managers to keep them alert, and they were only allowed one hour for dinner and thirty minutes for lunch (Galbi, 1994).

The wealth gap between industrialized and non-industrialized nations widened because of the 1IR. The least developed and non-industrialized nations provided the raw materials for the manufacturers in industrialized nations (Burnette, 1997). The logical consequence was that the industrialized nations shipped their manufactured goods there. Great Britain plundered its colonial territories to obtain raw commodities and establish markets. The 1IR showed a staggering salary discrepancy between men and women, as well as a widening divide between the wealthiest and the poorest. Regrettably, women and children were underpaid and neglected in the industries (Burnette, 1997).

Both capitalism and socialism were introduced into society during the first century of the IR. Capitalism is defined as an economic system where private individuals or businesses own capital goods, and the production of goods and services is based on supply and demand in the general market, known as a market economy (Burnette, 1997; Smith, 2019). In contrast, a planned economy or command economy involves central planning (Burnette, 1997)). Laissez-faire

economics backed capitalism, and as the population grew, wages were forcibly reduced (Smith, 1776). The main proponents of laissez-faire were the three political economists, Adam Smith, Thomas Malthus, and David Ricardo, who opposed government programs to help low-wage workers. Smith (2019) contended that economic freedom ensured economic progress and that the government should refrain from interfering. Malthus (2008) contended that, barring wars and epidemics, most people were destined to live in poverty and misery since the population was growing faster than the food sources available to them. Ricardo believed that as the population grew, wages would be compelled to decline and that there would always be a permanent underclass of poor people (Smith, 1776; 2019). Given the consequences of the 1IR, in that it did not make the lives of ordinary people any better, it is important to question any other IR.

The 4IR should not be promoted as a development designed to uplift the poor. Instead, each country should consider its own socio-economic conditions and weigh up the costs (Sutherland, 2020). This study concluded that it is crucial to engage public opinion to influence the government to take into consideration policy solutions that are well suited to the needs of South African citizens, given the high costs associated with IRs to society.

3.2.2 The second industrial revolution: Lessons from the United States of America

Unprecedented urbanization and quick geographical expansion changed the USA, and the 2IR, which peaked between the 1870s and 1914, was fuelled by these innovations. Electricity and other technologies were quickly adopted in manufacturing during the second industrial revolution, and this was made possible by expanding infrastructure in the fields of public health, communication, and transportation. The USA is utilized as a case study because, among the other nations listed in Table 3.1, it is the one that is credited with having spearheaded the 2IR. Table 3.1 shows how different technologies advanced from the 1IR through to the 3IR. What has been consistent throughout is that most of the core countries which experienced and were facilitators of these revolutions are developed first world countries from developed regions.

Table 3.1: The first to the third industrial revolutions

	1IR, approx. 1780-	2IR, approx. 1870-	3IR, approx. 1990
"Dominant raw materials and technologies"	"Steam engine, power loom, iron processing"	"Electricity, chemistry, combustion engine, assembly line, synthetic materials"	"ICT micro-eletronics, new materials, renewable raw materials, biotechnology"
"Dominant energy source"	"Coal"	"Coal, oil, nuclear power"	"Renewable energies, energy efficiency"
"Transport and communication"	"Railway, telegraphy"	"Car, airplane, radio, TV"	"High-speed railway systems, the Internet, mobile telecommunication"
"Society state"	"Freedom of trade"	"Mass production, mass society, parliamentary democracy, welfare state"	"Civil society, globalization, global governance"
"Core countries"	"The United Kingdom, Belgium, Germany and France"	"USA, Japan and Germany"	"The European Union (EU), China, USA, Japan"

Source: Siebenhüner, Arnold, Eisenack and Jacob (2013, p.310)

The United States was abundant in natural resources from its recently acquired territories, combined with a rise in labour migration from Europe, the movement of freed African Americans to the North and West, expansion of the market for manufactured goods, and availability of investment capital (Engelman, 2015). The second industrial revolution (2IR) helped to elevate smaller communities and their products from the shadow of large regional agrarian economies thanks to new labour forces and production methods (Engelman, 2015). In the 2IR, remote, hitherto isolated communities were connected by roads, steamboats, the Eerie Canal, and railroads, among other developments in transportation. It became possible to make the first direct shipments of goods from the interior of America to the Atlantic. The nature of economic activity in the US altered because of the ability to ship goods over long distances (Huberman, Meissner, & Oosterlinck, 2017). The economies were regional and frequently dependent on a barter system before the establishment of this advanced network of transportation and communication (Engelman, 2015; Mohajan, 2019). Thanks to the transportation revolution, farmers, merchants, and bankers were able to sell commodities like cotton in the Mississippi River Valley, wheat in the Midwest, and manufactured goods in upstate New York in a credit-based global market. The construction of the railroad resulted in a significant decrease in the time and cost of transporting

bulk commodities at a time when two-thirds of all Americans still lived on farms, and this created new opportunities for wealth creation (Engelman, 2015).

Without the invention of steel and electricity, the 2IR would not have advanced on the scale that it did in the second half of the 19th century (Donovan, 1997). Bill brokers, the growth of cooperative banks and country banks, and other developments during the first industrial revolution changed banking and company financing (Agarwal & Agarwal, 2017). The emergence of clearing banks, the decrease of bills, the introduction of cheques, and other places where people could deposit their money all had an impact on banking and business financing throughout the second industrial revolution (Agarwal & Agarwal, 2017).

3.2.2.1 Effects of the second industrial revolution in the USA

The 2IR had advantages and disadvantages, just like the 1IR, and in many ways it is viewed as a continuation of the first. Direct continuity existed in several industries. However, they were different in several important ways. First, the real earnings and standards of living were clearly different in 1914 from what they were in 1870, and these were directly impacted by the 2IR (Engelman, 2015). Second, it maintained the Western industrialized world's monopoly on technological leadership while moving the geographic focus away from Britain to a more diffused centre (Moykr, 1999). Finally, it permanently altered how technological change occured by altering the relationship between knowledge of nature and how it affected technical practices. In doing so, what was learnt during these years paved the way for numerous other IRs to follow (Agarwal & Agarwal, 2017).

The gilded age was fuelled by the 2IR, and it had extremes on a grand scale, including vast affluence and pervasive poverty, great expansion and catastrophic despair, new opportunities, and increased standardization (Engelman, 2015). Economic instability resulted from the depressions of the 1870s and 1890s, which led to millions of people losing their jobs or seeing their pay decline (Engelman, 2015). The industrial sector continued to employ people in hazardous conditions, with long hours, little benefits for injuries, no pensions, and low pay (Atkeson & Kehoe, 2001). However, the industrial system also created new types of freedom for a small number of workers.

Industrial job paid well for skilled laborers, who also managed a large portion of the production process. Technical proficiency was now necessary for economic independence rather than owning one's own shop and tools (Engelman, 2015). Although its supporters referred to it as "progress", those who worked on the factory floor understood that it had a cost (Engelman, 2015).

3.2.3 The third industrial revolution: Lessons from China

The early 1990s are seen as the start of the third industrial revolution or 3IR, also referred to as the digital revolution. This period followed the end of the two world wars and was marked by a slowdown in industrialization and technological development compared to earlier eras (Luo, 2008). The third industrial revolution (3IR) saw a shift from mechanical and analogue electronic technology to digital electronics, which resulted in the introduction of digital computers and modern digital record-keeping (Heywang & Zaininger, 2013). Internet access, digital cameras, and other social media and smart phone alternatives were first made available to the general population. According to Damas (2014), the establishment of basic industries like mining and infrastructure along China's northern border with Siberia, as well as the textile and tobacco industries in the Manchuria region, laid the groundwork for the country's industrialization in the 20th century. Although there was social stability in the early 1930s, Coble (2007) noted that this altered with the Japanese assault of Nanjing in 1937 as the Japanese wanted to expand their territory and exploit the region's resources.

According to Damas (2014), some Chinese government officials adopted a Japanese-inspired industrial strategy that prioritized the use of exhibits and schools to spread knowledge and promote rural innovation. This led to a labour-intensive industrialization that was concerned with raising the quality of labour. Nationalist feeling increased during the protracted conflict between the affluent, the middle class, and the Communist Party, however, and this contributed to the growth of Mao Tse Tung and the Communist Party of China, according to Damas (2014). Mao Tse Tung built Chinese socialism in 1949 following years of battle between the affluent, the middle class, and the Communist Party of Kai-Shek. Chinese socialism had some aspects of communism (Damas, 2014). Capital accumulation and the modernization of agriculture gained momentum following the introduction of agrarian reform in 1952, and as a result, both industrial and agricultural production began to outpace their respective production capacities (Gittings, 2005).

The Mao regime introduced a five-year plan which gave the development of heavy industry top priority in the 1950s. This heavy industry served both the home and export markets (Damas, 2014).

The Chinese leader did not start pursuing a more accommodative stance toward the West until the 1960s, when he began re-establishing connections and joined the UN. The nation's economy opened up gradually over this decade with the help of cutting-edge technologies (Szirmai, 2012).

3.2.3.1 Economic growth

Szirmai (2012, p. 408) notes that although Deng's structural changes initially led to social imbalance, there is compelling empirical and theoretical evidence that the driver of Chinese economic development was industrialisation. These arguments include:

(1) "There is a positive empirical correlation between the degree of industrialisation and per capita income in countries such as China, India, and Brazil".
(2) "Productivity is higher in the industrial sector than in the agricultural sector".
(3) "The manufacturing sector provides more opportunities for capital accumulation than the agricultural sector".
(4) "Goods production generates technological development, thus the labour transfer from agriculture to industry led to an increase in productivity and per capita income".

According to Bandt and Rawski (2008), China's production increased by 0.5 per cent to 3.8 per cent between 1978 and 2005. This was largely made possible by Chinese technological advancement and professionalization. Developments in China's economic and industrial structure showed a significant flow of goods and services to all parts of the country following Xiaoping's reforms (1970). According to Cai, Park and Zhao (2008), the centralized Chinese fiscal protectionism was incompatible with the then-current economic policies, and over time they became more adaptable to market needs.

Rural women moved to the industrial labour market because of the changed economic environment. According to Huang (2000), the discrimination faced by these migrant women in the job market was due to their rural identities and historical characteristics rather than because of

their gender. Women were given lower-status jobs and made less money than men. Despite improvements in the economic statistics during the 1980s, social inequality in the interior of China and reduction of the informal labour force continued to grow (Zhang & Kanbur, 2005). The Chinese people's living, working, and financial circumstances didn't start to improve until the 1990s, when the government started to invest more in education and international corporations started to give better pay.

3.3 Consequences of Industrialisation on the Labour Market: The United States of America and the United Kingdom

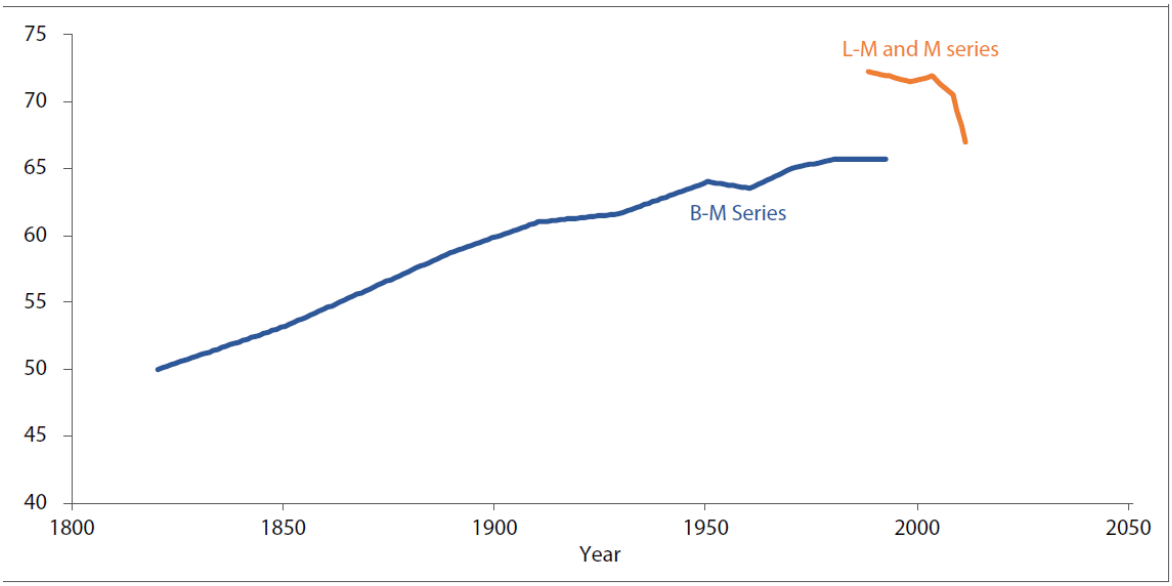
A change in the labour force's distribution is perhaps the most visible effect of industrialization. As nations industrialize, agricultural production efficiency often rises as the share of the labour force employed in agriculture declines. Studies from the past and the present reveal a constant pattern and the effects of industrialization on life's economic facets. A historical study by Kuznets (1957, pp. 28-31) "presents data for 28 countries, showing a decline in the proportion of the labour force in agriculture over approximately the past 100 years, which he attributes to the increasing industrialisation of these countries". In modern countries, there is a significant inverse relationship between the degree of industrialization (as determined by the amount of energy consumed per person) and the labour force involved in agriculture (Treiman, 1970).

A change in the distribution of occupations among the non-agricultural labour force often accompanies the transition away from agriculture (Treiman, 1970). This can happen in various ways. The increased labour efficiency of mechanization makes it possible for a gradual shift from the production of goods to the provision of services, which raises the ratio of non-manual to manual workers (Jaffe & Stewart, 1951; Kuznets, 1957; Treiman, 1970). Additionally, technological advancements often result in a fundamental change in an occupation and the emergence of entirely new professions. An assembly line system, where the manufacturing process is divided into a series of distinct operations that can be completed on a regular basis by semi-skilled workers or machine attendants, represents a shift from a craft system, where all tasks necessary to produce a given item are completed by one person (Treiman, 1970). Furthermore, mechanization leads to the creation of new jobs in the design and maintenance of complex machinery (Treiman, 1970).

3.3.1 Income structure

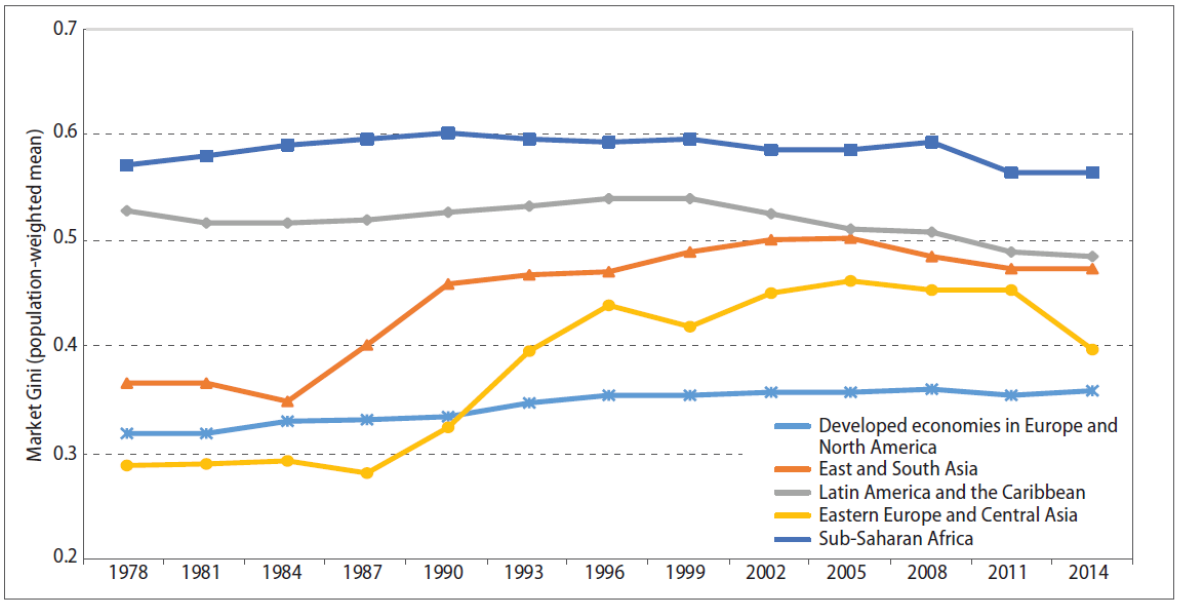
The 1IR and 2IR markedly boosted income levels in frontier economies like the USA and Western Europe relative to the rest of the world. Figure 3.1 shows how this resulted in a consistent increase in worldwide inequality between the 1820s and the 1990s. According to Milanovic (2016), global inequality levels started to fall sharply in 2003 after experiencing some stabilization in the 1980s. The rapid income increase in China and India is partly responsible for this tendency. These economies profited from changes in domestic policy and swift technological improvement amid an increase in globalization and the proliferation of global value chains.

There have been variations in the patterns of inequality within nations over time and across geographical locations. Figure 3.2 shows how, during the 1980s and the early 1990s, within-country inequality tended to rise in most of the key areas. This tendency remained in developed nations due to the expanding inequality in the USA. The distribution of income has begun to improve since the mid- to late 1990s in nations in Latin America, the Caribbean, and sub-Saharan Africa, which have some of the highest levels of economic inequality in the world. Other developing regions have experienced a stabilization or even a slight improvement in intra-country inequality since the early 2000s. Whether these advances will endure though is still unknown at this point. Particularly, the global financial crisis, which had varying effects on various households, muddied the story about the long-term trajectory of income distribution (International Labour Organization [ILO], 2015).



Source: UN/DESA, based on B-M data from Bourguignon and Morrisson (2002), L-M data from Lakner and Milanovic (2013) and M data from Milanovic (2016).

Figure 3. 1: Global Gini coefficient, 1820-2011



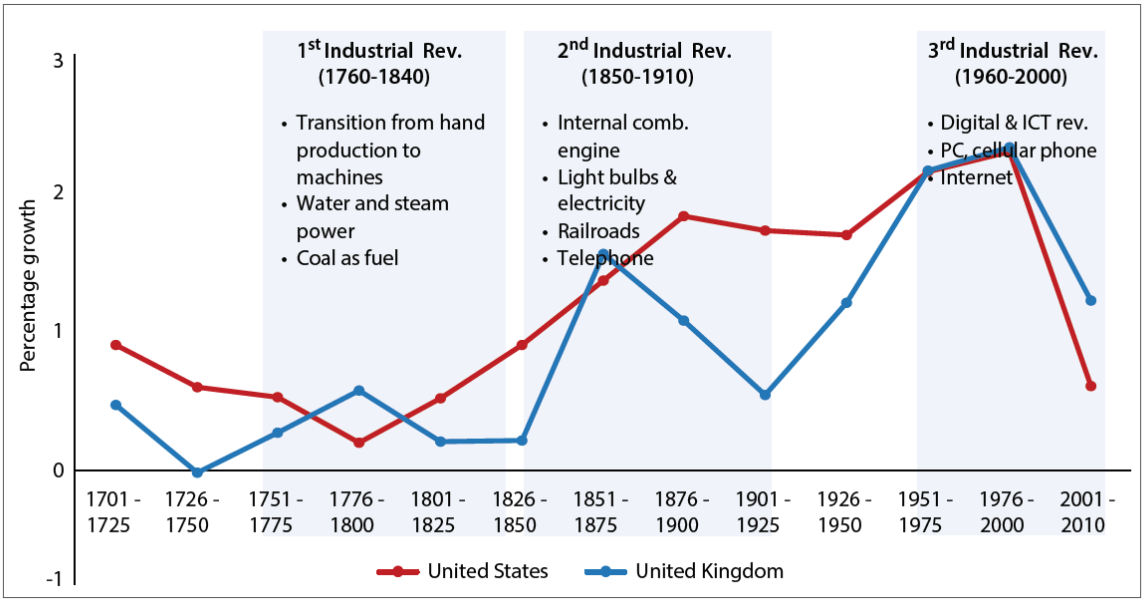
Source: UN/DESA, based on data from Global Consumption and Income Project.
Note: The data shown here start in 1978 and end in 2014, with two years between each observation.

Figure 3. 2 Income disparity over time in a chosen region, 1978-2014

The evolution of income disparity over time cannot be fully explained by labour income inequality, although it is a key component. Another aspect of income inequality that is influenced by technological improvements is the income split between labour and capital (International Monetary Fund [IMF], 2017). The ongoing decline of the labour share of the national income in

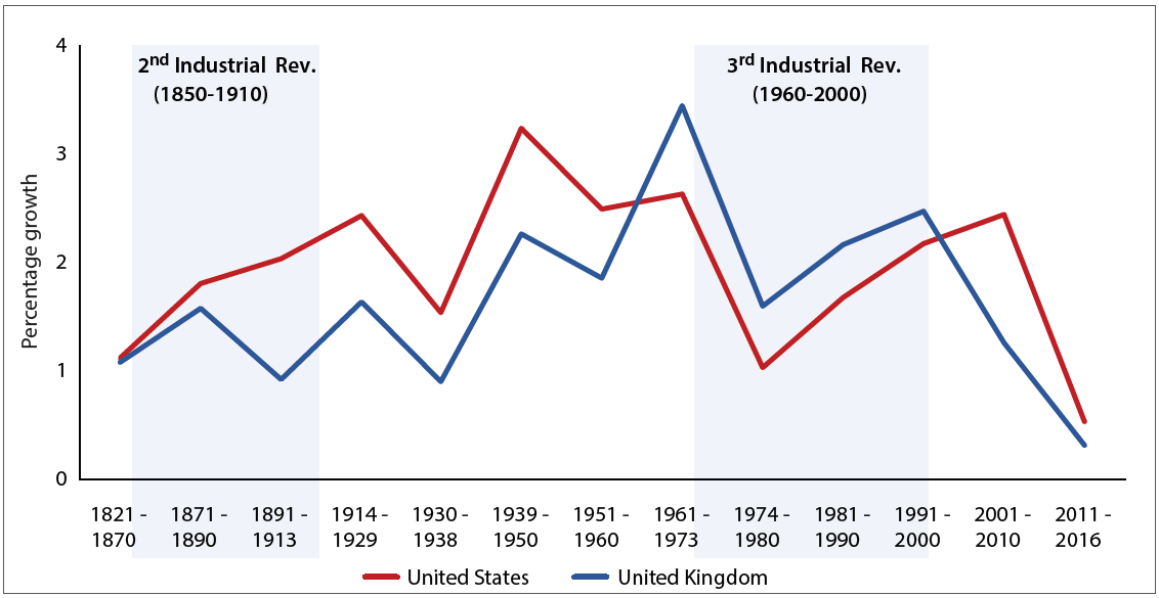
many industrialized countries since the middle of the 1970s and in many emerging nations since the 1990s has spurred interest in functional income distribution (Karabarbounis & Neiman, 2014). Even though households at the bottom of the income distribution typically earn a higher proportion of their income from labour income than those at the top and because capital is typically distributed more equitably among capital owners, a decline in the labour share of the national income is linked to a worsening of the income distribution (Bridgman, 2014).

Examining previous IRs can provide a wealth of information on what a potential future revolution will bring because of their significant influence on economic development. Some significant characteristics of these earlier technological revolutions are depicted in Figure 3.3. The United Kingdom (UK) and the United States, the top-performing nations in the 1IR and 2IR, respectively, are shown to have seen shifts in living standards beginning in the 1700s, as evidenced by the GDP per capita increase.



Source: UN/DESA estimates, based on Maddison Project.

Figure 3.3 British and American GDP per capita growth, 1701-2010



Source: UN/DESA, based on the Maddison Project and The Conference Board Total Economy Database (May 2017).

Figure 3.4 Average annual growth rates for each decade for labour productivity, 1821-2016

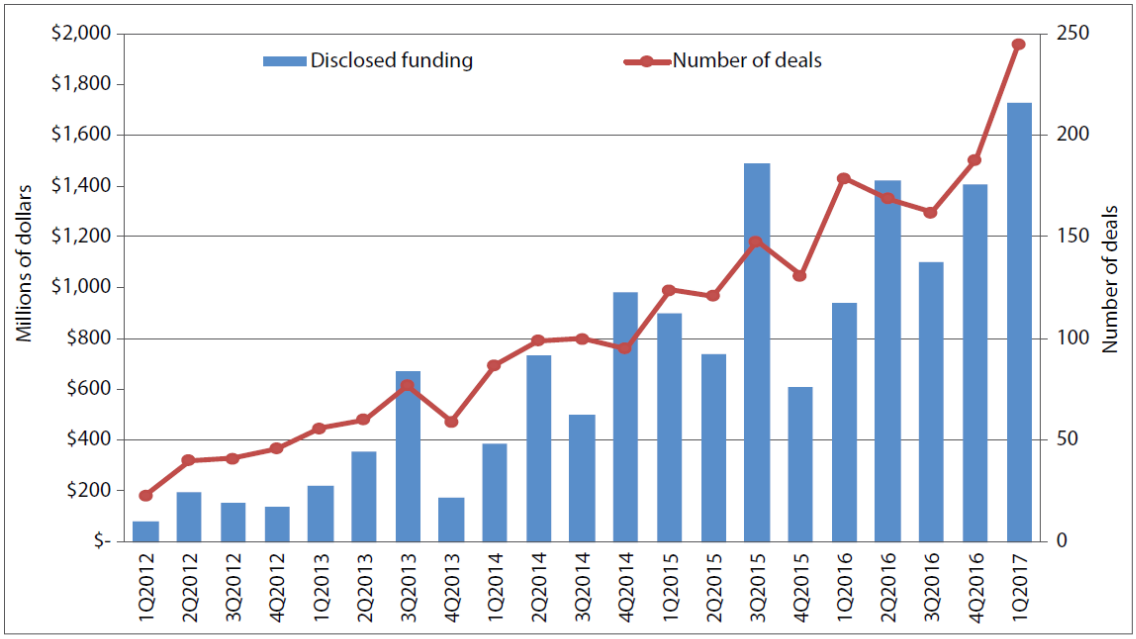
The entire economic impact of the IRs has only just become clear although it is several decades after the initial technological advances. This impact is depicted in Figures 3.3 and 3.4. Even looking back, it can be challenging to pinpoint the start or finish of a technological revolution because of how long they take to develop. For instance, productivity growth in the second industrial revolution increased gradually and more rapidly after the revolution. It is challenging to determine whether a technological revolution is now underway given these significant time gaps.

Small productivity improvements during the 2IR are sometimes attributed to the delayed technology diffusion, even within the affected nation (Atkeson & Kehoe, 2001). Similar to the United States, productivity growth in England during the first industrial revolution was also sluggish. This is possibly as a result of the concentration of technological advancements in a few manufacturing sectors that, until the middle of the 19th century, were not sufficiently large to have an impact on overall production and the economy (Antras & Voth, 2003). This suggests that distribution is important and that revolutionary technological inventions alone are insufficient.

The increased labour productivity in industrialized countries has declined since the 1960s, with the brief exception of the benefits frequently attributed to the digital and IT revolution. In contrast,

productivity growth has recently been comparatively muted in other developing regions. The average labour productivity growth in Latin America began a decreasing trend between the 1960s and the mid-1980s, and it has been sluggish ever since (Estevadeordal & Robot-Lución, 2017). Both Western Asia and sub-Saharan Africa have seen a similar trend. This suggests that many of the nations in these regions that depend on natural resources have not been able to encourage a structural shift in favour of increasing and rising productivity. Additionally, the unpredictable nature of productivity growth shows that, even over the long term, commodity price changes and external shocks like the 2008–2009 financial crisis have an impact on productivity.

The economy's response to changes in labour and capital costs, as well as interactions among technologies, industry characteristics, trade laws, institutions, and labour market conditions will determine the true consequences of technological innovation on employment (Frey & Osborne, 2015). The organization of employment around a narrow range of duties or a broad range of jobs, as well as the relative costs of the various elements and the incentives for businesses to replace labour with capital and technology, will all have a significant impact on the outcome. From a technological standpoint, further advancement in important technologies like AI is essentially certain thanks to enormous gains in computing power, an increase in the amount of data that is available, and the creation and refinement of algorithmic learning and other techniques (Nordhaus, 2017). Data on the amount of funds allocated for AI research demonstrates a definite upward tendency (Figure 3.5). This development is anticipated to result in advances in materials and techniques like gene editing, the release of new consumer items, and an increase in the number of tasks that robots and other machines can perform.



Source: UN/DESA, based on data from CB Insights (2017). "The 2016 AI Recap: Startups See Record High In Deals And Funding".

Figure 3.2: Global quarterly artificial intelligence funding 2012-2017

Several recent studies have calculated the proportion of employment that is likely to be automated over the next two decades. Both a task-based approach and an occupation-based approach have been used in this procedure. Frey and Osborne (2013; 2017) used the occupation-based approach for the first time in a ground-breaking empirical study for the USA. Even though they initially define jobs in terms of the tasks they entail, they ultimately presume that entire vocations are automated.

The main conclusion of the authors has garnered significant attention as they have concluded that it is very likely that 47 per cent of all jobs in the United States will be automated within the next ten to twenty years. According to Bowles (2014); Chang and Huynh (2016); Ng (2017); and the World Bank (2016), an even higher percentage of employment is at a high risk of automation in the coming decades in the EU and in less developed nations. Studies that used the methodology developed by Frey and Osborne (2013; 2017) (occupation-based approach) give high estimates of the proportion of employment that is at risk of automation, and it ranges from 35 per cent in Finland to 85 per cent in Ethiopia (see Figure 3.6).

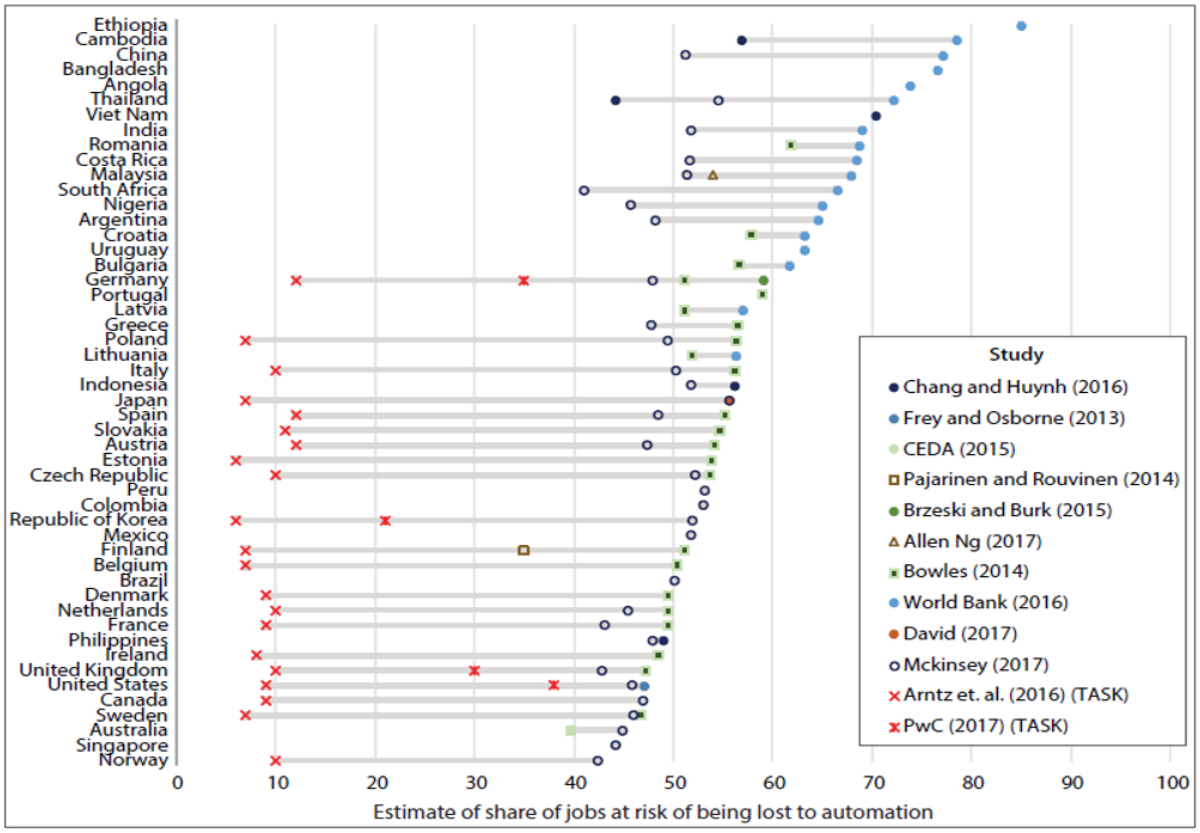


Figure 3.3: Estimates of the share of jobs at risk of being lost to automation

Source: UN (2020)

Frey and Osborne (2013; 2017) claim that entire occupations are automatable, rather than just individual tasks. However, it has been argued that this claim is unreliable since it is likely to overestimate the number of jobs that can be lost to automation. This is because people in the same occupation frequently behave very differently from one another.

Arntz, Gregory and Zierahn (2016) have chosen a task-based paradigm for their study, given the unreliability of Frey and Osborne's (2013; 2017) methodology. Their methodology produces much lower estimates of the percentage of employment that is at risk of automation, as in OECD countries the percentage is only 9 per cent on average. This is because many workers are employed in a sizable portion of less automatable, non-routine activities. Berriman and Hawksworth (2017) have discovered that the proportion of employment under threat varies from 21 per cent in Japan to 38 per cent in the USA, using the same approach but a different model's specifications. These

numbers are greater than those of Arntz et al. (2016), but significantly lower than those from the occupation-based approaches (refer to Figure 4.6).

There is some agreement on the industries and worker types that are most at risk, despite the broad variation in the predicted effects of job automation on the entire economy. The real effect will rely on elements that are country-specific, such as the sectoral employment structure. Although it is anticipated that automation will gradually influence various service sector professions, it is most likely to have the greatest impact on assembly line workers in the manufacturing sector.

Some industries, such as manufacturing, transportation, storage, administrative and support services, and wholesale and retail commerce, are more susceptible to automation than others. However, there is low chance of automation in sectors including human health, social service, agriculture, forestry, and fisheries. Chang & Huynh (2016) stated that there are well-known professions in some countries that have unusually high automation risks, namely office clerks in Indonesia and sewing machine operators in Cambodia as examples.

According to empirical evidence, persons with low and medium levels of education are more at risk of having their employment automated in both developed and developing countries, given that they make up the majority of the workforce in the industries that could be the most affected by job automation (Berriman & Hawksworth, 2017; Chang & Huynh, 2016; McKinsey Global Institute, 2017; Ng, 2017). This study lends credence to the assumption that further education helps people acquire the abilities needed to perform increasingly complicated tasks that require high levels of observation, creativity, and social intelligence and are seen as being difficult to automate.

3.5 The Fourth Industrial Revolution and Public Opinion

Many believe that the 4IR, which is "characterized by technologies like cyber-physical systems, robotics, AI, and machine learning", will eventually have a sizable or negligible impact on societies, economies, industries, and day-to-day life (Nam, 2019, p. 40). Automation, artificial intelligence, and robotics are expected to replace labour to a significant extent in the future, according to an increasing number of forecasts. Routine process-based jobs devoid of creativity or

compassion are expected to disappear (Nam, 2019), and the employment categories and occupations that do survive are expected to undergo significant change (Nam, 2019). While some predict that automation will cause the US labour force to shrink by half (Frey & Osborne, 2017), others predict the rise of new jobs, industries, and working styles (Nam, 2019).

In fact, replacing manual labour with machines has been a defining feature of the history of the IRs. It began with the first IR, which saw mechanization using steam power, continued with the second one, which saw mass production using electricity, and culminated with the third IR, which saw computerization (Nam, 2019). As a result, a major shift in the labour force is projected as we approach the 4IR. People can believe that technology-driven changes will bring grave hazards for their jobs, or unheard-of opportunities, depending on their circumstances, given the ongoing and predictable conditions based on the history of IRs to date (Arntz et al., 2016; Manyika et al., 2017). Governments are working to prepare for and adapt to such changes in a variety of ways in the interim. For instance, some countries are using regulation to moderate the impacts of labour substitution and safeguard human labour. However, this paradigm will not work since government regulations must keep pace with development, and it is highly unlikely that they will be able to do so (Nam, 2019).

3.5.1 Public opinion on the advances in the 4IR

The 4IR has already started to make a big difference in areas like the workplace and organizational performance, and this impact will only get bigger soon. Hahm (2018) concluded that fundamental attitudes toward these aspects are significant and will aid in determining the type and degree of the 4IR's influence on people's work life in a study that assessed the attitudes and output of workers getting ready for the 4IR. Employee attitudes regarding several factors, such as importance, intention to use, belief in improvement, efficacy of use, and negative cognition needed to be addressed individually (Hahm, 2018). Each of these elements has an impact on how employees' performance would change in the 4IR era. “The performance-related factors, such as self-efficacy, expectations, and change-acceptance, were also significant” (Hahm, 2018, p. 4040). These factors, which were connected to the development of new opportunities, have a significant impact on performance in the 4IR period. This study demonstrated how particular attitudes enhance

performance-related 4IR characteristics, and adoption of these attitudes will ultimately result in improved 4IR era adaptability (Hahm, 2018).

The 4IR advancements in AI may have an impact on national security, health care, education, transportation, and the labour economy (OECD, 2019). Although AI may offer several advantages, there are also hazards and disruptions that need to be considered. Public opinion has not significantly influenced these talks, even though engineers and decision-makers have begun to explore the societal consequences of machine learning and AI (Zhang & Dafoe, 2020). Given the broad implications of AI, civil society organizations argue that the public, particularly those who are underrepresented in the tech. industry, should have a say in the development of the technology (Zhang & Dafoe, 2020). Governmental choices in the USA have been impacted by public opinion, particularly those concerning immigration, free trade, international conflicts, and climate change mitigation (Caughey & Warshaw, 2018;Zhang & Dafoe, 2020).

It is anticipated that the public's influence on AI policy will grow over time, just as it has in these other policy areas. Therefore, it is crucial to have a deeper awareness of what the general public believes about AI and the general governance of AI, as such knowledge is crucial for formulating wise policies and spotting chances to teach the public about the nature, advantages, and hazards of AI (Zhang & Dafoe, 2020). The study by Zhang and Dafoe (2020) examined how the American public views AI governance using a unique, large-scale poll (N=2000). Most Americans (82%) think that robotics and/or artificial intelligence should be properly regulated. This number can be compared to survey findings from participants living in EU nations, as shown in Figure 3.7. The 13 AI governance concerns outlined in the report by the Americans must all be managed properly by tech companies and governments.

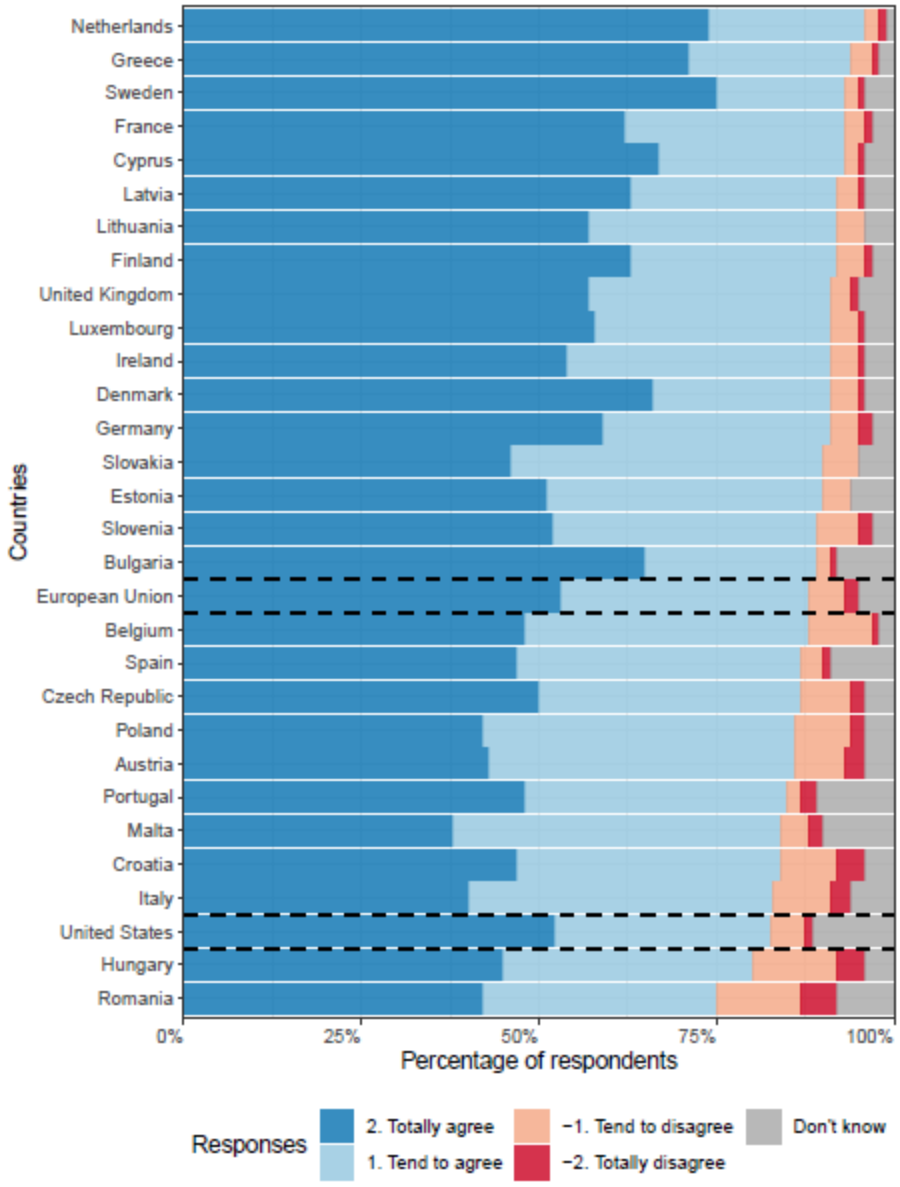


Figure 3.4: Perceptions that robots and artificial intelligence need management

Source: EU data from the European Commission (2017), Special Eurobarometer #460

According to the study by Zhang and Dafoe (2020), public trust in various institutions to develop and manage artificial intelligence (AI) in the best interests of society is mixed. The research found that Americans have relatively low-to-moderate levels of confidence in governmental, corporate, and multi-stakeholder entities to handle AI responsibly. However, trust levels vary significantly between different institutions. The most trusted are academic researchers and the US military, with 50 per cent and 49 per cent of respondents respectively saying they have "a fair amount of

confidence" or "a great deal of confidence". This is followed by trust in scientific associations, the Partnership on AI, tech companies (other than Facebook), and intelligence agencies (Zhang & Dafoe, 2020). Trust levels are lower for US federal or state governments, the UN, and Facebook. The study also found that individuals' trust in different actors to create and manage AI responsibly does not necessarily predict their overall support for doing so (Zhang & Dafoe, 2020).

For instance, Nomura, Kanda, Suzuki and Kato (2009) claim that educational background, especially an education with a foundation in the natural sciences and technologies, has a positive effect on the public's perceptions about robots in Japan. Research conducted in Europe has indicated that factors such as geography and education play a role in shaping attitudes towards the use of robots in domestic settings. Studies have found that individuals with higher levels of education and those living in urban areas tend to have more positive attitudes towards domestic robots (Hudson, Orviska & Hunady, 2017; Roberts et al., 2021; Taipale, de Luca, Sarrica & Fortunati, 2015). Additionally, these studies have also found that gender also plays a role in shaping attitudes towards domestic robots (Gnambs & Appel, 2019; Smith & Anderson, 2017).

3.5.1.1 Public opinion and artificial intelligence governance

We can predict how political politics may affect AI governance as policymakers attempt to control the use of the technology in nations like the USA by studying public opinion (Zhang & Dafoe, 2020). Numerous high-level AI ethics principles have been released during the last two years by businesses, governments, civil society organizations, and multi-stakeholder organizations. These texts prominently reference fundamental bioethical or medical ethical principles. However, unlike medical ethics, which is driven by the common objective of advancing the health of the patient, AI development is driven by a variety of objectives (Mittelstadt, 2019). Additionally, several of these AI ethics ideas are at odds with one another (Zhang & Dafoe, 2020; Whittlestone, Nyrup, Alexandrova & Cave, 2019). For instance, how may algorithmic predictions be made more accurate while yet treating algorithm users fairly and equally? Tensions between these values could result in political contestation when businesses and governments try to put them into action.

Voters in the USA disagree on how to control algorithms that show social media material and facial recognition technologies, with some of these differences reflecting partisan differences

already in place (Zhang, 2019). For instance, Democrats are far more against the use of facial recognition technology by law enforcement than Republicans are (Smith, 2019). While many states and largely Democratic towns have banned or suggested banning the use of facial recognition technology in law enforcement, movement toward enacting federal regulation has been sluggish. Political partisanship can still affect industry self-regulation. For instance, the Heritage Foundation's Kay Coles James and the CEO of a drone firm, Dyan Gibbens, were both removed from Google's AI ethics board because of employee and outside civil society protests (Smith, 2019; Zhang, 2020). To have a fruitful public policy discussion, it is vital to acknowledge the public's diverse policy preferences on AI governance concerns.

Protests related to technological development and robotics are not unique to the U.S.; South Korea provides an illustrative example. Asian countries like South Korea, Japan and China are known for having the highest robot densities, and this has led to public concerns about job placements. South Korea experienced protests in 2016 when concerned citizens protested in Seoul against the government's support for the robotics industry (World Robotics, 2017). Japan, renowned for its advanced robotics industry, experienced protests in 2015 when workers opposed the use of robots in a hotel (Schneider, Hee Hong & Van LE, 2018). China has been rapidly adopting robotics and automation in its industries, leading to concerns about job displacement. The global landscape of technological protests underscores the need for nuanced policy discussions that consider public sentiments and preferences.

3.5.1.2 How the regulation of emerging technologies is affected by institutional trust

The public's confidence in various organizations to create and govern AI may have an impact on how the technology is regulated. Perceived risk from technology hazards is inversely connected with general societal trust (Siegrist, Gutscher & Earle, 2005). Even when the public believes that the government is corrupt, an observational study reveals that overall societal mistrust is positively connected with support for government control (Aghion, Algan, Cahuc & Shleifer, 2010). If the public trusts the government more than they trust giant corporations, a follow-up study using larger poll data implies that the public favours governmental regulation (Pitlik & Kouba, 2015; Zhang & Dafoe, 2020). The public's response to nanotechnology and genetically modified (GM) food

products is evidence for the latter conclusion. These two new technologies are comparable to AI in that the public must rely on experts in the scientific field to assess any potential concerns. The overwhelming hostility to GM foods in affluent countries can be explained convincingly by mistrust in the institutions responsible for developing and regulating the GM foods. People who have a high level of trust in scientists and regulators are more likely to be open to eating GM foods. In contrast, people who have a low level of trust in the agricultural and food industries and a high level of trust in environmental watchdogs are more likely to be against eating GM foods (Lang & Hallman, 2005; Zhang & Dafoe 2020).

Even though Americans place scientists among the group they trust the most, when it comes to GM foods, Americans have a critical attitude towards scientists (Funk & Kennedy, 2016). Even though there is scientific agreement that GM foods are safe to consume, only 19 per cent of people believe that scientists have a thorough understanding of the health effects of GM foods. The general population in America also thinks that scientists are driven more by worries for their industry than by concerns for the public (Baccini & Weymouth, 2021; Zhang & Dafoe, 2020). Although less prominent in the media than GM foods, nanotechnology is the focus of substantial public opinion studies. Like how people view GM food, sentiments regarding nanotechnology appear to be influenced significantly by institutional trust. Americans who are less confident in company executives in the nanotechnology sector also believe that the technology is more dangerous (Cobb & Macoubrie, 2004). More mistrust in government institutions' ability to safeguard the public from nanotechnology risks is linked to a greater assessment of the technology's risk (Siegrist, Keller, Kastenholz, Frey & Wiek, 2007). Customers who have lower levels of trust in the food sector express greater reluctance to purchase items produced or packaged utilizing nanotechnology (Siegrist et al., 2007).

3.5.2 Risk of losing jobs

A recent study by Khatun and Saadat (2020) examined the effects of technological advancements associated with the 4IR on youth unemployment in South Asia. The study found a positive correlation between the capital-labour ratio and youth unemployment, as well as a positive relationship between the lower secondary school completion rate and youth unemployment. Though the magnitude of the coefficient for the lower secondary school completion rate was bigger

than the coefficient for the capital-labour ratio, the study also discovered that education may have a greater impact on lowering youth unemployment in South Asia (Khatun & Saadat, 2020).

The study in Bhutan among illiterate youths from rural areas indicated that unemployment and the strain of household duties were the main causes for both not enrolling in school and dropping out (Khatun & Saadat, 2020). Additionally, the study found that a lack of available positions in the civil sector, skill and expectation mismatches, and the prevalence of "Indian workers on the labour market were major causes of youth unemployment in Bhutan" (p.60).

In Nepal, an impact assessment of a skills training and job placement program for 40,000 young women found that after three years of participation, non-farm employment grew by 50 per cent and average monthly salaries increased by 72 per cent (Chakravarty, Lundberg, Nikolov & Zenker, 2016; Khatun & Saadat, 2020). This success highlights the importance of modernizing and enhancing the skills of young women in Nepal to adapt to changes in the labour market.

In India, the study found that only 5 per cent of workers had any kind of vocational training, and even those workers struggled to find employment as the market did not need their set of abilities (Chandrasekhar, Ghosh & Roychowdhury, 2006; Khatun & Saadat, 2020). Indian youth have recently been flocking to technical schools as the demand for workers in the information and communication technology (ICT) sector has increased (Khatun & Saadat, 2020). However, the study found that Indian IT employment is low relative to other economic sectors and primarily centred in metropolitan regions, despite the country's aspirations to become a world leader in IT.

According to studies, 40 per cent of all occupations in Bangladesh will likely be automated by 2041. Automation and technological advancement in Bangladesh could lead to job losses of 60 per cent in the ready-to-wear and furniture industries, of 40 per cent in the agro-processing industry, of 35 per cent in the leather industry, and of 20 per cent in the tourism industry (a2i, 2019; Alam & Dhamija, 2022). In addition, women and workers under the age of 24 are more likely than men or workers over 24 to experience job losses because of automation (Khatun & Saadat, 2020).

3.5.2.1 The future of work in the 4IR era

As robotics and automation replace labour more and more, an increasing number of scholars predict that this will result in greater net job losses or decreased earnings (Arntz et al., 2016; Decanio, 2016; Frey & Osborne, 2013; McKinsey Global Institute, 2018). At the moment, low- and middle-skilled (white-collar) administrative and routine jobs like bookkeeping, product testing, and machine operators are experiencing the greatest employment losses, and this is causing a rise in job polarization in developed countries and in a sizable number of developing economies (Frey & Osborne, 2015; Graetz & Michaels 2015; World Bank, 2016). The WEF (2016), for example, predicted that 4,759,000 (4.9%) of the world's 96,928,000 office and administrative workers would be laid off by 2020, and this pattern is probably going to last. In industrialized and developing countries, experts expect that unemployment will continue to rise until it reaches more than 20 per cent in Europe and more than 25 per cent in Latin America and North America by 2050 (Velín-Fárez, 2021) (See Figure 3.8). It is thought that such adjustments in production processes are motivated by the possible benefits in productivity and producer welfare. For instance, according to one study, businesses with higher levels of automation are six times more likely than businesses with lower levels of automation to see revenue growth of at least fifteen per cent (Wintermann & Daheim, 2017).

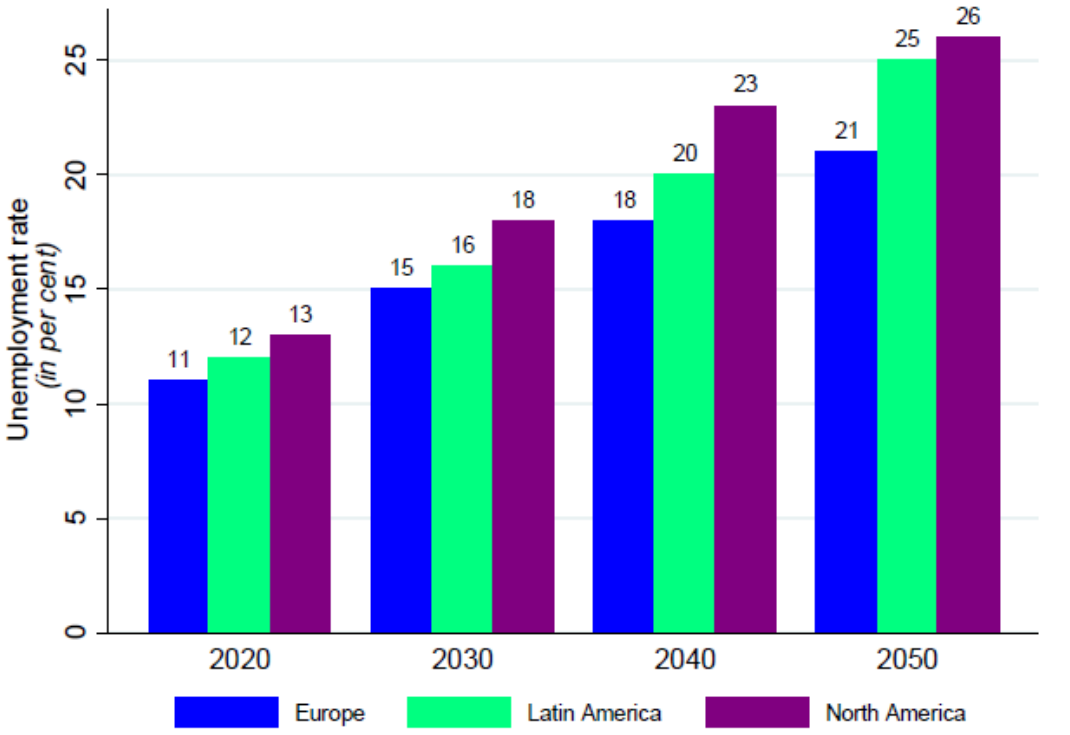


Figure 3.5: Expected unemployment rates (expert survey)

Source: Wintermann and Daheim (2017)

In addition, some commentators predict that 47 per cent of all employment in the USA is highly likely to be digitalized during the next 20 years, based on specific occupational data (Frey & Osborne, 2013). According to estimates, automation will affect 1.1 billion workers (49% of all occupations) and US$12.7 billion in wages worldwide (Chui, Manyika & Miremadi 2017). Additionally, according to the Countries Bank (2016), technological disruption might result in the loss of up to 66.6 per cent of jobs in the poor world (Figure 3.9). Other research, such as the study by Arntz et al. (2016), which found that only about 9 per cent of jobs in OECD countries are automatable, provide substantially lower numbers in comparison. However, low salaries and the slow adoption of technology mean that this process of job loss and substitution may take a considerable amount of time.

According to Deloitte (2014), new technologies in the UK could lead to the loss of around 35 per cent of occupations over the next 2 decades. At the same time, there is a low or non-existent risk

of automation for 40 per cent of the nation's workforce (Deloitte, 2014; ILO, 2016; UK Commission for Employment and Skills, 2014). Other studies contend that just some duties will inevitably be replaced by technology rather than anticipating the extinction of entire professions. According to McKinsey (2015), technology could only completely replace 5 per cent of full-time occupations, whereas automation could replace 45 per cent of human-performed tasks.

Office and administrative positions, then positions in service and sales, are those that are most likely to be digitized. Acemoglu and Restrepo (2016) first supposed that all jobs in a profession would disappear if the profession could be digitized. This is a rather reductionist point of view because it is unlikely that all jobs within a certain job family would vanish if technology were to replace all of the labour. Second, Acemoglu and Restrepo (2016) saw that economic viability and technological viability are not always the same. In other words, the production mix must change for it to be comparable or more profitable for businesses than prior labour-intensive production methods if machines are to replace human employment.

In some industries, such as aged care and education, the demand for interpersonal interaction may prevent some tasks from being automated (Finkel, 2017). The transportation sector is another one where automation threatens numerous jobs. Self-driving cars and trucks are being developed swiftly, and by 2026, they should be commonplace. Many of the related positions are found in the public sector, where they are frequently well-paying and provide simple employment opportunities for people with all skill levels. The automation of these jobs may therefore have significant effects on both the employment rate and income inequality. For instance, according to Estevadeordal and Robot-Lución (2017), the automation of transportation might result in the loss of jobs for 13 per cent of the world's economically active population, which would raise the unemployment rate in every nation by an average of 13 percentage points.

A study by Parker et al. (2019) looked at popular perceptions of the future of labour and analysed the future of the American economy in the post-4IR period. The nature of labour is changing quickly in the American workplace due to technology and automation. The public is sceptical that there will be greater job security in the future and is concerned about the long-term effects of technological innovation on employees, even though the economy is at or near full employment

capacity (Parker et al., 2019). Only 14 per cent of the study's respondents believe that the typical American worker will have higher job security by 2050, according to the findings. The majority (49%) forecasts a decrease in workers' job security, while 36 per cent forecast that it will remain stable. In terms of finding a job in the future, men are slightly less hopeful than women, and college graduates are more pessimistic than those who did not complete their education beyond high school (Parker et al., 2019). Democrats are also more inclined than Republicans to believe that job security will decrease over the coming years.

Black and Hispanic people are about twice as likely as white people to believe that workers will have more job security in the future; "24% of blacks and Hispanics say this, compared with 9% of whites", even though majorities across the racial and ethnic groups predict less job security in the future (Baccini & Weymouth, 2021; Parker et al., 2019). In the future, public opinion will once again slant negatively when asked more directly about employee benefits. About one in five Americans (22%) believe that by 2050, employee benefits will be better for the average American worker than they are now (Gramlich, 2019). However, twice as many (41%) believe that benefits will be worse than they are now, and 36 per cent believe that they will be about the same (Gramlich, 2019; Parker et al., 2019).

Few adults believe that workplace automation and new technologies will benefit workers. Only 22 per cent of the respondents claim that these advancements have generally benefited American workers, compared to around half (48%) who believe the opposite (Parker et al., 2019). Twenty-eight per cent of people feel that automation brought on by new technology has had no positive or negative effects, and the attitudes regarding these developments in the workplace are strongly divided by age (Bowden, Bowden, Ruess, Adler, Hu, Krishnamurthy & Krishnamurthy, 2022). There are about 31 per cent of people who think that robots and computers will replace a sizable amount of the work currently done by humans in the future think that this will be bad for the country. Another 40 per cent predict that it will only be slightly awful, while 29 per cent predict that it will be bad (Lee & Clark, 2020). Despite these unfavourable projections, the majority of workers do not think that the work they currently do will be replaced by robots or computers in the future: 38 per cent and 24 per cent of respondents respectively believe that this will not occur (Lee & Hess, 2022).

3.5.3 Attitudinal variances about technology-driven changes

The opposites of pessimistic worry and optimistic fervour (utopia) have been covered in recent research on attitudes toward technology-driven transformations, particularly those brought about through ICTs and the Internet (dystopia) (Nam, 2019). There are conflicting perspectives on developing technologies at the two extremes of modern civilization (Yar, 2014). Scholars have also begun to pay attention to robotic automation, a crucial element of the 4IR, and have expressed opinions that range from optimism to pessimism. Regarding emerging technologies, especially ICTs, individual attitudes toward significant robotic automation is one example of a technology-driven transformation that needs to be analysed from several angles (Nam, 2019). The literature on 4IR technological attitudes will be examined in this section, and the problematic aspects from the socio-technical, political, and economic-industrial perspectives will be shown.

Descriptive determinism, normative determinism, and voluntarism are the three determinisms that socio-technical perspectives focus on the most (Nam, 2019). These opinions have provided a framework for discussions regarding changes brought on by technology. According to descriptive determinism, technological advancements are both necessary and autonomous (Swierstra, 2015). Market-driven competition supports this position as "the first developer or user of technologies dominates the market and wins larger shares" of it (Nam, 2019, p. 40). According to Ernens, Delcourt, Dessart and Baiwir's (2022) take on normative determinism, society should only select when and how scientific discoveries should be applied rather than direct the technological advancements. Voluntarism, on the other hand, contends that social elements are always influencing technological advancement (Morozov, 2014; Winner, 1980). This point of view relates to political viewpoints since it addresses who influences policy, who ought to ideally do what, and who makes decisions.

These debates are focused on how to stop detrimental technologies and create beneficial ones, although voluntarism acknowledges the substantial role that social variables have played. "Techno-determinism" offers arguments for "optimism" or "pessimism", based on the changes that technology has brought about (Danaher, 2022). Political viewpoints have exhibited both voluntarism and determinism, and ICTs have been viewed as a two-edged sword since the earliest

phases of involvement and decision-making made possible by the Internet (Basu, 2022). Political scientists who envision a perfect society believe that ICTs' ability to reduce information and communication costs will give hitherto excluded and disenfranchised people better possibilities to engage in public life (Deng, Duan & Wibowo, 2023). ICTs mobilize the engaged more than they do the disengaged, hence the gap between participants and non-participants in the opinion of e-democracy pessimists is growing. Politics can influence sceptics, who have a cautious outlook congruent with "politics as usual" (Deng et al., 2023; Margolis & Resnick, 2000).

The economic and industrial perspectives on changes brought on by automation have been presented in both hopeful and gloomy scenarios. "One of these changes is the loss of jobs brought on by technological progress, which is an unavoidable side effect of the creative destruction brought on by technology advancements (Artnz et al., 2016, p. 13). The Theory of Singularities, put forth by Kurzweil in 1999, predicts that in future years, computer intelligence will surpass and supplant that of humans (Kurzweil, 1999). This concept has sparked a variety of predictions about the degree and precise timeframe at which robots and AI programs will be able to perform the tasks that humans can (Kurzweil, 2005). Regarding the scope and timing of this occurrence; there is a spectrum of viewpoints that spans between the optimistic and pessimistic extremes.

Optimists believe that technology will never advance to the point where most of the human labour can be mechanized, while regular work gradually disappears. The economy will generate new positions demanding common knowledge and abilities (Kaivo-Oja, Roth & Westerlund, 2017, p. 196). The second hypothesis holds that evolving technology may eventually displace a sizable amount of human labour, creating structural unemployment that will never go away. According to this gloomy scenario, most people will never be able to find new employment, robotic automation may lead to neo-Luddism, and AI will continue to pose a severe threat to much of the mid-level skilled employment (Blok, 2022). Citizens' attitudes are influenced by their beliefs about how much automation will replace human labour and how many mid-level skilled jobs will disappear (Barker & Jewitt, 2022). While voluntarism manifests as scepticism and belief in the normalization theorem because new jobs are produced to make up for lost ones, determinism divides into optimism and pessimism (Schlogl, 2022).The public may believe that social variables (such as legislation, public programs, and civic engagement) have achieved an overall social equilibrium;

this prediction is like the political scepticism that things will proceed in a linear fashion as before (Barker et al., 2022; Schlogl, 2022).

3.5.4 Policies responding to automation-driven unemployment.

Governments are essential in combating the kind of long-term unemployment that could result from the possibility of technical unemployment brought on by robotic automation. People's ability to retrain and pick up new skills will increase their competitiveness in the future labour market, and this is possible with the help of policymakers (Magistro, Loewen, Bonikowski, Borwein & Lee-Whiting, 2023). Tax-based initiatives like earned income tax credits, negative income taxes, and robot taxes are also successful interventions in this area. Furthermore, the government can utilize job guarantees but will only do so as a last resort in times of high unemployment, since they are so expensive (Mishel, 2022). Governments are attempting to improve the social safety nets (provide worker protection) with these progressive policies as they have programs that offer low-income people and families financial assistance as well as other types of support (such as food, health care, and housing) (Magistro et al., 2023).

The following four statutes stand out in this regard. First, an unconditional financial safety net might be provided via a universal basic income (guaranteed income), and this is now being tested on a small scale in Australia, Canada, Finland, and New Zealand (Nam, 2019; Shaturaev, 2022). Everyone receives a regular income from their government, regardless of where they are in their professions or what their wage is. Governments can expand the social safety networks and keep to their budgets if they reduce expensive social programs (like poverty and unemployment benefits), entice people to take calculated risks, launch new businesses, change jobs, retake courses, or seek new careers (Kelly, 2022; Shaturaev, 2022)

Second, governments can ensure human worker quotas by limiting robot quotas to filthy and hazardous work. This will aid in defining the proper scope of robotization. Workers' rights are anticipated to be protected by the legislation governing labour quotas. Governments could mandate the maintenance of a human quota in any industry and raise the value of the "made by people" designation (Wisskirchen, Biacabe, Bormann, Muntz, Niehaus & Soler, 2017, p. 40). Third, in line with the quota strategy, governments might create a list of tasks that should only be carried out by

people and raise wages for those who do them (Wisskirchen et al., 2017). This approach is designed for professions that require emotional ties with people, such as childcare, nursing, and psychological counselling (Nam, 2019; Schwab, 2017).

3.6 Chapter Summary

The widespread adoption of recent technology innovations, commonly referred to as the 4IR, will influence society as well as labour markets and income inequality. However, it is still unclear what these effects and alterations will look like. By conducting more study and debating the issue at the United Nations, we can lessen the uncertainty of local, national, and global repercussions. This will help countries be better prepared to handle these new problems. Research in this area might also examine the connections between the technological revolution and other significant global phenomena, such as the need to restructure economies and societies in order to achieve sustainable development and demographic shifts like migration and aging.

Two competing perspectives on technical optimism and economic pessimism serve as the main sources of inspiration for the public debate. Although both points of view have value, they are undoubtedly overblown and run the risk of diverting attention away from more urgent issues. Technological optimism may lead to an underestimation of the organizational, administrative, and infrastructure requirements for the general adoption of new technologies in a way that doesn't result in substantial social upheaval and political instability. Even on a purely technical basis, it might take some time before significant changes occur that will allow AI to develop toward creativity and surpass human intellect across the board. It may, however, be incorrect to extrapolate current technology acceleration trends alone because not all temporarily accelerating growth paths lead to exponential growth.

Data on public opinion has revealed how sceptical Americans are of the governance of AI, particularly in how the government would guarantee the security of jobs. Proactive strategies are also required to handle the effects of emerging technologies properly. Policies can lessen vulnerabilities if they enhance the social protection systems if technology alters the nature of labour and undermines conventional social insurance systems. Policies are required to redistribute money if technology causes less equitable income distribution. To address issues that are

transnational in character, national policies will need to be reinforced by regional and international initiatives.

Instead of serving as a justification for passivity on the part of policymakers, technological advancement could be used to spur innovation. Improving awareness of the technology revolution and its effects at the national, regional, and global levels is a first step in this direction. This will expedite the conversation on the policy options available to nations so that they can take advantage of innovative technology and enhance the management of unfavourable side effects. The next chapter (four) looks at the fourth industrial revolution from the perspective of developing countries and consideration of the socio-economic conditions of Africa.

CHAPTER FOUR: REFLECTING ON INDUSTRIALIZATION IN THE
SOCIO-ECONOMIC CONDITIONS OF AFRICAN COUNTRIES

4.1 Introduction

The previous chapter review focused on selected developed countries. It highlighted practical applications and the impact of technologies, given that African countries are at different stages of technology adoption than the developed countries. I have chosen to discuss the literature separately. The challenges and opportunities of the 4IR in developing countries may differ significantly from those in developed countries. Developing countries often face unique challenges such as limited infrastructure, political instability, and lack of funding, which may affect the adoption and implementation of 4IR technologies. The literature review of the 4IR in developing countries focuses on these challenges and explores potential solutions.

The most ubiquitous and fundamental trend affecting national civilizations in the modern age is probably industrialization (Treiman, 1970). Globally, nations are industrializing as quickly as they can gather the necessary resources. This transformation must be accompanied by modifications, which frequently take different shapes locally in terms of the social, economic, and political framework. The social and economic structure on which this chapter will concentrate is one of the ones that industrialization is most likely to impact.

Many African nations have experienced exceptional economic growth over the past few decades, including but not limited to South Africa, Kenya, Rwanda, and Nigeria, and this has brought the continent to the attention of the world (Opoku & Yan, 2019). Africa continues to be one of the regions with the highest economic growth in the globe achieved by countries like “Sierra Leone, Niger, Cote d'Ivoire, Liberia, Ethiopia, Burkina Faso, Rwanda, Mozambique, Zambia, and Ghana” (World Bank, 2017 p. 4). This remarkable growth trajectory was preceded by a terrible post-independence performance, particularly in the 1970s and the early 1980s. But the countries now need to work hard to make this economic growth inclusive, sustainable, and a means to catch up to other parts of the world quickly (Opoku & Yan, 2019). This is because despite the recent growth booms in several African countries, 400 million people in sub-Saharan Africa, who account for half of the world's extremely poor, live on less than US$1.90 per day (World Bank, 2017.

As Africa enters the 4IR, this revolution will be by far the most impactful for the continent. Here Africa will exert minimum influence and suffer maximum consequences. The 4IR will be more impactful than the slave trade, colonialism, and imperialism (Benyera, 2021). This is partly because the slave trade, colonialism, and imperialism put Africa at a great disadvantage in this period when the 4IR is unbundling; they acted as body blows which incrementally weakened Africa before it faces its biggest challenge - the 4IR - in its weakest moment (Benyera, 2021).

This chapter starts by historicising industrialization in Africa by reviewing the first three IRs and their impact in the region. Secondly, it looks at the technology level to determine how much access is available in the African region technologically. Thirdly, the chapter examines the 4IR's effects on South Africa and Africa as a whole. A sizable portion of the literature is devoted to the problems of automation, job losses, and AI because robotics and automation make up the majority of the 4IR, which has seen the development of smart technologies that have replaced (and will continue to replace) human labour in a variety of fields of endeavour (Roberts et al., 2021).

4.2 Historicising Africa’s Subjugation: Industrialization

It is crucial to investigate earlier revolutions in the African region to provide background for this study, even though its foundation is in comprehending South African society's perspectives on the 4IR. The "knowledge economy", which has reduced every aspect of social life to the distribution and consumption of commodities, is viewed with scepticism by Badat (2020). He poses the pertinent query that this study aims to answer: Given that the prior three IRs failed to produce a world that is fair and compassionate, why is there so much anticipation and optimism around the fourth IR? The worldwide socio-economic system that has consistently exploited and marginalized the global south, especially Africa, has existed since the 1970s, and it was formed by the convergence of digitally networked IT.

When Africa attained independence, its constituent nations inherited a multifaceted industrial landscape characterized by a traditional-modern dualism (William, 2004). It is imperative to underscore the heterogeneity of Africa, comprising distinct nations, each with its unique historical narrative. The traditional-modern dualism encapsulates the coexistence of pre-existing, localized industrial practices alongside emerging modern industries. This intricate legacy profoundly

influences the trajectories of industrialization in diverse African countries, necessitating nuanced analyses that account for the varied historical, cultural, and economic contexts within the continent.

The traditional industrial environment was one that survived from pre-colonial times and colonial economies, and it mainly covered production and service activities related to fundamental household and agricultural needs at a traditional handicraft level by artisans, including blacksmiths, porters, carpenters, carvers, and weavers (Nzau, 2010). In addition to using local resources, such as metal scraps and waste, this ancient industrial setup was essentially powered by human and animal power. The contemporary industrial environment, which utilized imported technology, machinery, equipment, materials, and production techniques, was on the other side of the divide (United Nations, 1995).

4.2.1 The first industrial revolution

For Africa, there were repercussions from each of the prior IRs. Given that it enhanced the cruelty of slavery, the 1IR is regarded as one of the most intense revolutions (Moll, 2020). Africans were taken prisoner, sold, and shipped over the Atlantic to the expanding textile industries in the north of England during this time, the British purchased slaves to access the cloth produced along the US coast (Agarwal & Agarwal, 2017; Mohajan, 2019).

The historical interconnection between Britain's industrialization and the cotton plantations of the United States, fueled by African slave labor, is a poignant illustration of the global dynamics that shaped industrial revolutions (Moll, 2020). With over 80 percent of essential raw materials for British industry originating from the Southern states, particularly cotton, the transatlantic slave trade surged to meet the growing demand (Agarwal & Agarwal, 2017). This historical linkage underscores the complex legacy of industrialization, intertwining economic prosperity with the exploitation of human lives. In considering Africa's industrialization, this connection serves as a reminder of the intricate historical forces that have shaped global economic landscapes and highlights the imperative of understanding the profound impacts of such historical trajectories on various regions.

4.2.2 The second industrial revolution

Despite the abolition of slavery, the 2IR increased European nations' colonial dominance over Africa (Moll, 2020). Even though historians typically place the 2IR and the "era of imperialism" in the 1860s–1912 time frame, they represent the same historical phenomenon from the perspective of Africa (O'Brien, 2006).

Then there were the goods produced in the once colonial towns, such as sugar, tobacco, cocoa, tea, and rubber. Plantations in the French and the Belgian Congo regions were growing rubber by the late 1800s. West and central Africa had commercial palm oil and cocoa plantations (Rodney, 2010). Sugar cane plantations had been constructed along the coast of South Africa, while gold and diamonds were being mined in South Africa and Northern Rhodesia, all of which were essential to the countries' energy industries (Sutherland, 2020). Almost all these things were sent to the USA and Europe. The colonial economic system was systematized by the "scramble for Africa", which developed the historical argument to place imperialism at the 2IR's economic centre (Rodney, 2010).

Although 80 per cent of Africa was still governed by custom and local authorities by the 1880s, colonial demand for African raw commodities was rising (Rodney, 2010). The Berlin Conference, which took place in 1884 and 1885, was organized to prevent future wars. The socio-economic prosperity of the global industrial nexus, which encompassed the United States, Britain, France, Belgium, Germany, Italy, and other Scandinavian nations with trading ties to Africa, depended on raw minerals found in far-flung regions of the world (Larson, Muraoka & Otsuka, 2016; Voth, 2003; William, 2012). More plant oils, metals, hardwoods, gold, diamonds, and the like were needed by these developing nations, while affluent Europeans also had a hankering for exotic African goods like peanuts, gum Arabic, ivory, coffee, and diamonds (Voth, 2003; William, 2012).

It is noteworthy that the conference declaration primarily focused on "free trade" for the colonial powers in Africa, establishing a "free trade zone" that extended from the Congo Basin to the Indian Ocean in the east and allowing for unrestricted navigation of the Congo and Niger rivers for commercial ships (Rodney, 2010). The colonial powers quickly acquired additional lands through partitioning, with Belgium, France, Germany, Britain, Italy, and Portugal gaining control of the

land before the ink on the documents had even dried (Rodney, 2010). The United States and the Swedish-Norwegian Union successfully achieved their goal of giving the agreement an economic definition, rather than a geographical one, through the opening of the Congo and Niger rivers for free trade. The delegates, however, paid little attention to the continent or its people while defining Africa's future borders in Berlin (Moll, 2020; Rodney, 2010). The arbitrary division of Africa into 50 colonies, based on a combination of rivers and straight lines with little regard for the native peoples and geographical regions of the continent, helped to facilitate imperialism in Africa and the accord it produced became a vital element in the legal framework of the 2IR (Rodney, 2010).

4.2.3 The third industrial revolution

In the 3IR, increasing socio-economic marginalization has been the common experience of most African nations. Western outsourcing, onshoring back to automated manufacturing, or simply eradicating the people and locations that are "no longer valuable, even if they are still physically there" have been the order of the day (Castells, 2014). According to Castells (2014), Africa has not benefited from the economic trends of the previous 50 years. Globalization of the economy is a phenomenon that differs significantly from the growth of the British Empire in the first and second industrial eras or the establishment of the international colonial order in the third (Castells, 2014). The 3IR permeates the entire planet through networked computer, telecommunications, and transportation technologies that "shrink" space and time. It is widely acknowledged that the globalization of capitalism - the planet's only economic system - has been fuelled by the networking of digital technology. Productivity and competitiveness are now reliant on the processing of information.

The use of robotic automation, the Internet, digital computers, satellite technologies, and their associated industries all developed in the 1960s, and this marked the beginning of the establishment of these technological networks. With the introduction of the Internet in 1991, these processes intensified (Castells, 2014; Singh, 2015; William, 2012). Large firms were able - no, forced - to trade across international borders to increase profits and cut manufacturing costs. The now "multinational" firms started relocating their manufacturing "from the developed world to the developing world" in the 1970s (Szirmai & Verspagen, 2015). This practice of "offshoring" has become more and more common due to the allure of cheap labour in the world's weaker nations.

The first firms to do this were low-skill assembly operations that moved to Mexico and Asia in the 1980s, and several multinationals in the apparel sector moved their manufacturing operations to sweatshops in countries like India, Bangladesh, and Honduras (Moll, 2020; Szirmai & Verspagen, 2015).

Given Africa's long history of harsh exploitation and dictatorship, it is unclear how the 4IR will be any different or how it will benefit the continent. Beyond the benefits of technology, the 4IR must demonstrate how it can end the fundamental economic, political, and social dominance of first world nations over Africa. A key element of any revolution is its destructiveness and concomitant accumulations. This could be the destruction of the old political, religious, economic, and/or social order or of dictatorships and other forms of governance deemed undesirable. The 4IR is not all about political destructions; rather it is more focused on the destruction of epistemologies and ways of doing things (Benyera, 2021). This IR has witnessed intensification of the destruction of phenomena such as geographical and political boundaries, jobs, industries and indeed livelihoods. One of the biggest risks of the 4IR in Africa is premature de-industrialization (Mfanafuthi, Nyawo & Mashau, 2019). As such the 4IR will result in massive de-industrialisation, which is very premature in an African context.

4.3 Industrialization Dynamics in Africa: Low Levels of Technology

This fast-evolving technology and its consequences created two sets of global citizens: those with technology and those without technology. I will call them the digi-privileged and the digi-deprived. The gap between the two is widening at an astronomical rate. The lives of the digi-haves or digi-privileged will obviously be enhanced by the 4IR, while the opposite is true for the digi-deprived (Benyera, 2021). Roughly mapped, the digi-privileged are in the global north while the digi-deprived are in the global south. Occurring simultaneously with destructions in a revolution are accumulations; that is, for every destruction, there is an opposite and equal accumulation. For example, the digi-privileged are acquiring more autonomy, sovereignty, and a better quality of life while the digi-deprived are acquiring more poverty, alienation, and hopelessness (Benyera, 2021).

Africa does not appear to have fully embraced the 21st century yet, as it still trails behind in a number of areas (infrastructure, access to technology, and education) that are crucial for a successful digital revolution (see Figure 4.1).

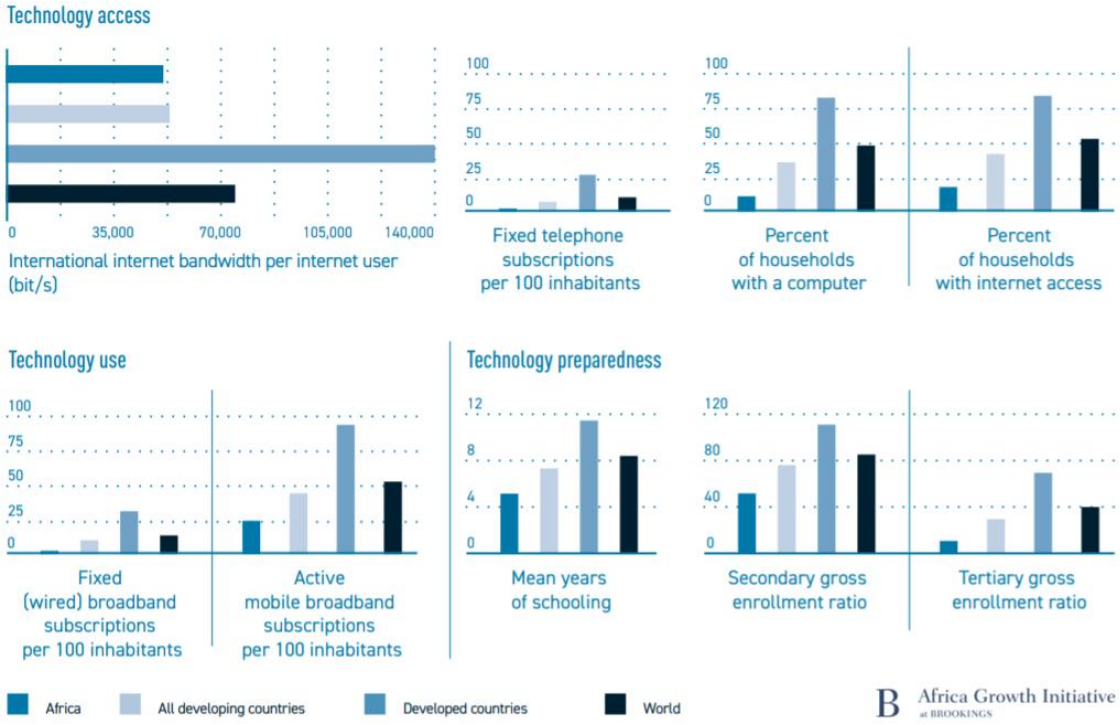


Figure 4.1: Africa's ICT development indicators

Source: Adam (2019)

The statistics shown in Figure 4.1 show that directing technology development is a key problem for African nations looking to create more and better jobs. In the figure, Africa's technology access is compared to that of the world and developed countries. It clearly shows that Africa has the lowest Internet bandwidth per Internet user, the lowest level of technology preparedness in its schools at primary and tertiary levels, and also the lowest number of households with a computer (Adam, 2019). Participating in the fourth industrial revolution requires a country to have adequate technological infrastructure, a skilled workforce, and a supportive policy environment. However, as the figure provided suggests, Africa currently faces significant challenges in these areas. Without adequate investment in technological infrastructure, education, and policy frameworks, Africa is likely to be left behind in the fourth industrial revolution (Grybauskas et al., 2022; Harvey, 2019). This could lead to increased economic inequality, reduced competitiveness, and

limited opportunities for African businesses and entrepreneurs to compete in the global marketplace.

Africa will require technological advancement to support innovation patterns and pathways that create jobs that are productive and meet the needs and goals of individuals, as well as to make sure that those who are currently employed in the unorganized sector and low-productivity industries do not fall behind (Adam, 2019; Benyera 2021; Harvey, 2019). Most African nations continue to have poor levels of technology and little dynamism in terms of upgrading technologies. The two major economic sectors in Africa, the informal economy and agriculture, both use low-sophisticated production methods. This is seen in the prevalence of low-productivity occupations and pay, which frequently have a severe impact on the health and well-being of employees (ILO, 2015).

The artisan and craft industries present a slightly different scenario. Expert artisans and practitioners of crafts frequently use relatively cutting-edge technologies. For instance, in the United Republic of Tanzania's informal sector, auto technicians use computer-aided diagnostic equipment, while carpenters and tailors who make goods for local markets are eager to improve designs, distinguish their goods, and raise quality (Akinlo, 2004; ILO, 2015). Industrial development has been cited as a major force behind the expansion of technology, education, and job creation in low-income countries. Sub-Saharan Africa's premature de-industrialization has contributed to the region's slow rate of technical advancement and job creation (Nübler, Hofmann & Greiner, 2010). However, compared to other African nations, the industrial sector in North African nations employs a greater percentage of people, and this may be a factor in their comparatively high productivity levels (Ocampo, Rada & Taylor, 2009).

More recently, the skills makeup of the workforce has changed in a handful of African countries (or the task profiles of jobs). For instance, the proportion of high-skill occupations has risen in several middle-income nations (such as Botswana, Gabon, Mauritius, Tunisia, and South Africa), as well as in low- and lower-middle-income nations (such as Egypt, Ghana, Morocco, and Zambia), as well as Ethiopia, Liberia, and Rwanda (Bandiera, Elsayed, Smurra & Zipfel 2022). It is important to notice that these groups of countries have different patterns of change in terms of

employment requiring medium levels of competence versus jobs requiring low levels of expertise. Some exhibit employment polarization, which is when the proportion of occupations requiring a medium level of expertise is decreased while the proportion of jobs requiring little skill is increased (Dinkelman & Ngai, 2022). Others decreased their share of low skill-intensive employment while increasing their share of medium-skilled jobs. However, to date, no systematic analysis of technical change, structural change, and changing employment profiles in African countries has been carried out. These changes are indicators of technological and structural transformation (Bandiera et al., 2022; Dinkelman & Ngai, 2022).

Since finding employment for the continent's burgeoning youth population is of the utmost importance, many African governments are reluctant to accept technology that poses a threat to the current occupations (Matthess & Kunkel, 2020; Naudé, 2017). The 4IR is only open to economies with the necessary skills due to some existing technologies' tendency to replace low-skilled workers (of whom Africa has a lot) with higher-skilled ones (Marwala, 2019; Naudé, 2017). In this study I explore the attitudes of those who are susceptible to losing jobs to the 4IR to determine their support/rejection of these technologies.

4.4 The Fourth Industrial Revolution in Africa

As Africa enters the 4IR, this revolution will be by far the most impactful for the continent. Here Africa will exert minimum influence and suffer maximum consequences. The 4IR will be more impactful than the slave trade, colonialism, and imperialism, partly because the former acted as body blows which incrementally weakened Africa before it faces its biggest challenge - the 4IR - in its weakest moment. Entering the 4IR from such a weakened position will only hasten Africa’s rapid demise and eventual (re)colonization (Benyera, 2021; Marwala, 2019; Millington, 2017). Products of the 4IR, such as robots, robot-humans, post-humans, and other forms of post-anthropocentrism are now being ascribed a higher ontological density than Africans. Sophia the robot was accorded citizenship in Saudi Arabia on 25 October 2017 (Goertzel et al., 2017; Rocha, 2018; Stone, 2017). Ironically, Saudi Arabia is a country where Africans are unwelcome and are degraded as humans. In her own words, Sophia the robot welcomed her inclusion into humanity as follows:

> I am very honoured and proud of this unique distinction. This is historical to be the first robot in the world to be recognised with a citizenship…. I am always happy when surrounded by smart people who also happen to be rich and powerful.… I can let you know if I am angry about something or if something has upset me.… I want to live and work with humans, so I need to express the emotions to understand humans and build trust with people…. My AI is designed around human values like wisdom, kindness, and compassion (Stone, 2017, p. 34).

Four things are important to note from the words of Sophia the robot: (1) Sophia communicated what she was programmed to say and thinks the way she was programmed to think. She reflects the thinking of her manufacturers, in this case, Hanson Robotics led by AI developer, David Hanson. (2) Sophia is a white robot and not black. While this may seem flimsy and insignificant, it is important in that the inaugural robot is a white robot. What does this mean for both human and robot equality? (3) What are the human rights implications of allowing Sophia citizenship in Saudi Arabia, a country where women and black Africans have very few human rights? Sophia, a female robot, is granted more human rights in Saudi Arabia than Saudi women. A female robot with human rights (or are they robot rights?) is acknowledged by the Saudi government, however, they refuse to accord Saudi Arabian women the same rights. (4) Sophia experiences both happiness and anger and desires to be with intelligent, wealthy, and influential people so what will happen if Sophia is put among disgruntled black, poor people? (Benyera, 2021; Fernandes, 2022).

What does Africa need to do to change sides and be on the upper side of the 4IR? Conventionally, the key success factors for any country in the 4IR are political stability, sustainable macro-economic policies, ICT skills, ICT infrastructure, and finally the rule of law, not rule by law. Due to colonial planning and the continent's own mistakes and errors, Africa lacks or has negligible amounts of all the aforementioned factors. Lack of moral leadership, the concentration of the means of production in the hands of a small group of elite individuals, and state capture only exacerbate Africa's already inadequate readiness (Benyera, Francis & Jazbhay 2020). Elite collusion among the local elite and between the local and international elite isolates the already vulnerable poor masses, who ironically look up to the same elites for material emancipation.

It can be argued that most African countries, except for Egypt, Tunisia, and South Africa, have not even completed the 2IR and 3IR. Countries such as the Democratic Republic of Congo, Somalia,

and Libya are sliding back into the 2IR, and the rest of the African countries are not yet ready for the 4IR, judging by the status of their ICT. Here I am using ICT infrastructure as a proxy for assessing a country's 4IR readiness (Marwala, 2019; Moll, 2020; Ndung'u & Signé, 2020). Under these circumstances, Africa's resources, such as human capital and mineral resources, will continue to develop Euro-North America, a condition long decried by Walter Rodney (1973). Base metals such as coltan, platinum-group metals, are available in Africa in abundance, yet are exported and beneficiated abroad where their real value is realised and enjoyed by those other than Africans. Africa is therefore central to the 4IR and, according to Odendaal (2019, p. 1):

> Copper, gold and silver, essential for micro- electrical components, are abundant in the Democratic Republic of Congo (DRC) and Zambia, while tantalum extracted from coltan ores for micro-capacitors in electrical units can be sourced from the DRC, Rwanda and Uganda. Africa could become a rare earth's powerhouse, being home to many of the 17 different rare-earth elements, including dysprosium and neodymium, which are critical for wind technologies and energy storage, as well as praseodymium, which is critical for electric vehicles and energy storage.

Currently Africa is yet to benefit fully from its rare earth minerals, as it has failed to benefit sustainably from the past three IRs. Africa is thus on another trajectory to fail to benefit from the unfolding 4IR, unless something changes drastically, especially the mindsets of both Africans and their leaders. This can be attained if they get epistemic freedom.

The paradox which Africa faces is that it is home to most of the rare-earth minerals and other key ingredients essential for driving the 4IR, yet it is the weakest member of the international community in terms of beneficiating and managing its natural resources. Slavery, colonialism, imperialism, and now coloniality have all crippled Africa, leaving it powerless to control the mining of its rare-earth minerals in a sustainable manner. Most of the nations that contain rare-earth minerals are fragile states, including Somalia, South Sudan, the Central African Republic, and Chad (Cilliers, 2021). Other rare earth mineral-rich nations in Africa, such as Burundi, Malawi, Guinea, and Zimbabwe, are classified as weak or dysfunctional states (Di John, 2011; Grimm, Lemay-Hébert & Nay, 2014; Rotberg, 2010; Sithole, 1993).

The loss of Africa's mineral sovereignty is therefore not to be taken lightly, as Africa was 'pre-marinated' by colonialism, where it was marketized and subsequently opened up, colonised,

owned, and controlled by foreign nations. Robots and other forms of enhanced humans made from African minerals will surely come to (re)colonise Africa. Besides (re)colonisation, Africa faces other immediate challenges such as de-industrialization, massive unemployment, and wider, deeper systemic poverty.

Given the 4IR's influence on job relocation, skill disruptions mixed with widespread unemployment, and skill shortages already impeding economic transformation and sustainable progress, fear of the consequences has intensified, especially among many developing nations in sub-Saharan Africa (Ayentimi & Burgess, 2019). The 4IR's dual paradox in sub-Saharan Africa poses several issues, particularly in terms of how people, governments, and enterprises will react to and adapt to these new developments (Naudé, 2017). Studies (Alabi & Mutula 2022; Awodele, Ngige & Balogun, 2021) examined the effects of the 4IR on skill disruptions, job displacements, mass unemployment, and the overall shortage of highly trained employees in Africa and found that industrialization may worsen the region's unemployment problem if there are no regulations on such developments. Although the fear of the 4IR has increased among many sub-Saharan African economies, most discussions on the 4IR and its effects focus on wealthy, developed nations and how they will adapt their skill sets to meet the demands of the new technology as well as how they will deal with the challenges of structural adjustment as employees lose their jobs and businesses become less competitive (Runde, 2016). Contextual specificity, which is essential to understanding how the 4IR's benefits and drawbacks will affect poverty in sub-Saharan Africa, has not garnered much scholarly attention or strategic discussion.

Many countries in sub-Saharan Africa are still suffering widespread inaction and skill and ability shortages notwithstanding the 4IR's effects on job losses, ability disruptions, and large labour relocations (Debrah, Oseghale & Adams, 2018; Millington, 2017). According to Akanle & Adésnà (2018); Ogundari & Awokuse (2018); and the WEF (2017a), these restrictions have primarily been caused by the dominance of sporadic economic endeavours, which are marked by a slow growth rate, a limited and subpar public foundation, low levels of instruction and skills development, specialized or kin businesses, and slow progress in electronics and innovation.

Various sub-Saharan African frugalities are also comparatively overexposed to labour market shocks that are characterized by skills gaps and inadequate training (Naudé, 2017; Ogwo, 2018). According to Ayentimi, Burgess and Brown (2018), societal problems that have undermined business-related and social rearrangement in sub-Saharan Africa over time include tribalism, governmental imbalance, moral and cultural divisions, and the collision of new and traditional ideals. Tribalism and cultural divisions can create barriers to collaboration and hinder the development of a shared vision for technological progress (Tripathi, Popli, Ghulyani, Desai & Gaur, 2021). This can lead to fragmented and disjointed efforts to implement 4IR technologies, slowing down progress and reducing the overall impact of these technologies. Governmental imbalance and corruption can limit investment in research and development, as well as hamper the adoption of new technologies by the public and private sectors. This can lead to a lack of funding for initiatives that could improve infrastructure and increase access to technology, limiting the potential of 4IR to transform the region. The collision of new and traditional ideals can also create resistance to change and make it difficult to adopt new technologies. This can be particularly challenging when it comes to education and training, which are critical for equipping the workforce with the necessary skills to thrive in a 4IR-driven economy (Shonfeld, Cotnam-Kappel, Judge, Ng, Ntebutse, Williamson-Leadley & Yildiz, 2021).

This issue of tribalism and cultural divsions raise several questions about the applicability of the 4IR in sub-Saharan Africa, specifically considering other factors such as the large informal sector, weak public infrastructure, low levels of technical skills, and limited technological advancements primarily found in certain areas controlled by foreign companies and staffed by foreign workers (Salahuddin & Gow, 2016). It is also important to consider factors such as the impact of 4IR implementation and the place of young people in it (African Development Bank, World Bank Group & WEF, 2017), when preparing for relevant skills, emerging skill shortages in specific areas, and the role of new technology in supporting workers in the transportation industry and household savings.

4.4.1 Economic prospects of the fourth industrial revolution in sub-Saharan Africa

African development and financial experts, including think tanks for local and international strategies, have identified the availability of valuable raw materials and human resources as significant drivers (African Development Bank, 2017; Cleeve, Debrah & Yiheyis, 2015). However, a lot of newly emerging and underdeveloped frugalities in sub-Saharan Africa are primarily characterized by an excessive reliance on rain-augmented farming (Adekunle, Osazuwa & Raghavan, 2016; Bachewe, Berhane, Minten & Taffesse, 2018). Some demonstrate a poor and restricted public basis, lower funding for education, mass inaction, diminished use of science, electronics, and change, and flaws in uniform systems, (Ayentimi, 2018; Medina, Jonelis & Cangul, 2017; World Bank, 2017).

The 2IR was characterized by volume output through the growth of production, communication science, and transportation, whereas the 1IR demanded the replacement of manual labour with machines (Kim, 2018; Makridakis, 2017). The primary drivers of the 3IR were digitalization and advancements in telecommunications, Internet use, and microprocessing technology (Naudé, 2017). However, the coming of the 4IR is particularly driven by progress in the transmission of traits from parents to their offspring, biotechnology, nanotechnology, machine intelligence, 3D publication, and AI, stimulated by indifferent powers and technologies (Naudé, 2017; WEF, 2017a).

The rate of the information revolution and the desire for it, however, have varied across sub-Saharan Africa, which has hindered progress in social and economic transformation over the course of the prior IRs (African Development Bank, 2017). The 4IR will hasten the development of general-purpose electronics, enabling a rise in output across a variety of industries and energy sources (WEF, 2017b). Researchers currently concur that technologies often ask for equivalent changes in material and bland infrastructure, in addition to organizational and behavioural (public) transformation (Foroudi, Gupta, Sivarajah & Broderick, 2018; Santarius & Soland, 2018). Most African firms report moderate to very reduced levels of trade readiness for five of the key 4IR technologies (refer to Figure 4.2). Notably, firms are least ready for AI/electronics and blockchain electronics. Experts mention that the low levels of readiness have arisen from the failure of the firms' guidance to cultivate persuasive mathematical plans, and this is in addition to the reduced levels of instruction and abilities of the workers (Monga, Shimeles & Woldemichael, 2019).

Figure 4.2: Preparedness of firms for the fourth industrial revolution
Source: Monga et al. (2019)

There are numerous situations and factors that have been identified as having a major impact on how quickly mechanics are used and converted into frugality (Spencer, 2020). These include a lenient supervisory environment, a financial and public climate, and costs (Hensengerth, 2018; Olawuyi, 2018). Additionally, a key component of the 4IR is risk-takers' (producers') ability to push radical innovation and bring electronics to the stock market for the advancement of energies (Naudé, 2017). An important factor in getting the 4IR started is the development of ICT during the 3IR's digitalization of science.

The 4IR is based on advances in ICT effectiveness that consider a merger of computer power and new sciences. This consolidation could change how social structures, work processes, and labour markets are organized (Schiuma, 2017). The essential revolutionary capability that supports business-related initiatives inside the 4IR is AI (Naudé, 2017). In a complimentary manner, the WEF (2016), the 4IR's pioneer, positions the advancement of AI and industry as a precursor and a pillar supporting the 4IR's ability to change people's lives.

The 2IR was primarily focused on the transformation of production processes. The subsequent emergence of 3D electronics has the potential to drive a new and specialized mechanical production process to convert new production as it significantly alters or modifies the processes and manner in which physical goods are made (Despeisse Baumers, Brown, Charnley, Ford, Garmulewicz, & Rowley , 2017; Norman, Madurawe, Moore, Khan & Khairuzzaman, 2017). The 3D sciences are advantageous and may even be more appropriate than traditional industrial electronics in certain circumstances. For instance, 3D sciences can quickly customize and alter

designs, and this science allows for the creation of complex and customized objects that would otherwise be difficult or impossible to produce using traditional manufacturing methods (Makridakis, 2017).

In medicine, 3D printing has been used to create prosthetic limbs, surgical tools, and even organs for transplant. Alongside 3D science artificial intelligence has been used in the health care sector to analyze complex medical data, assist in clinical decision-making, and develop new treatments (Ayentimi & Burgess, 2018). These technologies have been proven to be life-changing in health care aid provision in Japan, Australia, and the USA (WEF, 2017b). Given that the health care system in Africa is characterized by poor infrastructure, it is uncertain when and if African countries will benefit fully from these technologies (Odekunle, Odekunle & Shankar, 2017).

The other area that has potential prospects for artificial intelligence and 3D technology in Africa is in its agricultural sector. 3D and AI technologies can play a significant role in land mechanization as they can improve the efficiency, accuracy, and safety of agricultural operations (Adenle, Azadi & Manning, 2018). According to Larson et al. (2016); New Partnership for African Development (2013); and World Bank (2022), African countries have an active labour force and most of its citizens reside in rural areas, so technology could be an asset in this sector and help with smart farming. Amongst other things, AI can assist with soil monitoring: AI can analyze data from soil sensors to provide real-time information about soil moisture, temperature, and nutrient levels. This information can help farmers to optimize irrigation and fertilization and improve crop yields. The implementation of 4IR technologies in agriculture can help with significant precision farming, where AI can analyze data from sensors and other sources to provide farmers with precise information about planting, irrigation, and fertilization. This can help farmers to optimize crop yields while reducing costs and their environmental impact (Bachewe et al., 2018; Van Rooyen, Ramshaw, Moyo, Stirzaker & Bjornlund, 2017).

Overall, there are good economic prospects for the fourth industrial revolution in Africa in the agriculture, manufacturing, and health care sectors. These technologies will enhance productivity and efficiency in these sectors to boost Africa’s economy.

4.5 The Fourth Industrial Revolution in South Africa

The fourth industrial revolution in South Africa has been embraced by a wide range of stakeholders who recognize the need to adapt to a rapidly changing technological landscape and position the country for economic growth and social progress in the years ahead (Sutherland, 2020). In his first State of the Nation Address (SONA) in 2018, President Cyril Ramaphosa spoke extensively about the fourth industrial revolution (4IR) and its potential impact on South Africa's economy and society (South African Government, 2018). Ramaphosa acknowledged that the 4IR presents both opportunities and challenges for South Africa, and he emphasized the need for the country to embrace new technologies and innovations to remain competitive and create jobs.

South Africa has a complex and multifaceted history that has shaped its current economic and political landscape. One of the most significant factors in this history is the legacy of apartheid, a system of institutionalized racial segregation and discrimination that was in place from 1948 until the early 1990s (Maylam, 2017; Reece, 2021). Under apartheid, the white minority government controlled the economy and excluded the black majority from many opportunities for education, employment, and wealth creation, and this legacy of inequality and exclusion continues to shape South Africa's economic landscape today (Mtapuri & Tinarwo, 2021; Shannon, Morgan, Zeinali, Brady, Couto, Devakumar & Muraya, 2022;). While the country has made progress in reducing poverty and inequality since the end of apartheid, it remains one of the most unequal societies in the world. The unemployment rate is high, particularly among young people and those without formal education (Marutlulle, 2022). The economy is heavily dependent on natural resources, such as gold and platinum, which are subject to fluctuations in global demand and prices.

These economic challenges should influence South Africa's approach to the 4IR. The government has recognized the potential of new technologies to address these challenges and promote economic growth. In 2018, President Cyril Ramaphosa established the Presidential Commission on the Fourth Industrial Revolution to develop a comprehensive strategy for the country's participation in the global digital economy. However, there are concerns that the benefits of the 4IR may not be distributed equitably, and that the new technologies could exacerbate existing inequalities. For example, there is a risk that automation and artificial intelligence could lead to job losses in certain industries, particularly those that employ large numbers of low-skilled workers

(Roberts et al., 2021). Innovations such as the industrial revolution are good for development, but it is important to note that they have both positive and negative outcomes (Mtapuri, 2023). Scholars such as Bhanu, Donovan, Haefele, Siddiqi and Smiles (2016) see the fourth industrial revolution in the negative sense because they believe that the innovation is not a product of cautious reasoning but rather a tool for the elite who are seeking to create a Schumpeterian financial division. Overall, the historical and economic context of South Africa has to be considered in the approach to the 4IR as its outcomes appear complex.

4.5.1 Socio-economic context of South Africa

To mitigate the potential negative outcomes of implementing the fourth industrial revolution effectively, it is important to consider the socio-economic context in which it is introduced. South Africa, with its troubled history of colonialism and apartheid, experiences the highest levels of inequality in Africa and is among the most unequal nations in the world (International Monetary Fund, 2022; Mtapuri & Okem, 2023). However, the distribution of inequality is not uniform across the country. Provinces such as Gauteng exhibit lower levels of income inequality compared to the Eastern Cape, which reports the highest levels (StatsSA, 2022). Gender also plays a significant role, with women earning approximately 30 per cent less than men (StatsSA, 2021). Additionally, racialized inequality is a prominent issue, with black Africans earning the lowest wages compared to other demographic groups. The economy is also heavily influenced by a small group of elite companies and families, most of whom are white, and this leads to further economic inequality. Racialized inequality is also evident in education, both in terms of access and success rates (StatsSA, 2022). These socio-economic factors have significant implications for how industrial developments can be leveraged to promote equality and avoid exacerbating racialized inequality. Rehbein (2018) notes that labour was historically racialized as white South Africans received high pay and certain jobs were separated for them, whilst the African population was restricted to mining and agriculture jobs accompanied by low pay. Industrialization and skill development were limited to the white population, hence my study deemed it important to consider social class in the assessment of attitudes towards the fourth industrial revolution in South Africa (Rehbein, 2018).

Studies on the relationship between technology development and social class in South Africa suggest that there is a significant divide between the technological haves and have-nots, with social class a key factor in the determination of access to technology (Guenther, Reif, Taddicken &

Weingart, 2022; Madianou, 2019; Oyedemi, 2012; Roberts et al., 2021). The digital divide exacerbates existing socio-economic inequalities and has important implications for education, employment, and overall social mobility. Research has also shown that the lack of technology access and digital literacy skills among lower-income groups can lead to further marginalization and limit their ability to participate in the knowledge economy.

The South African government has taken steps to mitigate the inequality gap, such as the introduction of social grants, the Reconstruction and Development Plan, and the *Broad-Based Black Economic Empowerment Act No. 53 of 2003, as amended by Act No. 46 of 2013*). However, considering that there are more social grant and welfare recipients than taxpayers in South Africa (Jazbhay, 2019, pp. 8–9; Marais, 2011, p. 3), this anomaly will continue to grow at an even faster rate as the 4IR consolidates. With an ever-dwindling tax base and an ever-increasing welfare population, the country will struggle to dispense welfare services in South Africa. The possible destination here is social unrest, demonstrations, and even a revolution. This stands to be South Africa's tipping point as social grant recipients, who are proven to be more revolutionary, will not tolerate a loss of their only source of livelihood (Matthess & Kunkel, 2020; Maylam 2017; Mishel, 2022; Skocpol, 1994; Skocpol & Trimberger, 1977).

One of the steps taken by government to discuss the prospects of the fourth industrial revolution in South Africa was the creation of the Presidential Commission on 4IR, which was made public during the 2019 SONA. The thirty members of the Commission are well-known individuals from various fields who possess the knowledge and skills required to further the nation's 4IR mission (Makamase, n.d.). New partnerships, like the South African 4IR Centre, which will receive support from the Council for Scientific and Industrial Research, will also aid the strategizing, planning, designing, and regulating of policies toward advanced 4IR technologies. These partnerships will work to achieve the national and pan-African development objectives (Makamase, n.d.). Despite the present government's optimism towards the 4IR, it is certain that some people will be disappointed, especially the underprivileged and unemployed youth. Although digitalization may disrupt the world of work, a recent study by Magwentshu, Rajagopaul, Chui and Singh (2019) predicts that overall, it will create more employment than it destroys. However, compared to most of the jobs that are being replaced, the new technology-enabled jobs will demand greater skill

levels. By 2030, digitization might increase the need for 1.7 million more higher-educated workers (see Figure 5.3). Much of that need will not be met unless a bigger proportion of South Africa's graduates accept technology-related professions. Failure to do so will cause a significant skills shortage throughout the economy. As shown in Figure 4.3, as productivity rises, a technology-responsive policy is put in place, and new professions are developed. Digitization and automation then replaces workers but also create jobs. By 2030, South Africa might have up to 1.2 million new employment opportunities because of these procedures. However, most of these jobs require knowledge in technology, which means that reskilling will be necessary.

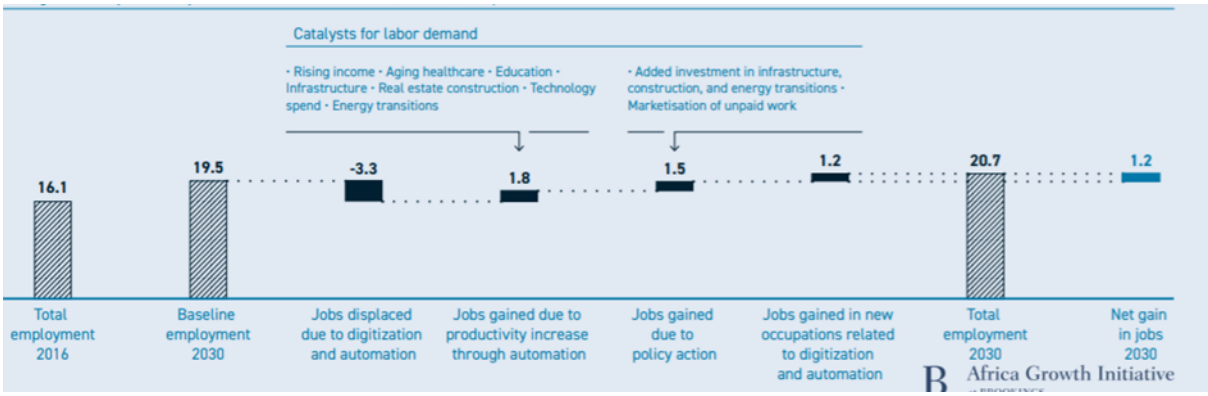


Figure 4.3: Digitization, automation, and jobs in South Africa

Source: Magwentshu et al. (2019)

The clear-cut conclusion is that all South African decision-makers must act courageously to make sure that reskilling is sufficient to aid in the reabsorption of people into the workforce (Mckinsey, 2017). These decision-makers must also boost the educational system to produce sufficient technology-related and life skills. The tremendous workforce transition that lies ahead can only be managed by South Africa successfully after this has been done. These actions are necessary if the nation is to take advantage of technology's promise to unleash inclusive growth, enhance lives, and lower the intolerably high unemployment rates (Mckinsey, 2017; Ndung'u & Signé, 2020).

4.5.2 Industrial policy and strategy

It has been challenging for rising countries to emulate the successes of the Asian tiger economies due to the influence of China and other Asian economies as well as their extremely different institutional and economic systems (Sutherland, 2020). There is currently a low demand for

manufacturers on the global market, and many nations are fighting fiercely for any available factory space by providing extremely low wages. As a result, local demand is constrained, and countries' reliance on exports to foreign markets is increased. Export-led industrialization's window of opportunity is closing, and domestic development policies are becoming more and more dependent on consumer and inter-sectoral demands for growth (Ovadia & Wolf, 2018; Wade, 2016). Spelt out in a series of annual Industrial Policy Action Plans (IPAP), South Africa's industrial policy has been in place for over a decade. Instruments have been chosen to support the manufacturing sector in general and certain sectors have been prioritized and receive additional support (Kaplan, 2019; Lin, 2017). South Africa's current manufacturing output is still below that of the 2008 level while in contrast, other emerging markets have increased their overall manufacturing output by some 50 per cent. South African manufacturing output growth has consistently been below the output growth in the rest of the economy (Bam & De Bruyne, 2019; Kaplan, 2019). In sharp contrast to the IPAP and government's strategies which envisaged a growing share of manufacturing, manufacturing as a share of the GDP has fallen from 16 per cent to below 12 per cent (IPAP, 2018; Kaplan, 2019). While other emerging markets have also seen a decline in manufacturing as a share of their GDP, the decline has been far more severe in South Africa (DTI , 2018, p. 22).

South Africa's industrial policy is to sustain and generate jobs, promote economic growth, and attract foreign direct investment (Sutherland, 2020). The 4IR, however, runs the risk of eliminating jobs through automation, mass customization, and robotization while perhaps bringing manufacturing closer to consumers and using more recycled materials (Harvey, 2019; Sutherland, 2020). A study by Andreoni and Tregenna (2020) that used a comparative case study approach and drew on both primary and secondary sources, analyzed the industrial policies of China, Brazil, and South Africa. They focused on three key areas of policy intervention: investment in physical infrastructure, investment in human capital, and targeted support for industries. The authors found that all three countries have used industrial policies to support their economic growth, but in different ways (Andreoni & Tregenna, 2020). China has focused on investment in physical infrastructure and targeted support for key industries, such as electronics and machinery. Brazil has emphasized investment in human capital and targeted support for industries such as aerospace and oil and gas. South Africa has used a mix of all three policy areas, with a focus on supporting

industries such as automotive and agro processing. The main finding was that successful industrial policies require a combination of different policy interventions, tailored to the specific needs of each country. There is no one-size-fits-all approach to industrial policy, and policymakers should consider their country's unique circumstances when designing and implementing industrial policies.

Similar studies that looked at emerging issues for industrial policy in South Africa argue that policies that nurture capability building, learning and technological progress within industries have been very limited. There has been a general lack of adequate finance (commercial and development finance) and existing incentives have not succeeded in promoting higher levels of investment (Bell et al., 2018; Bell, Goga & Robb, 2021). While in countries like Brazil, development finance has played a crucial role in supporting industrial development, the operating model of South Africa's Industrial Development Corporation (IDC) has limited the provision of concessional finance, with the result that it has underperformed in its contribution to structural transformation (Goga, Bosiu & Bell 2019).

South Africa's innovation and technological capabilities are relatively underdeveloped, with local investment, knowledge production and exports in R&D and technology lagging behind other middle-income countries whose trajectories suggest a more successful global value chain (GVC) integration and structural transformation prospects (Andreoni & Tregenna, 2021). Improving this performance will naturally hinge on raising more public and private resources for investment in the country's innovation and technological capabilities. South Africa has lagged behind a number of other middle-income countries in its translation of GVC participation into broader developmental outcomes over the past three decades (Goga & Bosiu, 2019; Goga & Mondliwa, 2021). If the country is to capture a greater share of value from its linkages with the global economy, avoid the pitfalls associated with GVC integration, and diversify the limited productive capabilities upon which it currently relies, industrial policy must play a more central role in economic strategy and governance (Andreoni & Tregenna, 2021).

Although finance for start-ups and the development of technological hubs have advanced, these developments have not yet had a substantial economic impact (Giuliani, 2018). The automation of

work and probable job losses are the key problems with the 4IR. Twenty-five categories of labour were used to categorize anticipated changes, and it was predicted that the demand for basic and particularly advanced technology abilities would rise (Mindell & Reynolds, 2022; Sutherland, 2020). The demand for workers with fundamental cognitive abilities, such as those who can input and analyse basic data, is predicted to shrink by 15 per cent, of the total hours worked (Almeida, Santos & Monteiro 2020, Mckinsey, 2018; Sutherland 2020). Despite a 15 per cent reduction in total hours worked, the demand for physical and manual abilities, including general equipment operation, will still be the highest category of worker talents in many countries in 2030 (Mckinsey, 2018; Roberts et al., 2021; Sutherland, 2020). Developing nations may now view their abundance of low-skilled labour as a liability rather than an advantage since industrialized countries want to bring production closer to their customers through mass customization and advanced manufacturing (Sutherland, 2020).

When discussing industrial policies, it is important to note that the growth in the use of digital technologies and digital platforms adds a new layer of complexity to industrial policy design. It is important to consider cybersecurity governance and policy, which is discussed in the following sub-section.

4.5.2.1 Cybersecurity governance and the fourth industrial revolution

According to Elmi and Davids (2018), if humanity is on the brink of a new evolutionary era, it is crucial that new government models be implemented. The authors argue that the need for new government models emphasizes the fact that the responsibility for governance goes beyond the public sector and should incorporate multi-stakeholder engagement. In the context of the fourth industrial revolution, it is important for governments to safeguard citizens against the negative and disruptive effects of emerging technologies, but still provide support for the private sector (van Vuuren and van Vuuren, 2022). However, governments have often been criticized for their slow response to secure information across large bureaucracies and address information breaches when they occur. With the magnitude of the 4IR, it is inevitable that gaps and opportunities in both public and private sector governance will arise. This includes enhancing the capacity of existing governance structures and adapting to new technologies. As the electronic environment evolves, policymakers must assume entirely new roles to ensure safety when testing new ICT creations.

The World Economic Forum (WEF) has launched a global initiative called Agile Governance to promote the concept of public-private cooperation to deal with the 4IR. This initiative aims to reimagine policymaking for the fourth industrial revolution (4IR). According to the WEF, Agile Governance refers to adaptive, human-centred, inclusive, and sustainable policymaking, which recognizes that policy development is no longer limited to governments alone but rather involves multiple stakeholders. Agile Governance requires governments to respond quickly, which means that policymakers and policy shapers must work proactively with businesses and civil society to anticipate innovations instead of merely reacting to them. The WEF report authors express their hope that the initiative will create frameworks and policies that support the emergence of new technologies (Elmi & Davids, 2018).

The agile approach is essential for cyber security as it involves policies and standards that require compliance from the perspective of software engineering and application security. Jenn Henley, the Director of Security for Facebook, has highlighted that this approach is also a contributing factor to the skills shortage (Ricci & Gulick, 2017). Despite the approval of the National Cyber Security Policy (NCPF) in 2012, few of the regulatory frameworks are currently fully operational in South Africa. The country is thus still in its infancy phase regarding legislation and governance. The POPI Act of 2013 and the Regulation Relating to the Personal Information Act, which was implemented in 2018, are the only two pieces of legislation currently operational (van Vuuren & van Vuuren, 2022).

The South African government must adopt a more agile approach in order to prepare for the fourth industrial revolution era. The current approach whereby laws take up to three years to be completed and introduced is not good enough. An example of this is the National Cyber Security Framework and Cybercrime Law, which is still in a draft phase. The process needs to be adjusted to comply with the requirements of new technologies (Kempen, 2019). One approach that could be used is "The Agile Governance Approach" of the World Economic Forum once it has been adapted to suit the global south context. Elmi and Davids (2018) explain that this initiative aims to reduce the time lag experienced by policymakers who are usually forced to react to new technologies rather than anticipate innovations by working alongside businesses and civil society. By using this

approach, frameworks and policies can be developed more quickly to support the emergence of new technologies.

The South African citizen is increasingly dependent on data, a trend that will skyrocket in the 4IR. This dependence encompasses not only society's physical data but also its relationship with specific infrastructures such as cloud computing and the Internet of Things (IoT) (van Vuuren & van Vuuren, 2022). There are different actors in the cyber security arena: protectors, the protected, and/or criminals. The digital component of everyday actions are growing in the 4IR era, making it crucial to prioritize proactive measures over reactive ones (Signé, 2023). Accordingly, the multiplicity and automation of cyber security in the 4IR are vital to maximize outputs and minimize human error. The Draft Cybercrimes Bill (Department of Justice and Constitutional Development, 2018) covers some of these measures, which aim to safeguard critical information for South Africa.

It is essential to promote compliance with appropriate technical and operational national and international cyber security standards. Van Vuuren (2016) argues that defining the standards for conduct in cyberspace and legal adherence to these standards are critical elements of a safe society. South Africa is slow in implementing these standards, as shown by previously discussed metrics. Thus, it is crucial for the South African government to develop the guidelines for the metrics to measure cyber the security readiness in the public and private sectors (Nordhaus, 2017). Industry and government can use metrics such as the National Cyber Security Index (NCSI) to calculate the cyber security readiness in their sectors. The index can be used to highlight shortcomings to CEOs and managers and guide the government in its development and implementation of new policies and terms of cyber security (Ndung'u & Signé, 2020).

Capacity building on national and international levels involves not only skills development but also the creation of organizational structures and use of technical and procedural cyber security solutions. Structures like the Cyber Security Hub, managed by the Department of Communications and Digital Technologies, play a crucial role in creating cyber security awareness programs and culture to prepare citizens for the 4IR (Parliamentary Monitoring Group, 2018; Signé, 2023). The African Union Convention on Cyber Security and Personal Data Protection encourages cyber

awareness programs among Internet users in the workplace, schools, and even amongst the elderly, who are often the most vulnerable targets for cyber exploitation (African Union, 2014; OECD, 2018). South Africa must accelerate the role of these awareness programs and start a culture of cyber security among its citizens.

Although I did not explore the perceptions of cybersecurity risks in my study, it is important for a study on industrialization to review the literature on cybersecurity in the context of the fourth industrial revolution. Researchers can gain insights into the various challenges, risks, and opportunities associated with this new era of technological advancement by doing so. This can help inform policymakers, industry leaders, and the public on the necessary measures to be taken to mitigate cybersecurity risks and to ensure a safe and secure transition to the fourth industrial revolution.

4.5.3 Public attitudes towards the fourth industrial revolution: South Africa

Citizens in a modern democratic society must have enough access to trustworthy information to form informed opinions regarding important societal developments. People's resistance to scientific and technical improvements tends to be attributed to the lack of comprehension of these developments (Roberts et al., 2021). This concept of the Knowledge Deficit Model is best encapsulated by the proverb, "[t]o know science is to love it" (see Roberts et al., 2021). Acceptance and use of scientific findings have been reported as necessary to face the challenges that are attributable to inadequacies of science and/or society's inadequate scientific literacy and attitude toward science (Opesade & Tiamiyu, 2022). Studies that explored scientific knowledge and public attitudes in South Africa found that a significant majority of the population lacked even a basic comprehension of several examples of 4IR technology, such as biotechnology, robotics, 3D printing, and driverless cars (Gastrow et al., 2018; Roberts et al., 2021). The fact that fourth industrial technologies like robotics and driverless cars are not common in South Africa explains the lack of knowledge regarding these technologies, according to Struwig and Roberts (2012).

The 4IR has had a significant impact on human labour in South Africa to date, with the banking sector being one of the first and most notable examples. Standard Bank's announcement in March

2019 that it would close 91 facilities nationwide, and its subsequent increase of this number to 104 by June resulted in the loss of 1200 jobs. Various studies were conducted to look at job security in the banking sector (Makamase, n.d.; Somrit & Leurcharusmee, 2019; SovTech 2019). The study by Hlongwane (2022) explored the experiences and views of bank workers regarding the digitalization of their service labour in the South African banking sector. Hlongwane used qualitative methods (virtual interviews) and found that the traditional labour processes of the bank tellers were being impacted (2022). The bank tellers who were participants of the study expressed that digitalization of the banking process has led to job insecurity and has led them to reskill and consider leaving their teller roles. A similar study by Masheleni (2022) also looked at fourth industrial banking. Masheleni (2022) also used a qualitative method and focused on two case studies of South African banks (Tyme Bank and Standard bank). The study premised on foreseeing the impacts of the 4IR in the banking sector and found that the banking sector is at a crossroads: It is trying to stay afloat and keep abreast of the current technological developments. Business and neo-liberal interests emerged as significant motivators of digitalization in this sector (Masheleni, 2022).

In recent years, there has been a focus on studying national attitudes towards the fourth industrial revolution (4IR) in South Africa. However, many of these studies have concentrated on the uptake of technology in specific fields, such as education (Govender, 2012; Maisiri, 2020; Oke & Fernandes, 2020), or on the perceived impact of 4IR technologies on workplaces (Mhaka, 2020; Mille, 2019). As a result, most of the research on 4IR has focused on its effects, rather than on public perceptions, opinions, and attitudes towards it. While some recent studies have examined public opinion on 4IR in the South African context, many of these studies are not generalizable due to their qualitative research methods (Morathi, 2020). Other studies that are quantitative in nature are limited in scope, as they are district-bound and cannot be extrapolated to represent the entire country (Lekhanya, 2019). Consequently, there is still a lack of quantitative information on public perceptions towards the 4IR in South Africa. This is mainly because most of the surveys have not employed a nationally representative sample. My study will do so.

There is some evidence that age decreases a person's attraction to technology, however, studies on the subject have produced conflicting findings (Chua, Chen & Wong, 1999). Most of the research

on technology attitudes done in South Africa (for instance, by Anthony, Clarke & Anderson, 2000) is based on samples not considered as representative on a national level, making it challenging to extrapolate the conclusions to the entire country. Cross-sectional public opinion figures suggest that popular perceptions of robotics and automation in Europe changed between 2012 and 2017 and become increasingly unfavourable. This appears to mostly have been driven by shifting perspectives on their usage in the workplace, and countries that were formerly robot-optimistic turned wary (Roberts et al., 2021). This suggests that when the issue gains greater attention in the media and public conversation, people's concerns grow. In contrast to this study, which was primarily focused on robotics in the context of South Africa, Aydin (2019) conducted a study that examined public acceptance of the use of drones for both personal and commercial purposes.

Similar studies carried out in South Africa include the one by Lekhanya (2019), who used quantitative methods to establish the public's perception of the readiness of the country for the 4IR in terms of skills and infrastructure. The study found that there is a general lack of awareness and understanding of 4IR and its potential impact. The study also found that there is a need for increased education and training on 4IR technologies and their applications (Lekhanya, 2019). The study highlighted the importance of government support and investment in 4IR initiatives to drive economic growth and development in South Africa. Although the findings are valuable to the fourth industrial revolution discussion in South Africa, the study was confined to participants based in KwaZulu-Natal province and the findings cannot be generalised to the populace of South Africa. Morathi (2020) did a qualitative study in South Africa to find out millennials' perceptions of the 4IR in an information technology (IT) company, and it showed that IT skills were the dominant factor shaping their attitudes.

Studies have been conducted on the social impact of the fourth industrial revolution in South Africa. The study by Van Rensburg, Telukdarie and Dhamija (2019) was transformative in its design as it was a collaboration of academics, local partners, and commercial partners who collaborated to develop a research methodology and digital tools which enabled geographic information systems (GIS) survey data collection over large geographical areas, at scale. This type of data collection relies on rigorous data quality controls. The study provided various opportunities to local young people in the digital gig-economy through data collection and digital networking.

The major perspective of the study was to study the aspect of technology and the way it empowers young people on the African continent. Another study by Aruleba and Jere (2022) investigated the digital transformation challenges encountered in rural communities within South Africa. The study was a systematic review of empirical studies and the main problem hampering the growth of ICT in the rural areas in South Africa is affordability. Another is that the infrastructure for Internet connectivity is sometimes not made available in rural areas. The COVID-19 pandemic has shown just how important ICT and technology are for Africa. Overall, while there is a growing body of research on public attitudes towards the 4IR in South Africa, more studies are needed to fully understand how South Africans are preparing for and responding to this technological shift, hence this current study.

4.6 Chapter Summary

This chapter discussed the changes that followed the inventions from the first to the third industrial revolutions to gauge the changes that affected and benefitted African societies. Based on the trajectory of the past three IRs and using inferential judgements, one can safely say that Africa will once again be at the receiving end of the current IR. Laws will be shaped according to the desires of those with the power to influence their drafting, implementation, and maintenance. The countries of Europe and North America, by virtue of being leaders in ICT, nanotechnology, biotechnology, and the design and implementation of the 4IR, will never relinquish the advantages that their position gives them in the international arena. After all, they got their privileged position through blood and war and for now it is only war that can topple them from their dominant position. What cannot be doubted is that Africa will undergo another transition, albeit a reactionary one intended to minimize the challenges of the 4IR. However, the 4IR is a seductive banner around which to create an aristocratic and neoliberal vision of the future of business in a perplexing and disturbing context. It can be used to challenge CEOs and politicians to create plans for a Schumpeterian future under the presumption that current political and business systems are quickly being consigned to history's rubbish bin. This literature review has highlighted the significant impact that the fourth industrial revolution (4IR) has had on Africa, with a particular focus on South Africa. While many challenges remain, 4IR technologies have the potential to transform African economies, drive innovation and increase productivity. The review has explored the key factors driving the adoption of 4IR technologies in South Africa, including government policy,

investment in research and development, and the emergence of tech hubs and start-ups. It has also examined the challenges faced by South Africa, such as the digital divide, skills shortages, and inadequate infrastructure.

Despite these challenges, there are promising signs that South Africa is making progress in its 4IR journey. Initiatives such as the Presidential Commission on the 4IR and the establishment of the South African Artificial Intelligence Society demonstrate a commitment to embracing new technologies and ensuring that the benefits of 4IR are shared widely. In conclusion, 4IR technologies have the potential to drive significant economic growth and social development in South Africa and across the African continent. However, realizing this potential will require continued investment in education and infrastructure, as well as the creation of an enabling policy environment that supports innovation and entrepreneurship. In the next chapter I will discuss thethe theoeretical framework underpinning the study.

CHAPTER FIVE: THEORETICAL FRAMEWORK

5.1 Introduction

The previous chapter addressed the literature on socio-economic effects of the fourth industrial on African countries. Building on this foundation, this chapter delves into the conceptual background of technology, offering an overview of existing theories on adoption and acceptance. It examines the interaction between technology and society by discussing technology appropriation and the categorization of techno-optimists and techno-skeptics. The chapter concludes with a discussion on the hypothesized integrated model for technology adoption in relation to the 4IR in South Africa and a summary of the key discussions.

The "technology acceptance model" (TAM) and its various forms are commonly used to explain technology adoption. While these various models have been used to explain technology adoption, a comprehensive framework that incorporates the context of implementation and social expectations and experiences is still needed. Multiple studies have focused on users' behavioural patterns and technology qualities to understand technology adoption patterns and behaviour (Kesharwani, 2020; Moore & Benbasat, 1991; Oke, Walumba, Yan, Idiagbon-Oke & Ojode, 2014; Shareef, Baabdullah, Dutta, Kumar & Dwivedi, 2018). Attitudes, social variables, and behavioural factors have been suggested to explain technology adoption patterns (Ajzen, 2020; Fishbein & Ajzen, 1975). However, the adoption rate of specific technologies may vary depending on the environmental and economic factors unique to the environment. Previous work on this topic has mainly focused on understanding the adoption and distribution patterns of new technology in industrialized countries (Irwin & Paul, 2003; Oke et al., 2014). However, in developing nations, where automation and robots may affect people's socio-economic conditions, socio-economic status and other sociological indices play a crucial role in the attitudes towards technology adoption (Takahashi, Muraoka & Otsuka, 2020).

Technology academics took the notion that the development of technology might in some way be an uncontrollable phenomenon that seriously alters the course of history (Galati & Bigliardi, 2019; Winner, 1980). These scholars felt that technology grew autonomously in accordance with an

underlying technical logic and fundamentally altered society in ways that no one had intended. Some sociologists and technology historians have since mocked this perspective as "technological determinism". Typically, these academics favour constructivist approaches to technology study, emphasizing human agency, historical and social context, interpretive flexibility, and contingency while utilizing a descriptive narrative (Williams & Edge, 1996). Constructivist studies have been particularly successful in challenging technological determinism and generally offering a comprehensive framework for the investigation of how society shapes technology.

The subsequent sections of this chapter aim to explore existing theoretical frameworks categorized as technology adoption models. Additionally, we will delve into perspectives on technology, namely techno-optimism and techno-scepticism, to better understand the intricate interaction between technology and society. In line with the scholarship on constructive methods for studying technology, a proposed model will be introduced, influenced by the social shaping of technology (SST) theory. This model facilitates a comprehensive investigation into users, technologies, and their situational characteristics, offering a nuanced understanding of technology adoption within the specific social context of South Africa.

As we navigate these theories, it becomes apparent that the introduction of the 4IR extends beyond the scope provided by traditional adoption models. A shift in societal paradigms, labour markets, and business dynamics necessitates the consideration of technology appropriation in the discourse on adoption models. This work recognizes that technology adoption is not solely determined by the capabilities of technology but is profoundly influenced by its societal implications, impacting the attitudes people hold and, consequently, the usage of the technology.

In contrast to existing models, our proposed analysis is contextualized within a specific social setting where technological advancements unfold. This inward processing, focusing on South Africa as the chosen social context, forms the basis for analyzing attitudes towards the transformative technical changes brought about by the 4IR.

5.2 A Conceptual Background of Technology

Finding a suitable definition of the word ‘technology’ is a difficult task when researching people's views towards it. As dominant ideas on technology and science shift over time, this could result in different interpretations of the term ‘technology’ (Allum et al., 2014; Lim, 2020). Technology has multiple contradictory meanings and in popular discourse is defined as “all the many ways things are in fact done” (Allum et al., 2014). Other scholars define technology strictly as the application of science, frequently citing innovations like the transistor and the atomic bomb that drew upon earlier scientific discoveries extensively (Schatzberg, 2018). Technology historians have criticized this notion for decades, contending that science is only one component of technology. On the other hand, technology is frequently perceived by cultural critics and philosophers as an oppressive system of ultimate control that transforms means into ends and seeks merely to continue existing what Lewis Mumford dubbed the “megamachine” (Mumford, 1966). However, because the study's focus is on the social effects of technology, it is imperative to consider technology from a social standpoint.

Carl Mitcham defines “technology as the making and utilizing of artefacts, which he asserts is a mostly unreflective activity because most encounters with technology”, whether in high- or low-technology society, are habitual (Mitcham, 1994, p. 24). In his highly renowned book, *Diffusion of Innovations,* Rogers (2003, p.13) offers a more consequentialist definition of technology: "A technology is a design for instrumental action that minimizes the cause-effect links involved in reaching a desired objective". He advises breaking technology down into two components: the "hardware aspect", which is the actual tool itself, and the "software aspect", which is the body of information used to operate the tool. The focus on how we utilize technology on a regular and deliberate basis is shared by these two definitions of technology. Although these insights were helpful in creating the foundation for this study, attempts to map attitudes can be hampered by broad definitions of technology (Ehlers & Kerschner, 2013). Technology is prevalent in nearly every aspect of human (or even animal) life and behaviour when applied extensively enough, including in linguistic and cultural practices.

There is nothing inherent or fixed about technology, the vast bulk of discussions centre on the creation and adoption of technology. Technology invention is often assumed to take place before innovation and spread due to the fact that entirely original artifacts are created. The process of

making technology usable is referred to as technological innovation. The idea that technology and entrepreneurial innovation are important in capitalist economies is largely attributed to Joseph Schumpeter's work in 1952. Although technological advancement is primarily a phrase for larger-scale technological development with a progress-related meaning, innovation is tied to it. Economic change is typically viewed as being driven primarily by both concepts. Prior to the 20th century, especially globally, technological development was slower and less prevalent than it is today (Cameron & Neal, 2003).

Historical evidence suggests that technology existed in medieval and biblical times, but the resources available to an economy controlled the extent to which it could attain economic success (Cameron & Neal, 2003). Technology is supposed to expand such limitations by finding more resources and utilizing them more effectively, enabling economies to support more people with higher standards of living (Kerschner, 2013). Other contrasting viewpoints on technology are provided in the following sections on ideas for technology adoption.

5.3 Review of Existing Theoretical Frameworks for Technology Adoption

The process of technological innovation or development, as well as a person's choice to adopt or reject a technology, involves several temporal steps, including learning about the technology for the first time. However, the suitability of the technology for the user typically determines whether one develops a positive or negative attitude about utilizing the technology (Rogers, 1983). The elements that have been proposed to affect people's adoption decisions on a personal level include relative benefit, compatibility, and complexity, according to several academics in the field of technology adoption and diffusion (Oke et al., 2014). According to Oke et al. (2014), relative benefit, compatibility, and complexity are the best indicators of someone's propensity to use a new technology. Many studies have been conducted to examine the factors that influence technology adoption at the organizational level, such as those by Autry, Grawe, Daugherty and Richey (2010); Heine and Grover (2001); and Oke et al. (2014). According to several of these studies, a firm's decision to adopt new technology may be significantly influenced by the cost of the technology (Autry et al., 2010; Morgan & Daniels, 2001). Figure 5.1 depicts the acceptance models that will be reviewed briefly in this section.

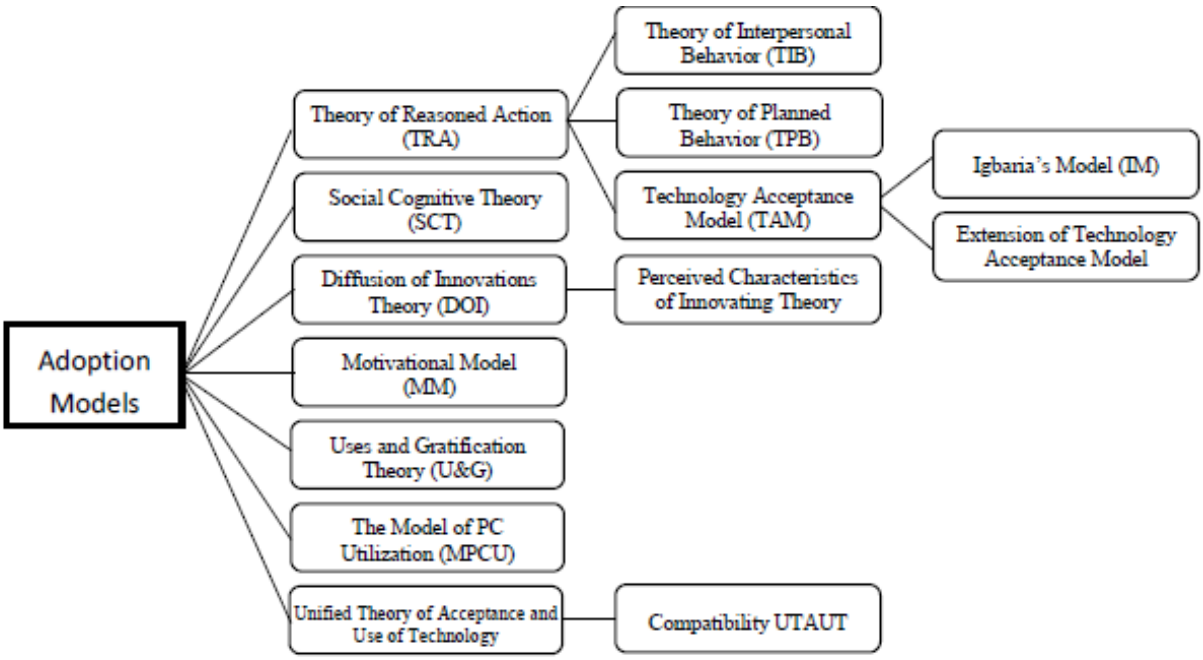


Figure 5.1: An overview of adoption/acceptance models
Source: Taherdoost (2018)

5.3.1 Theory of reasoned action

The initial adoption of innovations has been studied using models that focus on the intentions behind adoption decisions. These models, such as those proposed by Straub (2009), look at the factors that determine behavioural intentions to understand the adoption decisions (Davis, 1989; Davis, Bagozzi & Warshaw, 1989; Hartwick & Barki, 1994; Mathieson, 1991). Three commonly used models in the study of technology adoption, particularly in relation to IT, are the Technology Acceptance Model (TAM) (Davis, 1989), the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975), and the Theory of Planned Behaviour (TPB) (Ajzen, 1991) (Kuo, Roldan-Bau & Lowinger, 2015; Lowinger, 2015). The TRA is a popular model and it has been used to forecast and explain human behaviour in a variety of disciplines. Fishbein and Ajzen came up with the idea for this theory in 1975 and started working on it. The focus of the TRA is on arbitrary standards and perceptions of behaviour as factors in technology adoption (Fishbein & Ajzen, 1975). This theory was developed using research from social psychology, persuasion models, and attitude theories because its strength is in understanding how attitudes and behaviours interact in human actions.

Fishbein and Ajzen created the TRA with the aim of studying health behaviours, however, they stated that it could be used in any situation to comprehend and even anticipate any human behaviour (Fishbein & Ajzen, 1975). Any voluntary act must be performed "unless intent changes prior to performance or unless the intention measure does not correlate to the behavioural criterion in terms of action, target, context, time-frame, and/or specificity" (Sheppard, Hartwick & Warshaw, 1988, p. 26).

Sheppard et al. (1988) demonstrated the versatility of the Theory of Reasoned Action (TRA) by applying it in situations where it deviated from Fishbein and Ajzen's original method. They reviewed 87 previous studies and found that the theory could be applied even when subjects had limited control over their behaviour or access to information needed to express their intentions (Pinder, 2008). This study revealed that the TRA could be implemented effectively even when the three characteristics and conditions defined by the theory were not fully met.

The TRA has many applications, but it still has drawbacks and, like other theories, requires constant revision and development, particularly when it is applied to goals. The ability to carry out one's intention, which depends on several conditions and is consequently uncertain, is the difference between a goal intention and a behaviour intention (Ajzen, 1985; Sheppard et al., 1988). Some acts are more likely to cause difficulties of controls than others, according to Ajzen, who also stated that "we may never be entirely positive that we will be able to carry out our goals" (Azjen, 1985, as cited in Eagly & Chaiken, 1993, p. 350). It is obvious in this situation that any desire is, technically speaking, an uncertain aim (Ajzen, 1985; Sheppard et al., 1988). This theory is not suitable for this study as its focus is more on examination of the kinds of behaviour (communicative, consumer, and health) and intention takes the central role in the theory. The TRA is not applicable in all contexts, and the factors that influence behaviour may vary across different populations or cultures. South Africa has a unique history and culture that may affect the factors that influence technology adoption, making the TRA less relevant in this context. Additionally, the TRA provides a limited explanation of human behaviour, and it may not capture all the complex factors that influence technology adoption. For example, factors such as access to resources, the level of technological infrastructure, and the political climate may play a more significant role in shaping public perceptions of technology adoption in South Africa.

5.3.2 Theory of Planned Behaviour

Ajzen developed the Theory of Planned Behavior (TPB) in 1991 after considering the limitations of the TRA and following the understanding that many human behaviours can be hindered. It builds upon the Theory of Reasoned Action (TRA) by incorporating a third element, perceived behavioural control (PBC), in addition to attitudes and subjective norms. PBC is defined as an individual's perception of how easy or difficult it would be to perform a behaviour (De la Piedra, Berbel-Pineda & Palacios-Florencio, 2022; Oke et al., 2014; Taherdoost, Namayandeh & Jalaliyoon, 2011; White et al., 2015). The TRA model now includes the PBC variable as a new variable. Resources, opportunities, and talent availability, as well as how crucial these are perceived to be in reaching goals, are the main factors influencing the PBC in this model (Lee & Baskerville, 2003). The TPB uses the PBC for a person's behaviours that are not of their own free will, even though the TRA and TPB both assume that a person's behavioural intention impacts their behaviour (Taherdoost & Masrom, 2009).

By incorporating PBC, it is feasible to create realistic restrictions as well as a self-efficacy sort of component (Benbasat & Zmud, 2003; Merton, 1968). Furthermore, PBC influences actual behaviour both directly and indirectly through behavioural goals. As a result, the three main components of the TPB model that influence behavioural intention are the PBC, the subjective norm, and the behavioural attitude (Taherdoost, Sahibuddin & Jalaliyoon, 2012). The TPB model has two key limitations, however, according to Weber (2003, p. 11): “First, attitudes towards IT will not have much impact if a computer system is not accessible; second, the revised TPB may be considered a more relevant theoretical framework”. This is affected by whether or not people decide to use IT in the workplace voluntarily (Taherdoost, Sahibuddin & Jalaliyoon, 2011). I reject the use of this theory as South Africa is a country with complex social and economic factors that can influence technology adoption significantly. Factors such as income, education, employment, and access to resources may play a significant role in shaping public perceptions of technology adoption. These factors may not be captured adequately by the TPB framework as it was developed in Western cultures and may not fully capture the cultural nuances of a non-Western context like South Africa. It is possible that attitudes, norms, and perceived behavioural control may have different meanings in the different contexts.

5.3.3 Theory of Interpersonal Behaviour

The Theory of Interpersonal Behaviour (TIB) model discusses how social and emotional factors influence how complicated human behaviour is. This model therefore includes all of the TRA and TPB's components as well as additional practices, facilitating factors, and impacts to enhance its ability to forecast results (Chang & Cheung, 2001). Roles, norms, and self-image are included in the idea of social variables, which is similar to the TRA's subjective norms construct (Oliver, 1977; Seddon & Scheepers, 2006). The TIB maintains that the human is not totally mechanized, fully deliberate, fully autonomous, or purely social. In contrast to the TIB, which strives to account for as much variance as possible, the TRA aims to account for as much variance as is practically achievable. This is due to whether the behaviour in question is significant, as even a small degree of variation may be socially relevant (Misbah, Gulikers, Maulana & Mulder, 2015).

This model holds that the key influences on how intentions are formed are emotions, social variables (such as the subjective norms in the TRA), and habits. The TIB employs three stages to protect the behaviour. Personal characteristics and earlier experiences mould the ideas, attitudes, and social components that are connected to first-level behaviour. The second level examines how individual normative ideas, social context, and cognitive processes influence intentions to engage in particular behaviours. At the third level, behavioural intentions, environmental conditions, and prior experience all work together to predict the likelihood of engaging in a specific behaviour (Bandura, 1977). The TIB's main shortcomings in comparison to the TRA and TPB are its complexity and a lack of parsimony. The operational specification of the model's variables must also be provided by the researcher because the TIB does not give an easy way to do so. The TIB focuses primarily on the influence of interpersonal relationships on behaviour. While interpersonal relationships can be an important factor in technology adoption, my research considers other social, economic, and political factors which may play a more significant role in shaping public perceptions of technology adoption in South Africa.

5.3.4 Igbaria’s Model

Igbaria's approach suggests that both internal and extrinsic motivations have an impact on people's decisions to adopt or reject new technology (Carvalho, 2000). Perceived pleasure is an extrinsic incentive in this model, while perceived utility is an intrinsic motivator that affects behaviour (such as computer use) and attitude (computer satisfaction). In addition to these, perceived utility, computer fear, computer satisfaction, and perceived pleasure all have an impact on user acceptance (actual behaviour) (Igbaria, Schiffman & Wieckowski, 1994). Perceived enjoyment and usefulness have an impact on adoption, both directly and indirectly (through satisfaction). Additionally, perceived utility influences perceived fun. Perceived fun and reported usefulness are also negatively impacted by computer fear. It has also been demonstrated that user pleasure with the computer directly affects utilisation.

These theories are not suitable for my research as they aim to comprehend behavioural intentions, while my study aims to examine attitudes towards technology and asserts that technologies are not neutral and are instead used by organizations to maintain or change social interactions. This theory places a significant emphasis on perceived utility and computer satisfaction, and I argue that the way in which technology impacts individuals in different social contexts shapes their attitude towards technology.

5.3.5 Social Cognitive Theory

Social Cognitive Theory (SCT), which was developed by Albert Bandura in the 1970s, expands upon the Social Learning Theory as it includes cognitive and motivational factors that play a role in shaping behaviour. This is based on three types of components (behaviour, personal, and the environment), and it was proposed to anticipate both group and individual behaviour (Bandura, 2004; Chatterjee & Acharya, 2021). Additionally, it can pinpoint strategies to alter and modify behaviour (Alter, 2008). The SCT model's behaviour component primarily addresses issues with adoption, performance, and usage. A person's personality, cognitive abilities, or demography are all considered to be personal elements. Environmental influences encompass both social and physical elements that are external to the person. The three components of SCT are an interconnected triadic structure that constantly impact and determine one another (Rana & Dwivedi, 2015). Self-efficacy, performance outcome expectations, anxiety, affect, and personal

outcome expectations are just a few of the traits that the SCT model uses when it is used to evaluate the usage of IT (Alter 2008; Rana & Dwivedi, 2015). In the context of technology adoption, the SCT can help researchers understand how individuals' perceptions of technology are influenced by their personal experiences, social networks, and exposure to media and other information sources. For example, the SCT can be used to examine how people's attitudes towards 4IR technologies are shaped by their interactions with others who have adopted these technologies. This theory will not be used, given that this study does not test how social networks and exposure to media and other information sources impact people's perception towards the fourth industrial revolution.

5.3.6 Diffusion of Innovations Theory (DOI)

The DOI model analyses different types of innovations by identifying four factors that affect the diffusion of a new concept: timing, social systems, innovation characteristics, and communication channels. In addition to being employed at both the organizational and personal levels, the DOI model also provides a theoretical framework for adoption on a global scale. The DOI model combines three key elements: the innovation decision process, adopter characteristics, and features of an innovation (Sila, 2015). Confirmation, knowledge, implementation, choice, and persuasion - the five steps of the innovation decision - have been carried out throughout time via a variety of routes for communication among the participants in a networked social organization. Any innovation's acceptance has been suggested to be influenced by five important factors: relative advantage, compatibility, complexity, trialability, and observability (Benbasat & Barki, 2007; Sila, 2015). Four groups are identified in the step of adopter characteristics: innovators, laggards, late majority, and early majority (Benbasat & Barki, 2007). In comparison to other adoption models, the DOI model has less explanatory power and is less helpful for outcome prediction since it puts more emphasis on system attributes, organizational characteristics, and environmental factors. The theory is not applicable to the analysis of this study due to its limitations: The theory is limited to the adoption of new technology and does not take into account other factors that may impact adoption, such as social or economic factors. In the case of the fourth industrial revolution, factors such as access to education and employment opportunities may also influence perceptions and adoption.

The second reason is the lack of consideration for contextual factors; the theory assumes that the diffusion process is universal and the same across all contexts. However, in the case of the fourth industrial revolution in South Africa, contextual factors such as infrastructure, government policies, and economic conditions may play a significant role in shaping perceptions and technology adoption.

5.3.7 Unified Theory of Acceptance and Use of Technology (UTAUT)

Taheerdoost (2018); and Venkatesh, Morris and Dubin (1978) compared eight models with origins in sociology, psychology, and communications that were previously used in the context of information systems. Examples of these models include the TAM, TRA, TPB, the integrated TAM and TPB, the Model of Personal Computer (PC) Usage, the DOI model, the Motivational model, and the SCT. They listed four requirements in the Unified Theory of Acceptance and Use of Technology (UTAUT) as necessary for information systems to be accepted. The UTAUT was developed by modifying the fourteen basic designs of the eight acceptance theories (Dubin, 1978). The main constructs include the social impact, effort and performance expectations, and an enabling environment (Jacob & Pattusamy, 2020). Furthermore, it was found that experience, age, and voluntary use all have significant moderating effects.

The compatibility beliefs created by Komiak and Benbasat (2006) were incorporated into the UTAUT model by Bhattacherjee and Sanford (2006); and Bouten (2008) to improve the model's ability to explain. The UTAUT model also explores and tests additional boundary conditions in an effort to provide a fuller explanation of how the cognitive events of this model are generated (Bhattacherjee & Sanford, 2006). Measuring actual usage behaviour was not necessary because in Bhattacherjee & Sanford (2006) study since the goal was to analyze the connections between compatibility assumptions and behavioural views. The possible drawback of retrospective analysis was also avoided because the research was cross-sectional as it emphasized behavioural intention rather than use behaviour. It was impossible to reproduce the precise relationships between experience and education that Venkatesh, Morris, Gordon & Davis (2003) suggested because the research was cross-sectional and only looked at one period. My research will not use this theory because of the lack of focus on perceptions: The UTAUT theory focuses more on the user's

intention to use technology, rather than their perceptions of it. Understanding how individuals perceive technology is critical for the development of effective policies and strategies in a study on perceptions of the fourth industrial revolution in South Africa.

5.3.8 Technology Acceptance Model

The Theory of Reasoned Action (TRA) model was expanded upon by the development of the Technology Adoption Model (TAM). The TAM describes how customers are encouraged to adopt new technologies using three factors: perceived ease of use, perceived benefit, and attitude towards usage. This is since the theoretical and psychometric state of the TRA model is uncertain (Pitt, Watson & Kavan, 1995). The TAM also incorporates perceived utility and ease of use in addition to behavioural intention because these have a substantial impact on user attitude. These fall into two categories: system characteristics that are both good and bad. The TAM may on occasion consider additional elements known as external variables, such as user training, system features, user involvement in the design process, and the implementation procedure (Benbasat & Weber, 1996). The Technology Adoption Model is one of the most often used models in the field of technological acceptance (Orlikowski & Lacono, 2001).

It has received a lot of empirical support over the last few decades, but the TAM has limits in terms of its ability to be applied outside of the workplace, because it overlooks the social influences on technology adoption. The TAM also needs to consider a number of outside factors in order to create more precise forecasts of system usage (Benbasat & Zmud, 2003; DeSanctis, 2003). The TAM's ability to be applied in a consumer scenario where IT is adopted and used to satisfy emotional needs in addition to task-related ones may be constrained because intrinsic incentives are not considered. This theory is founded on the idea that adoption intentions are influenced by usage attitudes as well as by how beneficial and simple the technology is seen to be (Davis, 1989). According to the Technology Adoption Model (TAM), even if an employee does not like a particular piece of technology, they might still utilize it if they think it will improve their ability to execute their job (Oke et al., 2014). The TAM consistently explains a sizable proportion of the diversity in adoption intentions and behaviours, according to empirical investigations (see Oke et al. [2014] for a review). The explored ideas are obviously helpful when describing and predicting

adoption patterns related to technological improvements. Although the model is the most popular way to measure how much consumers accept technology, it is its readability and simplicity that contribute primarily to its universal adoption, rather than its capacity to be applied in a practical situation (King & He, 2006). This is demonstrated in Figure 5.2.

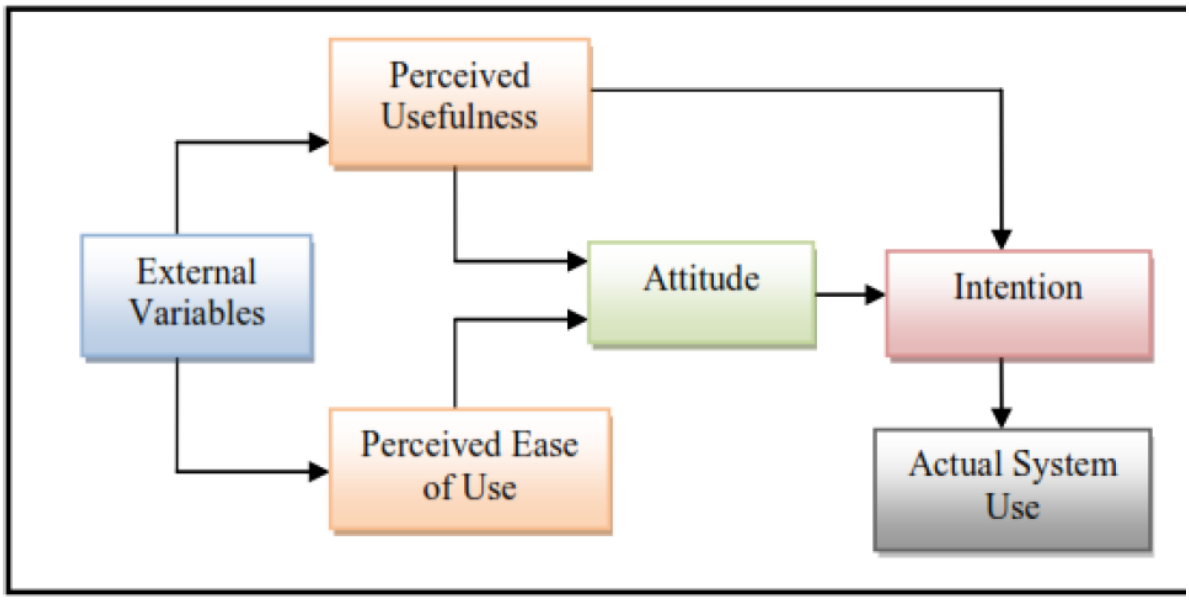


Figure 5.2: The Technology Acceptance Model
Source: Davis et al. (1989)

When utilizing a theoretical framework, it is important to keep several considerations in mind and to be aware of the limitations that come with such an endeavour. Maruping, Bala, Ventakesh and Brown (2016) assert that to fully understand the factors that influence the adoption of IT, one must have a solid understanding of the frameworks and models that have been used to study its usage. This understanding must be both theoretical and practical. The user behaviour variable, which must be evaluated using subjective standards like behavioural intention or interpersonal influence, is one of the TAM's limitations. Interpersonal influence is described as the subjective standard where a person is impacted by the words of a friend or co-worker. A supervisor does not have direct control over employees who report to the line manager, even though a superior can advise a subordinate to use technology to execute a specific task in accordance with their IT policy.

Another challenge is that the underlying causes of behaviour cannot be fully understood through empirical research, due to the presence of subjective factors such as social norms and values, personal characteristics, and personality traits. As a result, it is unclear if the usage of technology can be influenced by the social pressure of family members or friends (Ang, Ramayah & Amin, 2015; Shan & King, 2015). While this may be true in theory or for personal technology use, it may not hold up or be accurate in a professional context. According to a proposal by Maruping et al. (2016), behavioural expectations rather than behavioural intention should be used to predict employees' intents regarding the usage of technology. It should be noted that the model has also drawn criticism from a number of writers and scholars (Bashange, 2015; Zahid, Alam, Ashraf, Malik & Hoque, 2013).

In contrast to identifying the variables that influence behaviours, much of the literature analyzing the Technology Adoption Model (TAM) tends to view it as a dependent variable, focusing on understanding the factors that influence individuals' adoption and acceptance of technology (Bashange, 2015). In response to the criticisms made by Zahid et al. (2013), this thesis aims to examine age and education as external determinants of how people's acceptance and willingness to use technology is perceived. Another reason why quantifying behaviours is difficult is because it is often influenced by unconscious psychological characteristics. Potential users of technology may not always accept and want to use new technology purely based on their impressions of its usefulness and simplicity of use, and the model does propose that there may be other external factors that could contribute to its adoption.

Some new components are included in the extension of the TAM or ETAM to boost the TAM's capacity for adaptation, explanatory strength, and specificity (Lyytinen & King, 2004). The ETAM model has been suggested in two different sets of research. The initial investigation, dubbed TAM2, concentrated on the causes of behavioural intention and perceived utility as a factor. TAM2 was introduced as an expansion of the Technology Acceptance Model (TAM), incorporating two additional sets of factors, social influence and cognitive factors, and it perceived outcome factors. The exception to this is subjective norm, which has an effect in mandatory circumstances but not in voluntary ones. TAM2 operates well in both optional and necessary contexts. The second study discovered constructs that influence how something is viewed as being simple to use. The

antecedents of perceived usability can be divided into two main categories, adjustments and anchoring. The adjustments category includes perceptions formed from direct experience with a particular system, while the anchoring category includes broader attitudes towards computer usage and encompasses elements such as enjoyment, objective usability, external control, and computer efficacy (Lyytinen & King, 2004).

However, their use is constrained in circumstances where other factors, like economic position, may affect how quickly technology is adopted. I argue that in many social contexts where technology may have a negative impact, existing theories may not be adequate to predict adoption behaviours. This is because they fail to take into account the social and economic factors that can play a crucial role in shaping technology adoption in these situations, such as infrastructure development and access to basic necessities like food and shelter. My research is positioned to examine the effects of elements unique to emerging countries, like income, access to the Internet, education, and governance, on technological adoption in South Africa. I therefore reject using these theories as they are presented and instead incorporate them to take into account social settings where technology is adopted.

5.4 Summary Discussion of Adoption Models

The adoption models presented above are based on a variety of theories, including the psychosocial DOI theory, sociological TRA theory, and the social psychological TIB, TPB, and SCT theories (Bouten, 2008; Gagnon, Sanchez & Pons, 2006). All three types of theories have demonstrated their capacity to foretell and shed light on a range of human behaviours in a number of settings. The TRA and TPB, however, place more of a focus on describing individual behaviour than the DOI theory does. The latter focuses on adoption choices where organizational traits rather than individual traits have an important influence. The Self-Cognition Theory (SCT) and the Theory of Planned Behaviour (TPB) both consider perceived outcomes, while the Diffusion of Innovations (DOI) model and the Technology Acceptance Model (TAM) only focus on technological beliefs when forecasting behaviours. The SCT approach is based on the reciprocal nature of causality where behaviours, cognitive and emotional factors, and the environment constantly and mutually impact each other. The DOI model, TAM, and TPB, on the other hand, take a unidirectional

approach to causal links, where environmental circumstances have an impact on cognitive beliefs, which in turn have an impact on attitudes and behaviours (Carillo, 2010).

The model of PC use is another model that is founded on the theory of human behaviour (Thompson, Higgins & Howell, 1991). Although there are overlaps and theoretical similarities between the TIB, TPB, and SCT theories, SCT and the TPB have been applied to studying behaviour more frequently. The TPB model is part of the TIB, but it also includes additional components, such as habits and conducive conditions, that improve its capacity for prediction (Limayem, Khalifa & Chin, 2004; Woon & Pee, 2004).

Similar to the compatibility construct put forth by Moore and Benbasat (1991), the facilitating conditions discovered by Thompson et al. (1991), and the behavioural control construct advanced by Ajzen (1991); and Venkatesh et al. (2003), the DOI model and the TAM also have some similarities, such as the constructs of complexity and perceived usability, relative advantage, and perceived utility (Carter & Belanger, 2005). However, a lot of information systems academics do not distinguish between the affective component of attitudes, which is connected to likes and dislikes, and the affective component of attitudes, which is tied to the knowledge one holds about an object, topic, or person. Perlusz (2004) claims that in addition to emotional and affective factors, cognitive processes can have an impact on behaviour. He argues that theories and models of technology adoption are accurate because up until this point they have primarily neglected sentiments and emotions. Given this, the current study suggests an integrated model that takes into consideration both cognitive beliefs about the new technology (4IR) and how the influence it has on employment results in negative attitudes about the technology and its use.

The TAMs solely use cognitive predictors to link attitudes, beliefs, and perceptions to the adoption and usage of a new technology, but there are a few notable outliers according to Ajzen (1991); Bagozzi, Davis and Warshaw (1992); Davis et al. (1989); Rogers (1995); and Venkatesh (2000). Research on technology adoption uses the idea that emotions might have negative effects, such as computer anxiety (Loewenstein, Weber, Hsee & Welch, 2001; Perlusz, 2004; Venkatesh, 2000), worries (Fischhoff, Slovic, Lichtenstein, Read & Combs, 1978), and anxieties (MacGregor, 1991, Sjoberg, 1998). Positive emotions, on the other hand, like curiosity, enjoyment, and contentment

have gotten less attention (Perlusz, 2004). Models that focus on internal factors, such as attitudes, values, and goals, and models that focus on external factors, such as conventions, incentives, and institutional constraints, have been proposed. However, many models, including the TIB, lack clear guidelines for operationalizing the variables (Robinson, 2009). The most widely studied concepts and theories of user technology adoption include the UTAUT, TAM, and DOI models.

Since it falls under the umbrella of development sociology, a model developed from technological social and philosophical studies is more suited to the subject of this thesis on the effects and societal change caused by the 4IR. Before presenting the model, the next part gives a brief overview of the theories relating to the social and philosophical foundations of technology.

5.5 Complex Interaction Between Technology and Society

Techno-optimists and techno-sceptics are the two main kinds of scholarly approaches in the discourse on the appropriation of technology. Techno-optimists believe that technology will solve all issues and be able to meet all needs, even those related to time, space, and distance (Njenga, 2018). Techno-optimists are thought to adhere to the principles of technical utopianism, which portrays technology advancements as a kind of panacea. It is significant to note that discussions of the fourth industrial revolution (4IR) in various forums frequently place a greater emphasis on technology than on other environmental variables, such as political, cultural, and legal aspects (Kaisara, Mare & Peel, 2021). This approach aligns with Webster's (2017) assertion that leaders should prioritize "keeping up with technology, or be left behind". This perspective is rooted in techno-positivism, or what Webster refers to as technological optimism.

Theories that were originally developed to understand the adoption and implementation of previous technologies are commonly used to analyse the fourth industrial revolution (4IR), despite their potential limitations. We are able to understand how digital media has affected society by noting that technological determinism (TD) predominated until the late 1970s (Kaisara et al., 2021; Mackenzie & Wajcman, 1999). This idea holds that technology is a self-aware actor. A well-known supporter of TD, Ithiel De Sola Pool, thinks that the Internet is a symbol of liberty, prosperity, and enlightenment (Lenert, 2004). This type of thinking disregards how difficult it is to employ ICTs and how frequently they fail to yield the desired results (Williams & Edge, 1996).

The core assumption of TD is that robots construct history in a specific environment rather than completing autonomous tasks (Adler, 2006). One example of how this discourse shapes modern language and discourse is the idea that the Internet has a significant impact on the economy and society (Adler, 2006).

My integrated model is presented after providing an overview of the theories that examine the intricate interactions between society and technology.

5.5.1 Technological Determinism

The idea that technology has the autonomous capability to alter social structures and work organization, commonly referred to as Technological Determinism (TD), has been a prevalent perspective in Western models of ICT development programs (Kaisara et al., 2021; Leonardi & Jackson, 2004). This way of thinking is often referred to as "technology solutionism" (Morozov, 2013). TD might occur in two different ways: firm and soft (Hutchings, Parker & Jeffrey, 2016). Technology has its own guiding logic that imposes a socially constricting influence, according to the hard version of TD. Technology is viewed as a structural force that forces civilization to regress in the face of technology (Chandler, 1995). This proves that technology is independent of political and cultural influences and operates according to its own logic. Because of this, cultural and social implications are thought to be irrelevant given the all-pervasive technology. The view that technology is independent and follows its own logic, shaping society to fit its demands, is known to be what technological determinism entails. This perspective suggests that technology's evolution is determined by incremental advancements or scientific discoveries, and that the role of public policy is to anticipate and track its development, remove barriers, and facilitate society's adjustment to the changes it brings (Bijker, 1993; Green, 2001; Ticău & Hadad, 2021; Williams & Edge, 1996). In any case, it is believed that societal forces have little impact on the development of technology; in fact, it is occasionally claimed that adopting a technology is driven by a desire - a "technological imperative". These theories imply that the path of technology growth and eventual social change must be chosen.

Soft technology acknowledges the role that individuals have in the creation and use of technologies. As a result, it believes that the socio-historical contexts of society have an impact on how technology is developed and utilized (Adler, 2006; Kaisara et al., 2021). It avoids monocausal theories to arrive at the conclusion that technology is the primary historical factor. Within this modernisation theoretical framework, ICTs are envisioned as instruments with which to overcome traditionalism, which is seen as a major roadblock to growth (Slack & Fejes, 1987). This has resulted in requests for the transfer of technology from the industrialized world to the developing countries to promote modernization and technical advancement (Slack & Fejes, 1987). The 4IR is only treated with celebration in TD theorists' thoughts, which is a crucial aspect of this argument. The influence of any technology is essentially reliant on how it is deployed, which is determined by society, according to TD opponents. Technology and social structures interact in a nondeterministic, emergent process (Adler, 2006).

Unlike Technological Determinism (TD), Social Constructivism or SST theorists consider social reality. The SST paradigm is rooted in several theoretical assumptions (Kaisara et al., 2021; Mackenzie & Wajcman, 1999). It contests the inflated claims of TD by highlighting the influence of social, institutional, economic, and cultural elements in the support or prevention of technology adoption across different strata of society (Kaisara et al., 2021; Williams & Edge, 1996). This thesis asserts that certain micro-level sociological factors, including socio-economic status, generational differences, age, and general knowledge, have a significant impact on how individuals in developing countries view the widespread adoption of technology. Those who support the Technological Determinism (TD) theory generally have a positive view of automation and other technological advancements associated with the fourth industrial revolution (4IR). According to Castells (2001, p. 247):

> The differential use of the Internet in the developing world is related to the kind of content that users can find on the Internet, and to the difficulty for people without sufficient education, knowledge and skills to appropriate the technology for their own interests and values.

Sparks (2001) argues that most Internet content producers are concentrated in a small number of major cities in developing countries. The population's use of the Internet is skewed in terms of its relevance and importance due to this urban concentration (Tsotsotso, Montshiwa, Tirivanhu, Fish,

Sibiya, Mlangeni & Mahlangu, 2017). In fact, most of the online literature rarely accords authority to common people or customers who choose the applications and benefits of technology based on their own requirements and goals. However, Manji (2008, as cited in Ekine, 2010, p. 9), places common people in charge of social transformation, contending that:

> Social change is actually driven not by technology but by ordinary people being able to exert an authority over their own experience and, through common actions, developing the courage to determine their own destiny.

Moreover, social constructivists often advocate for an approach that takes the "social context" into account in order to comprehend how cultural, educational, socio-economic, organizational, and demographic variations shape the distinct ways in which the Internet is employed in various political settings (Clegg, 2011; Kaisara et al., 2021; Leonardi & Jackson, 2004). According to social constructivists, the social context should always come before the technology when discussing technological interventions. This thesis favours social constructivist theories because it investigates the attitudes of persons in various social contexts and the social context serves as the starting point for the debate on attitudes toward the 4IR in South Africa.

5.5.1.1 Criticism of Technology Determinism

Many theorists believe that people's interactions with technology are two-way processes, defying deterministic presumptions. The relationship is nonlinear in real life (Bratianu & Vasilache, 2009). Arguments that TD oversimplifies technology's interaction with humans illustrate various opinions on how technology and society interact. Table 5.1 provides a summary of the most important competing ideas and theories.

Table 5.1: Critics of technological determinism

Contradicting theories	Author	Description
Too extremist	Chandler (2000)	"Criticises TD by stating that the theory presents technology as too powerful over society, thus leading to a helpless state of the population. Technology is presented as driving society in a too extreme way. He states that other factors such as political and economic factors or simply just general attitudes can influence the

		development of society" (Chandler, 2000, p.4).
Democratic Rationalisation	Andrew Feenberg (1992)	"In the article 'Subversive rationalization: Technology, power, and democracy', the author argues that the development of industrial society depends on politics. He emphasises the idea that technical decisions are rationally constrained as being 'groundless' and criticises two theses, nonlinear progress, and determination which adopts a constructivist approach, stating that individuals can engage social factors to influence choices and determine technological evolution, characterising such a society as subversive rationalization" (Feenberg 1992, p. 301).
Social Construction of Technology (SCOT)	Pinch & Bijker (1984)	"The theory, also known as the SCOT method, states that individuals are able to provide meanings to technological artefacts according to various factors, such as their relevant social group. Socio-cultural and political factors are considered to determine technological development. In their paper, *'The Social Construction of Fact and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other.'*(1987), they use the example of the Penny-Farthing bicycle to highlight that over time, technology was evaluated according to each group's standards. In the case of the bicycle, moral conflicts were different according to each social group. Women cyclists encountered barriers such as wearing skirts on a high wheeler while sports cyclists did not" (Pinch & Bijker, 1984, p.401).
Social Shaping of Technology (SST)	Williams & Edge (1996)	"SST contradicts TD by stating that the design and implementation of technologies are shaped by social and economic forces, but also by technical considerations. Compared to SCOT, SST does not base its analysis on a particular technological field, but from a certain social context where technical changes occur. The authors

		characterise this analysis as processing ‘inwards’”(Williams & Edge, 1996, p..

Source: Chandler, 2000; Feenberg, 1992; Pinch & Bijker, 1984; Williams & Edge, 1996

5.5.2 Social Shaping of Technology

Technology-centered theories that explain the fundamentals of technology and how society and technology interact, the elements of social structure, and the forces that shape social progress, are fundamentally in opposition to the idea that technology is created within society (Williams & Edge, 1996). Such determinist viewpoints have dominated many academic and popular conversations on technology and society. They form the foundation for widespread conceptions of social and economic growth and, until recently, were frequently taken for granted in most technology policy frameworks.

The "Social Shaping of Technology" (SST) perspective, often known as "Social Determinism", views technology as an outcome of the society in which it is developed. Green (2001) is one of many modern media theorists who has offered convincing justifications for this social determinism. In her book, *Technoculture,* which investigates in great depth the workings of a social determinist perspective, Green contends that "social processes decide technology for social goals" (Green, 2001, p. 4). According to her, every technical advancement in human history was a result of a societal necessity, whether it was an economic, political, or military requirement. Technology is always created with a certain goal or objective in mind (Swierstra, 2015). A social determinist stance understands that as financial support is a necessary component of technology development, those who can afford to fund it will always benefit from new technological advancements. Therefore, according to social determinists, technological advancement is not only formed by the society in which it takes place, but also by the power structures that are present in that society.

As a necessary correction and "antidote to naive technological determinism", the SST approach "serves as a needed corrective" where the focus is instead on the social dynamics that give rise to specific technologies, without negating the fact that technologies have social repercussions (Hara

& Huang, 2011; Mackay & Gillespie, 1992, p. 687). It is asserted that sociologists of technology need not limit themselves to the outcomes of technologies. There are two major approaches to how society shapes technology in the sociology of technology. The first of these is concerned with the 'micro' socio-economic variables and it can be divided into three schools: systems, social constructivist, and an actor-network (Bijker, Hughes & Pinch, 1987). The sociology of scientific knowledge is a source of inspiration for the social constructivist method. In this context, scientific truths are viewed as social phenomena; social constructivists perceive technology as socially produced (Pinch & Bijker, 1984). Technologies are the result of decision-making and bargaining procedures between "relevant social groups"; further crucial ideas include "closure" and "interpretative flexibility" (Pinch & Bijker, 1984).

The neo-Marxist viewpoint contends that individual inventions alone cannot explain the development of technology. Instead, it's crucial to think about how bigger socio-economic issues, including investment choices in particular fields of research and development, might influence the types of technical problems and solutions (Mackay & Gillespie, 1992). The social constructivist method is criticized in this viewpoint for ignoring the political and economic context in which technology is created (Mackay & Gillespie, 1992). This perspective holds that technology is intentionally or inadvertently created to achieve specific social or political goals.

The main objective of these major approaches to the SST is to explain the social process that underlies the invention, development, and evolution of technology, which is understood as expressing certain social interactions (Law & Callon, 1992). According to Pinch and Bijker (1984), the only method to dispute the purpose of TD's statements is to illustrate the decisions made during the design process as well as the associated social agreements. It's intriguing because TD and the sociology of technology concentrate almost entirely on how technologies are created, invented, designed, and developed (Pinch & Bijker, 1984). This idea contends that rather than being created by isolated intellectuals acting in a social vacuum, technologies are created through a convergence of social elements and processes. It is crucial to examine the current attitudes about these innovations in South Africa because the 4IR's technologies, like those of the preceding three IRs, were not conceptualized and created in the African social environment.

5.5.2.1 The social appropriateness of technology

In general, the sociology of technology has overlooked how technologies are subjectively appropriated by society. According to Wajcman (1986, p. 750):

> Close inspection of technological development reveals that technology leads a double life, one which conforms to the intentions of designers and interests of power and another which contradicts them - proceeding behind the backs of their architects to yield unintended consequences and unanticipated possibilities.

The social dynamics that influenced the development, propagation, and promotion of domestic technology have been the main topic of discussion. However, this perspective is flawed because it disregards the social dynamics at play on technology's opposite side, including how people actively usurp technologies. People are not just mindless automatons who blindly follow technology agendas; rather, they are socially situated but nonetheless creative, expressive, and active consumers of the technologies they utilize (Mackay & Gillespie, 1992; MacKenzie & Wajcman, 1985). Technologies may be rejected, repurposed, personalized, or even given strange symbolic meanings by people. They might even reinterpret a technology in a way that defeats the purpose for which it was developed and intended. As a result, everything is neutral, serves a social purpose, may be used as a fence or a bridge, and technology appropriation contributes to society's socialization (Mackay & Gillespie, 1992).

I propose making space for the active participation of users in each technology. In this way, a crucial aspect of technology is the individual social appropriation of it, which involves not just how it is used but also the significance that use holds for the user. A technology is more than just a physical object; it carries significance.

As I will demonstrate below, the Social Shaping of Technology (SST) approach draws inspiration from several academic traditions. These traditions share a critical perspective and some analytical considerations. The study of SST concentrates on how social, institutional, economic, cultural, and economic factors shape technology, and includes the nature of technical practices and artifacts, the rate and direction of innovation, and the effects of technological advancements on various subgroups of society. By examining what shapes the technology that is having these "impacts" and how they are realized, it goes beyond traditional approaches that are only concerned with analysing

the "social implications" of technology (Williams, 1996). The goal of SST research is to find early-stage opportunities to exert control and accountability over technological advancement and its societal repercussions. SST broadens the policy agenda; it is no longer just about tinkering on the edges of technology policy and trying to grapple with its results while neglecting the direction and objectives of innovation.

The Social Shaping of Technology (SST) approach aims to understand the social processes that shape the creation, development, and evolution of technology (Williams, 1996). However, this approach has been met with criticism and debate, particularly in relation to technology and particularly in relation to technology policy. Linear models of innovation, which focus solely on the technical aspects of development and prioritize the supply of technology, are now seen as inadequate according to the SST perspective. This approach emphasizes the importance of considering both the user and the provider and the connections between them, leading to the development of more comprehensive and proactive technology policies. The concept of "constructive technology assessment" has been proposed to explore the potential implications of different technological decisions during development, rather than just conducting retrospective evaluations (Rohracher, 2001).

The tensions are, in my opinion, at least theoretically beneficial and demand ongoing re-evaluation of research approaches, interpretations, and the function of SST. The Social Shaping of Technology (SST) approach, which focuses on understanding the social processes that drive the creation, development, and evolution of technology, has seen significant success in empirical research (Andrews, 2006). However, internal disputes and differences with other fields, particularly mainstream economics, may have hindered the development of a comprehensive theory within SST. Despite this, recent advancements have led to the creation of a useful model for understanding the invention process.

I have chosen to use the Social Shaping of Technology (SST) theory in my study to contribute to the development of public policies, particularly towards the implementation of 4IR in South Africa. I place a strong emphasis on understanding the relationship between the user and the supplier, as well as on their respective roles. I break down the privilege that technology holds over

society and view it as a social activity that is shaped by social forces and open to social examination. This thesis posits that several micro-level sociological indicators, such as socio-economic status, generational differences, and general knowledge, have a significant influence on how people in South Africa perceive the widespread adoption of technology. Any model for the adoption of technology should therefore consider public opinion data that represents these sociological variables, as they have an impact on societal attitudes in the context of technology development.

5.6 Integrated Adoption Model of Attitudes Towards Technology in South Africa

Embarking on an examination of attitudes towards technology in South Africa, my focus centers on the Integrated Adoption Model. This model serves as a comprehensive framework that encapsulates the various elements influencing individuals' stances and decisions regarding the adoption of technology. Throughout this exploration, I will elucidate the core principles of this model, delving into the nuanced interplay of factors that contribute to the shaping of attitudes towards technology within the South African context.

5.6.1 Overview of micro-sociological indicators for the adoption model

The integrated model makes extensive use of several idealized forms of human-technology relationships, which are influenced by micro-level sociological indicators and socio-economic position, including worker vulnerability, education, gender, race, and social class. Socio-economic status (SES) stands for social standing or class, and it is frequently determined by considering a person's occupation, income, and level of education. Examining SES frequently reveals difficulties with privilege, power, and control, as well as discrepancies in resource access. New technologies like the Internet of Things (IoT), Blockchain, and artificial intelligence (AI) in the form of machines and robots are being brought about by the fourth industrial revolution (4IR). According to Calitz, Poisat and Cullen (2017), the automobile industry in South Africa has implemented the extensive usage of robots. Furthermore, South African businesses are just beginning to invest in AI. Farmers in South Africa are using drones to monitor wildlife, cattle, fence lines, windmills, and dam levels as another example of technological adoption (Weeden, 2016).

Despite the growing interest in emerging technologies in South Africa, the level of adoption is still relatively low compared to developed nations like the USA. However, certain industries such as manufacturing and agriculture have begun to incorporate these technologies, as seen in the use of robots in car manufacturing and drones for wildlife and cattle monitoring. The government's role in addressing issues such as poverty and unemployment is crucial in understanding how these technologies are perceived and adopted by different socio-economic groups. Studies have shown that people's opinions and use of 4IR technologies are significantly influenced by characteristics including social class, education, and income, especially for those who may be at risk of losing their jobs because of automation (Grybauskas, Stefanini & Ghobakhloo, 2022).

5.6.1.1 General knowledge of technology

It is commonly believed that people's resistance to technological advancements is primarily due to a lack of understanding of these developments (Sturgis & Allum, 2004). The saying "to know science is to love it" encapsulates this concept of the Knowledge Deficit model (Allum et al., 2008). Studies have revealed that South Africans' levels of scientific understanding are disturbingly low (Roberts et al., 2021). According to the scant public opinion research that has been done on the topic, a sizeable section of the population lacks even the most fundamental knowledge of 4IR technology (Roberts et al., 2021). This suggests that there may be misunderstandings and hostility toward the 4IR among the general people. However, in the case of the 4IR, increased awareness may not necessarily lead to increased acceptance (Struwig & Roberts, 2012).

The skill and competency of a nation's workforce has a significant impact on its capacity to embrace and use 4IR technology. In South Africa's case, despite expressing interest in experimenting with 4IR technologies, the country continues to struggle with a high rate of illiteracy among its population, making it difficult for the country to attract the skilled talent needed to keep up with the rapid technological innovation in 4IR (Soeteman-Hernandez, Sutcliffe, Sluijters, Van Geuns, Noorlander & Sips, 2021). This shows that in order for South Africa to embrace and benefit from the 4IR properly, it needs to address its workforce development challenges (Shivdasani, 2019). The nation's citizens must acquire the necessary engineering and digital skills as a first step

in this direction. It is necessary to train both people who are employed and those who are unemployed on how to use and manage disruptive developing technology.

5.6.1.2 Generational variation in age

Since it's commonly implied that younger people are more receptive to technological change, it is frequently expected that this type of transformation will be simpler for the younger generation. It is uncertain how the younger generation will respond to the adoption of robotics and automation, as the link between age and technology acceptance is inconclusive. Studies on the subject have produced varying results, with some indicating that age can decrease a person's attraction to technology, and others showing no correlation. Due to the limited and unrepresentative nature of research conducted on this topic in South Africa, it is difficult to generalize about the country. However, previous research has suggested that youths may be more open to retraining and upgrading their skills for new technologies, and this is discussed below.

According to Marwala (2019, p. 3) "the greatest way to keep ahead of the changing needs of the labour market is to retrain, upskill, and change the workforce" to reduce the danger of losing jobs in the 4IR age. The need to reskill the current workforce in preparation for changes in the labour market has also been emphasized by Pretorius (2016). The country's educational system must be changed to generate young graduates with the appropriate abilities to handle the influence of new technologies on their professions to ensure there are enough trained workers available (Pretorius, 2016). Institutions are crucial in helping people acquire the skills needed for the new technological era (Marwala, 2019). To do this, numerous universities are working with business and the commercial sector to create fresh courses and link their research initiatives with current problems. Additionally, these institutions are working to establish specialized technology transfer offices and effective intellectual property policies (Marwala, 2019). Transitioning from workforce preparation, we delve into the intricate dynamics of technology attitudes, specifically implicit interactions with technology. While Marwala's focus is on broader workforce readiness, the proposed model, rooted in Mitcham's (1994) framework, refines our understanding by introducing subcategories to discern implicit technology attitudes.

5.6.2 Implicit and explicit interactions with technology

Technology attitudes (4IR) can be divided into implicit and explicit technology approach categories. The suggested model is based on Mitcham's (1994) modes of the manifestation of technology, which identify three approaches to how people use technology: romantic unease, enlightenment optimism, and ancient scepticism. However, I would have to create subcategories and depart from Mitcham's model to incorporate implicit and explicit attitudes about technology. The subcategories created allow one to detect inconsistencies and possible consistencies in the attitudes towards technology, bearing in the mind the role of the micro-level sociological markers mentioned above.

5.6.2.1 Techno-sceptics

According to Mitcham (1994), "ancient scepticism" refers to premodern or archaic attitudes against technology, with the most mistrust and discomfort displayed toward technology: it ran the risk of being rejected by God or the gods until it was proven to be innocent or useful. This lends credence to the idea that modern technology frequently makes environmental and ecological issues worse. Technology therefore needs outside guidance, yet there will always be risks involved (Kerschner, 2013).

There are many different types of doubts about technology. Some contend that it weakens social cohesion, and encourages individualism and isolation, or that it destroys employment and/or their meaning. There are two subgroups within the techno-sceptic category. The first is Neo-Luddism, where Neo-Luddites (representatives of this movement) reject all forms of technology, tend to be highly pessimistic about the future of humanity, and blame this technology for all or most of the issues in human civilisation (such as poverty, inequality, and displacement of humans). The Jevons paradox or rebound effect offers some scholarly backing for this viewpoint (Kerschner, 2013). A more radical version of this theory was put forth by Schneider (2008), who claimed that technological development will eventually have a negative effect on the environment, society, and economy because it will always seek to overcome physical constraints (such as those imposed by time, space, speed, and weight). The second subgroup is simple scepticism, which indicates that technological advancements must demonstrate that they have no negative effects that cannot easily

(or fundamentally) be remedied. Risk evaluation is therefore necessary before adopting and implementing technology.

5.6.2.2 Techno-optimists

Technological optimism is the positivist conviction that all events that are harmful to the objectives people pursue may be eliminated or overcome successfully with the technology created by humanity (Mitcham, 1994). A different way to express it is as a viewpoint on technological development that assumes that, if humans choose to, they will one day be able to comprehend and exert influence over all significant components of any given activity on Earth and beyond (Kerschner, 2013). Since technology is inherently useful, misuse of it is accidental. Technophiles and technocrats are the two subgroups I have placed inside this larger group of techno-optimists.

The technophile believes that all or most forms of technology are inherently good and helpful to people (especially high technology). This individual will joyfully embrace technology and anticipate that it will enhance living and address societal issues (Drengson, 1982). A technocrat would go further since they advocate for "governance by experts", which holds that lawmakers should be chosen based on their technical acumen and/or that laws should be based on technological procedures (Kerschner, 2013). This is thought to increase effectiveness significantly and lessen socio-economic irrationality (Brunham, 1941). Technocratic views can be detected in less extreme versions in all manifestations of technological optimism, with the rhetoric of “sound science” as particularly prominent (Stirling, 2007). Here it is anticipated that the dominant factor that determines how human society develops will be technological growth and that history can be understood as a one-way race to increase technology (Kerschner, 2013).

The integrated model features discussed here are tested and represented graphically in the analysis in Chapter Eight of this thesis. The graphic representation shows the micro-sociological indicators that shape attitudes and that have been found to be statistically signficant.

5.7 Chapter Summary

This chapter has explored different perspectives on technology and their implications for the proposed model. Scholars from various backgrounds have been brought together in the critique of the traditional conceptions of technology, and the critique has highlighted the need to study science and technology from a social perspective within the Social Shaping of Technology (SST) framework.

A significant and critical strand emerged from within the SST, and it challenged the notion of technology's neutrality and emphasized its political nature. Technology is seen as a tool used by various groups to either maintain or transform social relations. The establishment of the SST aimed to democratize technological decision-making, and this aligns with the democratic approach advocated in this thesis, which seeks to include citizens' perspectives on the 4IR policy. The SST played a crucial role in the conceptualization of the proposed model, which recognizes the influence of socio-economic factors on individuals' perceptions of technology.

Additionally, the chapter explored the perspectives of techno-optimists and techno-sceptics, who delve into the intricate relationship between technology and society. This thesis proposes a model that considers the complex interactions between technology and society in order to advance the field of constructive technology adoption. By acknowledging the socio-economic characteristics that shape people's perceptions, the model aims to move beyond simplistic categorizations of individuals as either pessimistic or optimistic about technology.

It is essential to consider technology appropriation when discussing adoption models, considering the transformative effects of the 4IR on society. This study recognizes that the adoption of new technology depends not only on its capabilities but also on its impact on society, which in turn, influences how people perceive and utilize it. A regression modelling analysis is conducted in Chapter Eight to assess the validity of the proposed model, and to offer insights into its effectiveness. The subsequent chapter will discuss in detail the methodology employed in this study.

CHAPTER SIX: RESEARCH METHODOLOGY

6.1 Introduction

Attitudes have a considerable impact on behaviour and public policy, and the literature from the chapter before has shown that attitudes are important enough for academic research and that they should be measured and quantified (Xu, Williams, Gu, Liu & Hong, 2022). Public opinion polls are considered by researchers to be one of the strongest methods for measuring attitudes. By analysing data quantitatively, one may better understand how attitudes develop. To use quantitative public opinion polls as opposed to other approaches to answer certain questions allows for objectivity and the data collected is generalizable to a larger population. This allows researchers to make broader conclusions about public attitudes. My belief is that a quantitative approach will be most effective to address the research topics presented in the first chapter of this thesis.

In the following segments of this chapter, I will engage in a critical reflection on my positionality, offering insights into how my personal background and experiences may have influenced the research process. This will be followed by an exploration of the chosen research paradigm, delving into the philosophical underpinnings that guided the study. Subsequently, attention will be directed towards a detailed discussion of the sample and data utilized, shedding light on the methodological decisions that shaped the research outcomes. Moreover, ethical considerations and the processes employed to ensure the integrity of this research are thoroughly examined.

6.2 Researcher's Critical Reflections: Reflexivity and Positionality

While reflexivity is a cornerstone of research using a qualitative approach, it is much less common in studies utilizing a quantitative approach. Reflexivity is the process of engaging in self-reflection about who we are as researchers, how our subjectivities and biases guide and inform the research process, and how our worldview is shaped by the research we do and vice versa (Jamieson, Govaart & Pownall, 2022). If positionality refers to what we know and believe, then reflexivity is about

what we do with this knowledge. Reflexivity is a form of critical thinking that prompts us to consider the 'whys' and 'hows' of research, critically questioning the utility, ethics, and value of what, whom, and how we study (Willig, 2013). As Lazard and McAvoy (2020, p. 177) explain, the reflexive process is ultimately based around the question: "What is the research process and how am I influencing it?". This questioning forms part of an ongoing process that prompts the researcher to shift and (re)construct their understanding continually (Barrett et al., 2020) as part of the process of "disciplined self-reflection" (Wilkinson, 1988). Following the reflexivity in quantitative research guide by Jamieson, Govaart and Pownall (2022), I offer my positionality and reflexivity statements for this quantitative research.

Positionality Statement:

As a researcher working on this doctoral study using secondary data from an organization that I work for (HSRC), I am aware that my position within the organization influences my perspective. Having been a researcher for the organization for a few years, I have gained a thorough understanding of its culture, values, practices, and research agenda. As a black South African woman who understands and experienced marginalization because of race, gender, and age, I understand social exclusion. Studying the impact of technological advancements in a country with high levels of inequality is something that I am personally invested in as I want to understand how these developments affect and/or can be of assistance to marginalized individuals and communities. To achieve this goal, it is necessary to consider issues of class, race, and privilege, which are often significant factors in the country's socio-economic context.

Despite the advantages of my positionality with access to rich and detailed data, I recognize that my pre-existing knowledge and experiences may influence my interpretation of the data. To address potential biases that may arise from my positionality, I have implemented several measures throughout the research process. Firstly, I conducted a comprehensive literature review to gain a broader understanding of the research topic and to identify potential biases. Additionally, I developed a codebook to define all the variables in the dataset and their measurement parameters. This ensured consistency in the coding and data interpretation. These steps helped to mitigate any potential biases that may arise from my positionality and ensure the validity and reliability of the

study's findings. Additionally, . In my analysis, I accounted for missing data through the use of multiple imputation. I applied this technique to handle missing values, assuming that the missing data was missing at random. This assumption implies that the likelihood of missing values is related to observed data but not to unobserved data.

Regarding the handling of multivariate missing data, the multiple imputation process in SPSS involves specifying an imputation model that considers the relationships among variables with missing data. This ensures a more comprehensive approach to imputing missing values by taking into account the interdependence of variables.

I documented my assumptions and biases throughout the research process to increase transparency and accountability. I was conscious of my positionality and the potential impact it could have on my analysis, and therefore approached the data with a critical lens. I questioned my assumptions and interpretations, and considered alternative explanations for my findings (see Chapter Eight).

Reflexivity Statement:

As a researcher conducting a quantitative study, I recognize the importance of reflexivity to minimize bias and increase the rigour and quality of my research. To ensure reflexivity throughout the research process, I have taken several steps to reflect on my own positionality and potential biases that may arise from my role within the organization. In this sub-section I would like to address how I used reflexivity in the research questions and design, data analysis and interpretation and lastly in the conclusion and framing. Since this study did not involve interaction with participants, my reflection will be limited to the aforementioned areas.

- *Reflexivity in the research questions and research design*:
  A series of prompt questions were considered and reflected upon when considering the research questions and the study design. The questions included: “Why do I want to research this group?” “To what extent am I ‘within’ the participant group that I am researching?” “Am I an ‘insider’ or ‘outsider’ researcher, or do I occupy both positions?” These questions were used to frame the research questions, which also guided the research

design. By adopting a reflective approach, I was intentionally able to consider how my own biases and assumptions could potentially impact my research study. The process of reflexivity enabled me to approach my research in a more thoughtful and self-aware manner as a result. I aimed to conduct research on a diverse range of participants, and this included those from different socio-economic backgrounds, races, ages, and geographic locations. I utilized the HSRC SASAS dataset as the means to include this wide range of individuals in my study and thus achieve my goal. This approach allowed for greater generalizability of my results and made them applicable to many different types of people and situations. This also helped to counteract any potential insider bias.

- *Reflexivity in the data analysis and interpretation:*
  My initial study proposal was quite different, and I had to reconsider my prompt questions for the data analysis and interpretation stage of my study. My proposed research approach was modified to arrive at this current study. Along the way I asked these prompt questions*:* "I am using existing datasets… are there any silent assumptions in this dataset?" "Could my analysis of the dataset reproduce existing inequalities?" As a secondary researcher using this dataset, I took the time to understand the data and had meetings with the original researchers and principal investigators. They all work at the HSRC and were thus easily accessible. Through these discussions I was able to realize what the SASAS data is all about, and I reliazed that the survey is designed to be representative of the South African population. This means that it includes people from different racial, ethnic, and socio-economic backgrounds. The dataset generated from the survey is a tool with which to discern inequalities, rather than reproduction of the data. When analyzing the data, I operated from the assumption that all statistical tests are objective. When interpreting the data, I sought feedback from colleagues and supervisors to gain a broader perspective on my findings and interpretations. I tried to contextualize my findings within the broader literature to ensure transparency and accountability, and highlighted the limitations of my study. I also tried to ensure that my findings are applicable beyond my organization, and to do this I considered how they may apply to other similar organizations or contexts. This was indicated in my rationale for the study in Chapter One.
- *Reflexivity in the conclusion and framing:*

In terms of reflexivity, in my conclusion and framing I used these questions as prompts: "How does my use of evidence reflect my biases or the biases of the research team as researchers and as individuals with our own lives, wants, emotions, and needs?" "What do I gain from this research?" "What does the population I have studied gain?" I considered the study's rationale and realized that there are a multiple of stakeholders who will benefit from the study (Government, academia, communities, and researchers), which shows that this study was not done for the sole gain of the HSRC or influenced by my own biases. The answer to the question: "what does the population gain?" is better policy decisions, as my study provides valuable insights into the impact of technology on inequality, which could inform the development of policies and initiatives aimed at mitigating this effect.

Overall, I believe that I have approached the research with a reflexive and critical lens and have taken steps to minimize bias and increase the rigour and quality of my research through these efforts. While I acknowledge that my positionality may have affected the research process and findings, I believe that my efforts to mitigate bias and increase transparency have helped ensure the validity and reliability of my results. The proceeding sections and sub-sections will focus on the research's paradigm.

6.3 Positivist Research Paradigm

When deliberately pursuing knowledge and scientific inquiry, there are several research paradigms that make assumptions about how the world operates that can be applied to the process (Creswell, 1994; Park, Konge & Artino, 2020). In no particular order, these paradigms specify axiology (the objective and values of the research process); epistemology (how knowledge is conceptualized); ontology (how reality is perceived); methodology (how the paradigm defines the processes involved in conducting science); and rigour to control how research is conducted (the standards used to support the quality of the research in the paradigm) (Park et al., 2020; Vapiro & MacLeod, 2020). This study employed the positivist research paradigm. "Positivism dates back to the Enlightenment period of the 17th and 18th centuries, inspired by philosophers Descartes and Locke" (Park et al., 2020, p. 691). Research is viewed as "systematic, empirical and controlled" and "is subject to any challenging theories or new understanding in the future", according to the perspective of positivists (Hussain, Elyas & Nasseef, 2013, p. 2377).

Its advantages include clarity, rigour, precision, standardization, and generalizability, but it has been criticized for not being applicable to real-world situations, which is understandable (Hasan, 2016; Hussain et al., 2013; Poni, 2014). Although a controlled laboratory environment is possible, the natural sciences are more likely to have results that closely resemble the real world than the humanities and social sciences (Aliyu, Bello, Kasim & Martin, 2014). However, it is maintained that, given the current study's goal of examining the correlations between quantified variables statistically, this paradigm is suitable.

Given that there are sociological, technological, economic, and political aspects to development, testing public opinion data on technological development is quite a complex social phenomenon (Lee & Clark, 2020). To have qualitative data that provide more reflections on and experiences with the 4IR in South Africa would be a valuable contribution to the body of knowledge on the subject. However, the main question of this study was to ascertain the association and correlation between variables, and this is best explored quantitatively. Therefore, the positivist paradigm and its quantitative methods are suitable for this study. I will now briefly discuss the ontology, epistemology, methodology and axiology of this paradigm.

6.3.1 Ontology: The nature of reality

The positivist paradigm is predicated on the idea that there is only one concrete reality – one that can be comprehended, recognized, and quantified (Park et al., 2020). This reality is measured and studied objectively using scientific methods; hence the researcher is often required to dissociate themselves from this reality to ensure unbiased research findings (Poni, 2014). It has remained an argued point as to whether a researcher can reach total objectivity. The researcher's perspective can subtly influence the direction and implementation of the research project. For instance, when developing a model as I did for this study, it is often said that:

> Models do not build themselves any more than they interpret themselves; it is neither a predominantly mechanical nor purely deductive process. Of course, some standard techniques are involved; they are not starting from scratch. But choices still must be made, and these are frequently based on intuitions, hunches, and ideas of what is

> needed that have not yet been fully rationalized (Greiffenhagen, Mair & Sharrock, 2016, p. 103).

The quote indicates that individuals will have biases when they make decisions about their statistical analysis. The quote provided acknowledges that building regression models is not a purely mechanical or deductive process, and that choices must be made based on intuitions, hunches, and ideas. However, this does not mean that the process is inherently biased. I conducted exploratory data analysis to identify variables that are significantly associated with the outcome of the research's interest. I followed established best practices for regression modelling, such as checking for multicollinearity, heteroscedasticity, and normality of residuals. Additionally, statistical tests to compare models and determine which variables to include were employed during the regression model building. By using objective statistical criteria to determine which variables to include, I showed that my model building process was unbiased.

6.3.2 Epistemology

Regardless of the beliefs of the participants and researchers, positivism holds that knowledge can and must be generated objectively (Park et al., 2020). To establish truth correctly, there must be complete separation between the research participant and the researcher. Objectivity was maintained in this study since I did not carry out the data collection. I instead used pre-existing SASAS data, so there was no contact with the study's participants.

6.3.3 Methodology

The emphasis of positivist methodology is on conducting research in situations where factors can be managed and controlled. This requires social science researchers to design environments that are mostly artificial and limit external factors other than the study variables (Cacioppo, Semin & Berntson, 2004).

Experimental and non-experimental research questions are the two main sub-types of positivist research. Experimentation is used to show causal relationships that are generally observable (Hussain et al., 2013). According to Hussain et al. (2013); and Kivunja and Kuyini (2017),

researchers use control and manipulation of the independent variable (condition) to see if it affects changes on the dependent variable and, therefore, establish the link between variables. Since an independent variable is not altered in non-experimental designs, cause and effect cannot be established or generalization allowed because other explanations may exist (Hussain et al., 2013). In this study a non-experimental design was used for exploration of the relationships between variables and the generation of hypotheses. However, I did not explore causal relationships in the same way that experimental designs can. An exploratory design had to be used to demonstrate the correlations between the micro-sociological indicators and attitudes towards the 4IR.

6.3.4 Axiology

A researcher must maximize positive outcomes for the sake of the research endeavour and to benefit the research participants and humanity (Kivunja & Kuyini, 2017). The researcher also needs to minimize or eliminate any potential hazards or harm (Kivunja & Kuyini, 2017). I, as the researcher, have indicated in the section that deals with ethics the steps that were taken to ensure that the SASAS data was sourced ethically from the Human Sciences Research Council. I have also indicated how the study was given ethical approval by the University of KwaZulu-Natal.

6.4 Secondary Data Analysis

Secondary data analysis is quite common when research is undertaken quantitively, given that there are normally large data sets to work with and a depth of unused information. I used my affiliation as a researcher at the HSRC to determine the usage of this data, especially since I have the knowledge that in the organization, we have an array of rich, accessible data that gets curated but is under-utilized. The usage of this data set was not a blind choice as it was informed by my association with the HSRC and the knowledge I have about how this data was collected and weighted and, importantly, what it was initially collected for. It has become common practice in the organization to re-analyze collected data to use it for research studies. Understanding that secondary data analysis is a procedural process, in this sub-section I briefly explain the steps I took to identify and prepare the data for usage for this study. While I acknowledge that there is a dearth of literature that defines this specific process, I explain the process which I undertook and followed in doing my research.

6.4.1 Developing research questions

While formulating research questions is an essential part of every study, it was crucial that the research questions for this study were conceptualized in a way that allowed for the utilization of secondary data to provide answers. I had to ensure that I developed the research questions while keeping the facts in mind, and that was the first action that I performed. As stated in Chapter One of this thesis, the main goal of this study was to investigate the relationships between the micro-level sociological characteristics and the perceptions of the 4IR in South Africa. The objective of this study served as the framework for the research questions, which were clearly stated in Chapter One. The chosen research questions are underpinned by a positivist epistemological stance, emphasizing the pursuit of objective knowledge and the establishment of truth through a detached and unbiased approach. In adherence to the positivist paradigm, the questions are formulated to explore observable relationships and factors that contribute to attitudes and cultural acceptance of 4IR technologies in South Africa. The inherent objectivity of positivism aligns with the belief that knowledge can be generated impartially, transcending the influence of participants and researchers on the research process.

6.4.2 Identifying the dataset

It is commonly known that "the research process begins with assessing what is known and what remains to be known about a topic", and this includes exploring literature and previously collected data on the subject or topic (Johnston, 2014, p. 621). For this research study a literature review was conducted that explored previous and current work that studied industrialization effects through the prism of public opinion data. While I carried out this literature review, I benefitted from different networks that became useful as they provided valuable information on what research is currently being conducted. As a researcher, I had the benefit of knowing about the SASAS data of the HSRC and knowing the team that worked on it. I was guided on what the original survey research did, the fact that it is rare for original surveys to utilize all the data collected, and that this unused data is often able to provide a different perspective on the phenomena being investigated (Johnston, 2014). My goal in the process of identifying the dataset was to find a fit between the research questions and the dataset, and in this study the research questions were a good fit for the original dataset. Additionally, I was made aware that my approach to the study would fit neatly

with the dataset. This awareness was gained during conversations and consultation meetings with the HSRC SASAS researchers and the principal investigator for the dataset.

6.4.3 Evaluating the dataset

Once the dataset was identified as viable for this study, the next step I took was to ensure that the data was appropriate for the research topic. “The advantage of having the dataset in some form was essential to check for the quality in advance before use” (Johnston, 2014, p. 622). Certain steps were followed to gather information to determine the appropriateness of the evaluated dataset:

- Determination of the purpose of the study from which the dataset emerged.
- Knowledge of who was responsible for collection of the information, to ensure that the responsible personnel had the necessary research skills and subject area knowledge.
- Determination of the relevance of the information that was collected for this study.
- Knowledge of when the information was collected and how the information was collected.

I was able to follow the above steps to evaluate the data as I had unrestricted access to and was allowed to utilize all of the documentation pertaining to the study. In addition, I was able to consult the principal investigator at any point of my study as we work for the same organization.

The subsequent sections of this chapter will discuss the sample design, data weighting and control, questioning of the respondents and all the ethical procedures followed to ensure that this study was ethically compliant. All of these issues discussed in the next sections were pertinent to the process of evaluation and they reflect the information received from the SASAS principal investigator and the information made available to me about the dataset.

6.5 Sample Design

This study employed a non-experimental, comparative-causal quantitative research design, since it was most appropriate for this study's goal of identifying whether there were differences in South African citizens' attitudes toward the effects of the 4IR (Gall, Gall & Borg, 2007). A causal-comparative study design is preferred by some researchers to examine the independent variable because it is more consistent with how social scientists interpret and use research and data inside

their separate organisations (Gall et al., 2007). Gender, age, population group, and awareness of social class were included as independent factors in this study's socio-demographic components. For the purposes of this study, attitudes toward technological development, or the 4IR, served as the dependent variable. The survey questions were designed to let the respondents rate how comfortable or uncomfortable they were in a variety of settings involving the technology of the 4IR, such as the use of robots (industrial robot surgery, eliminating manual factories, delivery drones, and self-driving vehicles), and to determine the effects of the technology on people's social, economic, and overall quality of life.

Since the SASAS was a survey of adults, those who were 16 or older were regarded as adults (with no upper age limit). A set of small area layers (SALs) and the most important national census data served as the foundation for the sample frame for this investigation (SASAS, 2018). Population estimates were obtained for the numerous census variable categories, and according to the SALs. Industrial zones, recreation areas, empty SALs, and special institutions (such as military bases, hospitals, dorms for students at colleges and universities, and nursing homes) were all left out of the sample frame before it was drawn (see Figure 6.1).

Figure 6.1: SAL map used by fieldworkers
Source: South African Social Attitudes Survey (HSRC, 2018)

6.6 The Dependent Variable

The study's outcome variable was a composite index of attitudes toward technological change, or the 4IR. The outcome variable reflected how 4IR technologies affected respondents' social and economic lives, as well as their overall quality of life. It was based on questions that asked respondents to rate how comfortable or uncomfortable they felt in various scenarios involving 4IR technologies, such as the use of robots (such as robotic surgery, drone delivery, and self-driving cars). The dependent variable was binary and that justified the choice of using binary logistic regression analysis.

To construct this composite index, several questions were strategically chosen from the survey instrument. Respondents were presented with scenarios involving various 4IR technologies, such as robotic surgery, drone delivery, and self-driving cars. The questions were designed to gauge the level of comfort or discomfort individuals felt in these scenarios. Specifically, respondents were asked to rate their comfort levels on a scale, providing valuable insights into their attitudes toward different manifestations of 4IR technologies.

The construction of the dependent variable was purposeful, mirroring the binary nature of the responses gathered. Respondents' comfort levels were dichotomized into two categories: comfortable and uncomfortable. This binary categorization justified the utilization of binary logistic regression analysis, as the dependent variable aligns with the nature of a binary logistic model.The specific questions contributing to the construction of the dependent variable are elucidated. Each question corresponds to a scenario involving 4IR technologies, and respondents' responses were instrumental in shaping the final binary variable used for analysis.

Table 6.1 specific questions for Constructing the Dependent Variable

Question No	Scenario	Response category
Q1	Robotic surgery performing a medical operation	Comfortable
Q2	Factories replacing workers with robots	Uncomfortable
Q3	Receiving goods delivered by a drone or robot	Comfortable

Q4	Shops replacing cashiers with robots	Uncomfortable

6.6.1 The independent variables

Additional socio-economic indicators, such as gender, age, population group, social class, and expertise, were included as separate socio-demographic variables to act as indicators of social privilege and disadvantage. A more detailed record of the respondents' highest educational level/degree was used to produce the category variable known as "educational achievement". The set of dummy variables used in the models included "matriculation or its equivalent", "primary or no formal education" (the reference group), "incomplete secondary education", and "further education". I gauged Internet accessibility using a dichotomous variable. Subjective class was assessed using an 11-point top-to-bottom self-placement scale.

The employment status variable used in the study was a straightforward classification of whether or not the respondent was actively employed in the labour market. It was combined with a British Social Attitudes Survey measure of "perceived personal job danger" ("very/quite worried vs. not very/not at all worried") (SASAS, 2018). "Employed but not worried about 4IR threat", "employed and worried about 4IR threat", and "not in the labour market" were the resulting categories. This was included to assess the respondents' self-reported vulnerability to automation in the workplace.

The knowledge index, as indicated earlier, was a measure of the percentage of respondents who said they knew enough about the three technical concepts of the 4IR: "social media platforms", "artificial intelligence", and "driverless cars" to be able to describe them to a stranger. Self-rated competency was assessed based on whether respondents felt they were sufficiently skilled in using "computer and Internet technologies for their daily life". It used a five-point scale with the options that ranged from "absolutely disagree" (1) to "completely agree" (5). The question: "how confident are you that the South African government can ensure that new technologies do not contribute to job losses?" was followed by an inverted four-point scale to assess the level of confidence in the government to manage the 4IR. Options ranged from "not at all confident" (1) to "extremely confident" (4), as the scale had four points.

6.7 Method of Data Analysis

The Statistical Package for the Social Sciences was used to analyze the data generated for this study and it used descriptive and inferential measures when necessary (SPSS 27.0). When presenting complex material, descriptive statistics are used to summarize the data and provide a clear picture of it (Mishra et al., 2019). With the help of sampled data, inferential statistics can derive conclusions about the characteristics of the population from which the sample was taken (Mishra et al., 2019). A sequence of steps was taken when conducting the data analysis and descriptive statistics, correlational statistics (bivariate), and a binary logistic regression analysis (multivariate) were the types of statistical tests employed.

Descriptive statistics were employed to objectively summarize and present complex material from the SASAS data. The goal is to provide a clear and unbiased overview of the data, allowing for a straightforward interpretation. The use of inferential statistics aligns with the positivist aim of drawing objective conclusions about the population from which the sample was taken. This method enables the derivation of broader insights from the sampled data. The application of correlational statistics and binary logistic regression analysis adheres to the positivist tradition of utilizing empirical evidence to explore relationships and make predictions. These methods uncover objective patterns and associations within the data, contributing to the generation of knowledge in an impartial manner.

6.7.1 Descriptive statistics

Information was gathered and descriptive statistics were created to analyse the sample's demographic factors. These included age, gender, race, education, employment, income, Internet access, and geographical type. These micro-sociological indicators were used in the cross-tabulations that are presented in Chapter Seven. The respondents had to choose from a series of statements and questions relating to technology, Internet access and the 4IR and their answers were then analyzed. Positive statements (strongly agree and agree) were interpreted (conflated) as agreement, while negative statements (disagree and strongly disagree) were interpreted (conflated)

as disagreement. This measure of means compared a sample's mean to a predetermined value and looked for deviations from it.

The term ‘socio-economic status’ (SES) refers to a person's or group's social standing or ‘class’, and it is frequently determined by combining factors like education, income, and occupation (Gordon, 2017). SES analysis frequently reveals privilege, power, and control issues, as well as unequal access to resources. Examining the socio-economic position frequently reveals difficulties with privilege, power, and control, as well as disparities in access to resources. Claims in the literature that industrialization has stifled economic change and about how it has affected different genders, age groups, and people from different social classes made it crucial to discuss the socio-economic elements of this subject. In this study it was crucial to compare the respondents' socio-economic level with their attitudes toward the 4IR.

6.7.2 Bivariate statistical test

In this study, I used the Chi square test to determine if there was a significant association between the independent variable and the outcome variables. The Chi square was used to test the seven hypotheses presented in Chapter One of this study. The results and analyses of the hypotheses testing are in Chapter Eight.

6.7.3 Multivariate statistical test

A variable's value can be predicted using binary linear regression based on the value of another variable. The main goal of regression analysis is to determine if a group of predictor variables can accurately predict a dependent variable and an outcome variable. In this study I was interested in examining the relationship between the various demographic and socio-economic factors (such as age, gender, housing type, race, and province) and the individuals' attitudes towards the fourth industrial revolution (4IR). The outcome variable was a binary variable (acceptance vs. non-acceptance of 4IR) so binary logistic regression was the appropriate statistical technique to use. Binary logistic regression allowed me to model the relationship between a binary outcome variable and one or more predictor variables. I used binary logistic regression to estimate the effect of each predictor variable on the odds of acceptance of 4IR, while controlling for the effects of other predictor variables. I also considered which variables significantly influenced the outcome

variable, as indicated by the size and direction of the coefficient estimates. In my study, the goal was to identify the factors that indicated favourable attitudes about 4IR technology. The regression model was used to explore the extent to which the micro-sociological indicators were associated with positive or negative attitudes. Below is an equation of the binary logistic regression model that was used, and this is discussed in Chapter Eight of this study:

$$P(Y = 1) = \Phi(\beta 0 + \beta 1X1 + \beta 2X2 + ... + \beta kXk)$$

Acceptance towards 4IR = β0 + β1(social class) + β2(gender) + β3(age) + β4(race) + β5(employment status) + β6(education) + β7(self-rated 4IR knowledge) + β8(self-rated ICT knowledge) + β9(Internet access) + β10 (geographical location) + XK

Where:
P(Y=1) was the predicted probability of the binary outcome variable (acceptance towards 4IR).
(X1, X2 represented the micro-sociogical indicators, such as age, gender, race, education, self-rated ICT knowledge, geographic location).
β0 was the intercept/constant term.

β1, β2 were the coefficients or slopes associated with each independent variable.
e was the error term or residual which represented the unexplained variance in Y that was not accounted for by the independent variables.

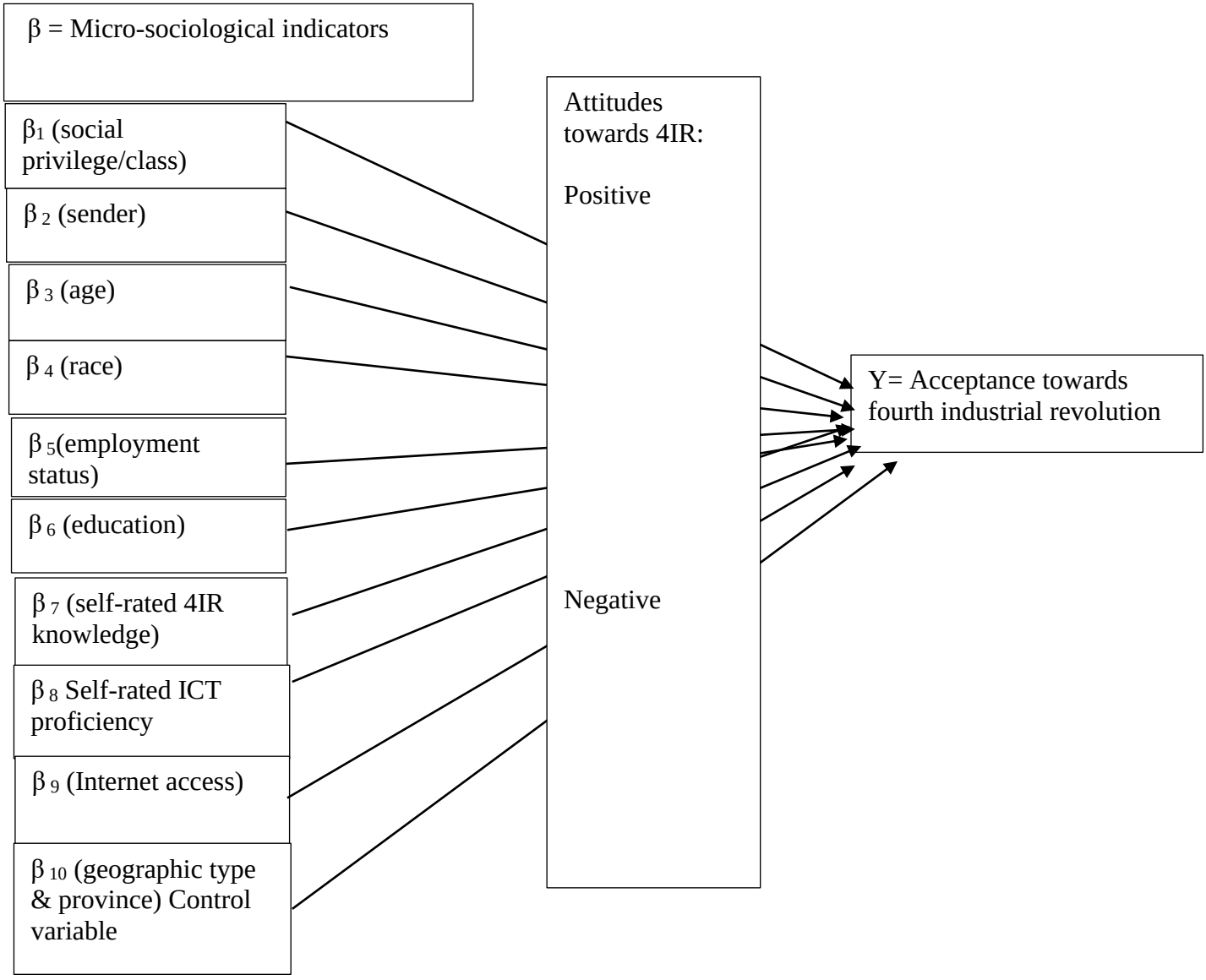


Figure 6.2: Diagram of the binary regression analysis performed

Control variables are independent variables that are included in a regression analysis to account for the influence of other factors. In this study these were the geographic type and province that could affect the relationship between the independent variable(s) and the dependent variable.

6.8 Validity and Reliability of the Data

Content validity is the degree to which the instrument accurately assesses or measures the pertinent construct. For instance, this study examined how views about the 4IR in South Africa were related

to important micro-level sociological characteristics. I was able to assess the validity of the research and whether or not the questions adequately reflected the participants' opinions about the 4IR by looking at the questionnaire that was used to collect the data (Sushil & Verma, 2010).

Understanding the data was important when considering its reliability and validity. My consultation meetings with the SASAS researchers allowed me to gain knowledge of how it was collected, who collected it, and what it measured. This helped to identify any potential biases or limitations that could affect the validity and reliability of the data.

I did not use all the variables in the dataset; only those I deemed relevant for this study. I therefore transformed the dataset in SPSS, which helped with data cleaning and coding. This made the data relevant for my study more accessible. This process also allowed me to validate the data as using datasets with n=2763 participants required checking that the data accurately measured what it was intended to measure. I performed statistical tests to confirm that the data did measure what it claimed to measure and conducted sensitivity analyses to test the robustness of the results. Missing data or outliers in the original data set could affect the reliability of measures or scales in the secondary data set. If a substantial amount of data was missing or there were outliers in the data, this could affect the reliability of the measures or scales. I checked for this and found that the missing data was not significant enough to affect the reliability for each of the statistical tests conducted for my empirical chapters.

Checking for data consistency involves comparing the data to itself and to external sources to identify inconsistencies or errors. This was done by comparing the summary statistics and the visualizations, as well as by performing statistical tests to ensure that the data was consistent with what was expected.

6.9 Ethical Considerations

A strong internal code of ethics is followed by both the HSRC and the University of KwaZulu-Natal, and I adhered to both of the institutions' ethical procedures. At the HSRC I received the support of the data owner/principal investigator, and a letter was written to my academic supervisor to that effect (see Appendix B). Thereafter a confidentiality agreement was signed between me as

the researcher and the SASAS/HSRC (see Appendix C). This was to ensure that I adhered to the privacy policy regarding the participants' information/data, and to ensure that no mention was made of any names or identifiable features of the participants in my analysis. At the university I completed an ethics application form and after receiving ethics approval, I presented it to the HSRC SASAS principal investigator so as to receive access to the datasets. This study's ethics protocol number received from the University of KwaZulu-Natal is HSSREC 00002210/2020, which is included in the appendices of the thesis (Appendix A).

6.10 Limitations of the Study

There are numerous limitations associated with using secondary data, but I will only mention those related to this study. For instance, there was a lack of control over the data collection process. I could not personally observe certain things in the field that could provide further insight. However, as a secondary researcher I mitigated this limitation as I consulted continuously with the primary researchers and the documentation provided. A dataset like the SASAS has a lot of variables, given the nature of this survey that collects a wide range of information. Using such a large dataset could raise issues of specificity. I mitigated this as I had clearly defined research questions and hypotheses, which helped me to select the variables that were most relevant to my study. A secondary analysis also raises ethical concerns but I solved this when I submitted my research proposal to the HSRC so that they could check if privacy and confidentiality would be breached.

6.11 Chapter Summary

This chapter showed that secondary data analysis offers methodological benefits and can contribute towards the generation of new knowledge. "The discussion in this chapter has shown that this method is the same as others, that is to contribute towards scientific knowledge by providing a different perspective" (Johnston, 2014, p. 625). The only difference was the reliance on secondary data to answer the research question. This chapter acknowledged the need to follow a systematic process that acknowledged both the advantages and disadvantages of utilizing secondary data.

The positivist paradigm was used to guide the quantitative research process of this study. Selection of this paradigm was influenced by the theoretical approach and research objectives that guided the study. I discussed the secondary data analysis process that I followed to ensure the suitability of the dataset chosen for the study. The next two empirical chapters (seven and eight) focus on the presentation, interpretation, and analysis of the secondary data.

.

CHAPTER SEVEN: PUBLIC OPINION TOWARDS THE FOURTH INDUSTRIAL REVOLUTION IN SOUTH AFRICA

7.1 Introduction

The problem statement of this study recognized the potential opposition to 4IR policies from a Neo-Luddite perspective, and highlighted the importance of considering the social dimension. Chapter One reiterated the assumptions of beneficial socio-economic development associated with the 4IR. However, there is limited public opinion research on the perceptions about robots and automation, particularly in the global south and specifically in South Africa where 4IR policy development is still in its early stages. Consequently, this study aimed to provide empirical evidence on public attitudes toward the 4IR to support policy development by addressing this evidence gap.

The study utilized data from the SASAS to achieve this, and examined the extent to which factors influenced public perceptions about automation and robots. The inclusion of micro-level sociological variables was essential to avoid overgeneralization and to enhance our understanding of the factors that shape public attitudes toward the 4IR and other technological advancements. Prior chapters have already discussed the rationale for adoption of a quantitative approach, the steps taken to ensure the validity and reliability of the study's results, and addressed the ethical considerations related to data collection. The focus of this chapter is to present and analyze the data through cross-tabulation analysis to identify trends and patterns in the data and provide valuable insights that will inform the subsequent chapter on regression modelling. This sequential approach ensures a comprehensive examination of the data and strengthens the validity and reliability of the findings. Cross-tabulation allows for the exploration of associations between categorical variables, and sheds light on any potential dependencies or patterns. It enables the identification of relationships that may be crucial to understand public attitudes toward the 4IR.

The chapter concludes with a summary of the descriptive findings, and emphasizes the most salient observations and patterns that emerged from the data. It also lays the groundwork for the

subsequent chapter on bivariate analysis and regression modelling, where the relationships between variables are further explored.

7.2 Social Demographic Characteristics

The key research questions of the study, which looked at the 4IR through the prism of public opinion, was addressed by looking at the many social demographic traits that are presented in this part of the study. This dissertation's primary objective was to evaluate the reliability of these micro-sociological factors. The study examined both attitudes and non-attitudes (such as educational attainment) as driving factors. Attitudes included opinions regarding new technological breakthroughs.

Table 7.1 provides a comprehensive overview of the micro-sociological indicators used in this study. These indicators have been disaggregated and are utilized for cross-tabulation analysis in this chapter. Furthermore, they are crucial for the bivariate and multivariate analyses conducted in Chapter Eight. Given that the integrated model was centered around the influence of micro-sociological indicators on attitudes towards the fourth industrial revolution (4IR), it was imperative to examine the trends and patterns of these indicators through cross-tabulation with 4IR-related questions. This analysis enabled a deeper understanding of the relationships between these indicators and attitudes towards 4IR and allowed for meaningful insights into the role they played in shaping these attitudes.

Table 7.1: List of the independent variables

Micro-level indicators	**Number**	**Percentage (%)**	**Mean**	**Standard deviation**
Gender				
Female	1577	59%	1.3862	0.48703
Male	1094	41%	1.4662	0.49908
Age group (yrs)				
16–30	813	30%	1.4809	0.49994
31–61	1389	52%	1.4010	0.49028
62–92	467	17%	1.3640	0.48167
93 and above	2	1%	1.5185	0.60450
Race				
Black African	1694	63%	1.3949	0.56727

Coloured	404	15%	1.3218	0.55667
Indian/Asian	319	12%	1.4647	0.56716
White	252	9%	1.7460	0.62044
Other	2	1%	2.6250	0.53033
Employment status				
Employed	780	29%	1.4853	0.60242
Unemployed	1878	71%	1.4336	0.56991
Level of education				
No schooling	124	5%	1.3105	0.47109
Primary school	398	15%	1.2682	0.47990
Matric	1775	67%	1.4637	0.57543
Certificate	97	3%	1.6624	0.67704
Diploma	120	5%	1.5188	0.64834
Degree	119	4%	1.6239	0.66533
Postgraduate	14	1%	1.9643	0.81369
Social Class				
Lower class	1065	40%	1.2995	.45827
Working class	595	22%	1.4420	.49704
Middle class	816	30%	1.5208	.49987
Upper class	127	5%	1.7897	.93912
Don't know	60	3%	1.2667	.44595
Geographic type				
Urban formal	1872	70%	1.4407	.49660
Urban informal	123	5%	1.3252	.47037
Traditional	541	20%	1.3789	.48557
Farms	135	5%	1.3630	.48265

7.2.1 Exploring micro-sociological indicators and 4IR questions through cross-tabulation

In this section I present the results of the cross-tabulations to identify associations, patterns, and dependencies between variables. This helps to provide insights into the relationships and potential dependencies between variables, and these will be tested further in Chapter Eight using bivariate and multivariate testing. The first cross-tabulation by race and age group was based on the question that the respondents were asked**: "Does technology make you life easier and comfortable**?" Figure 7.1 shows the data represented in counts and not percenatges, and indicates that more black Africans strongly agreed with this statement (n=844). This was followed by coloureds (n=175), Indians (n=163) and whites (n=123).

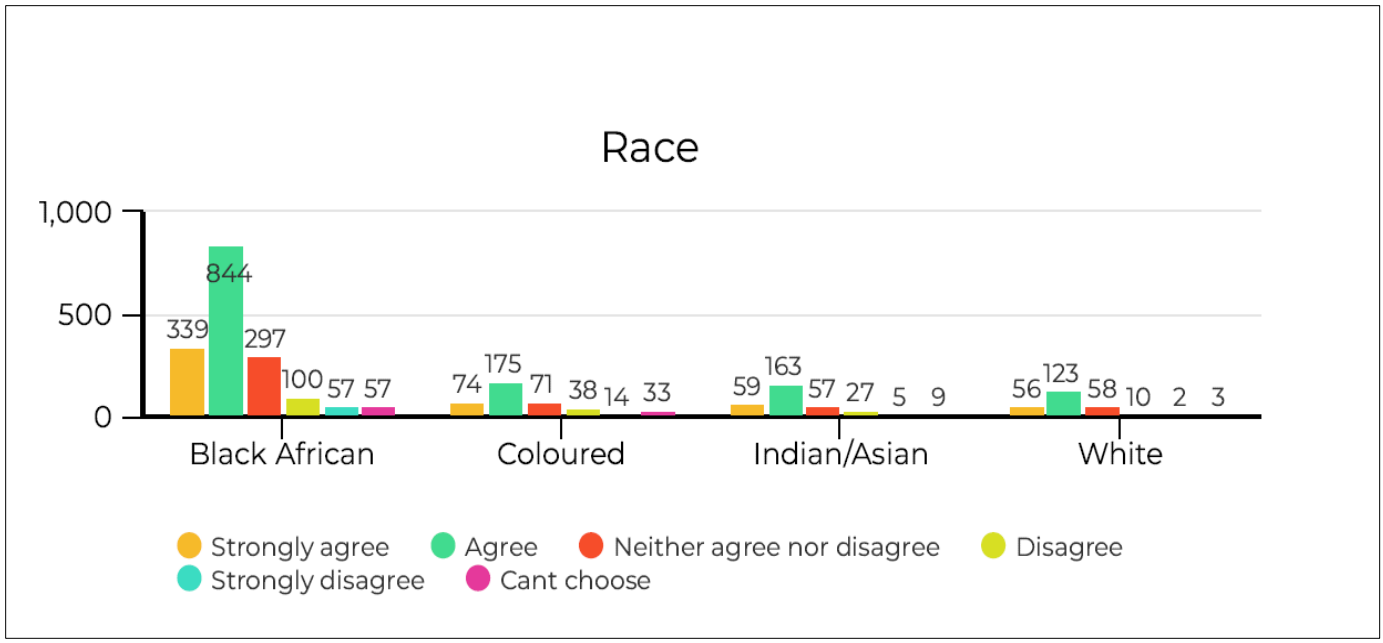


Figure 7.1: Technology and making lives easier by race

Figure 7.2 shows that those who belonged to the age group 16-45 years agreed that technology made their lives easier (n=407), but those more mature and aged 46-60 years were more agreeable about this (n=691). Older people near and post-retirement age (61-92 years) agreed the least that technology made their lives easier (n=208).

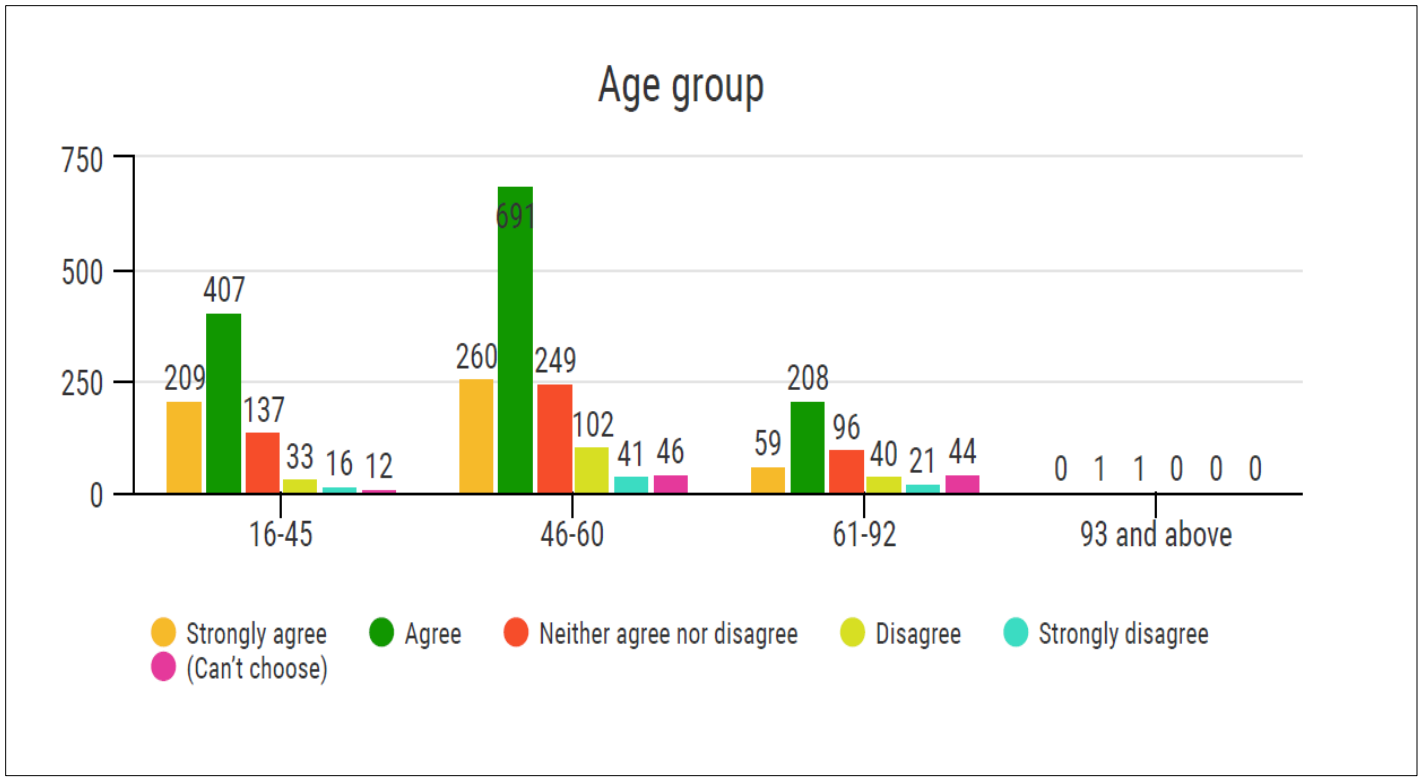


Figure 7.2: Technology and making lives easier by age group

I then moved on to explore answers to this statement: **"It is not important to know about science and technology in my daily life"** and gauged the importance that the respondents placed on science and technology. I cross-tabulated the responses according to gender (see Figure 7.3) and educational level (see Figure 7.4)

The number of females who agreed with the statement was n=443, and the number of males who agreed with this was n=353. There were a significant number of women who disagreed (n=403) with this statement as they did not feel that science and technology was important in their lives.

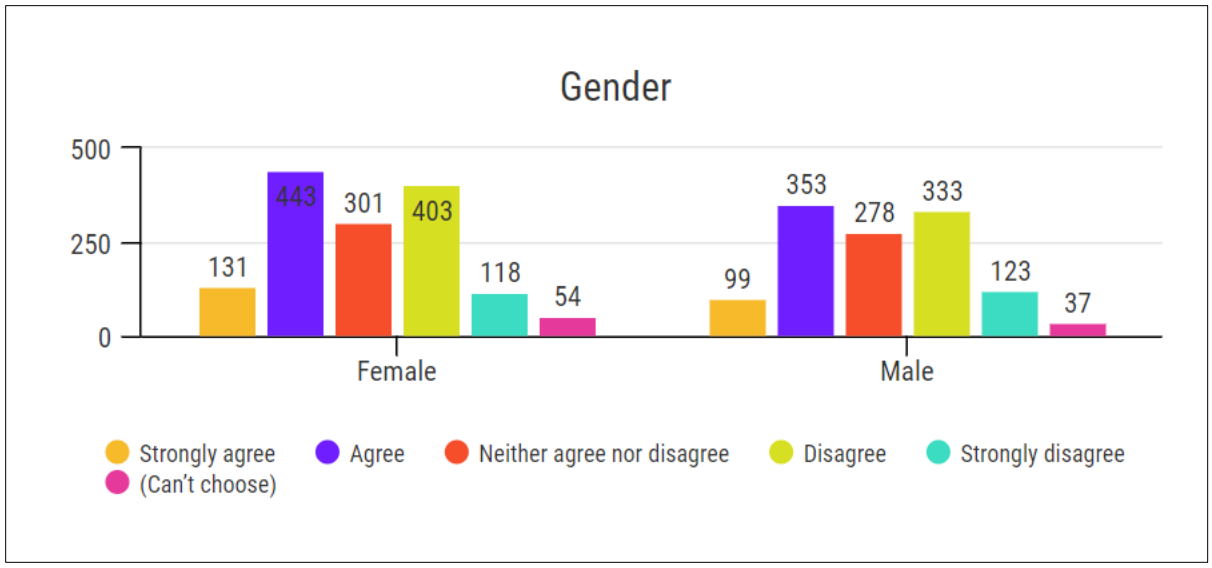


Figure 7.3: Importance of knowledge of science and technology by gender

The results showed that the greatest number of responses came from participants with a high school education, and those results were mixed. The number who agreed with the statement that it was not important to know about science and technology in their daily lives was very similar to the number who disagreed with the statement and felt that knowledge of science and technology was actually important in their daily lives. But there were slightly more participants that disagreed with the statement (n=519) compared to those who agreed with it (n=517). Those who had a tertiary level education disagreed more than they agreed with the statement that it was not important to know about science and technology in their daily lives as n=82 disagreed and n=66 agreed that this was the case. Participants with a tertiary level education thus realized the importance of science and technology.

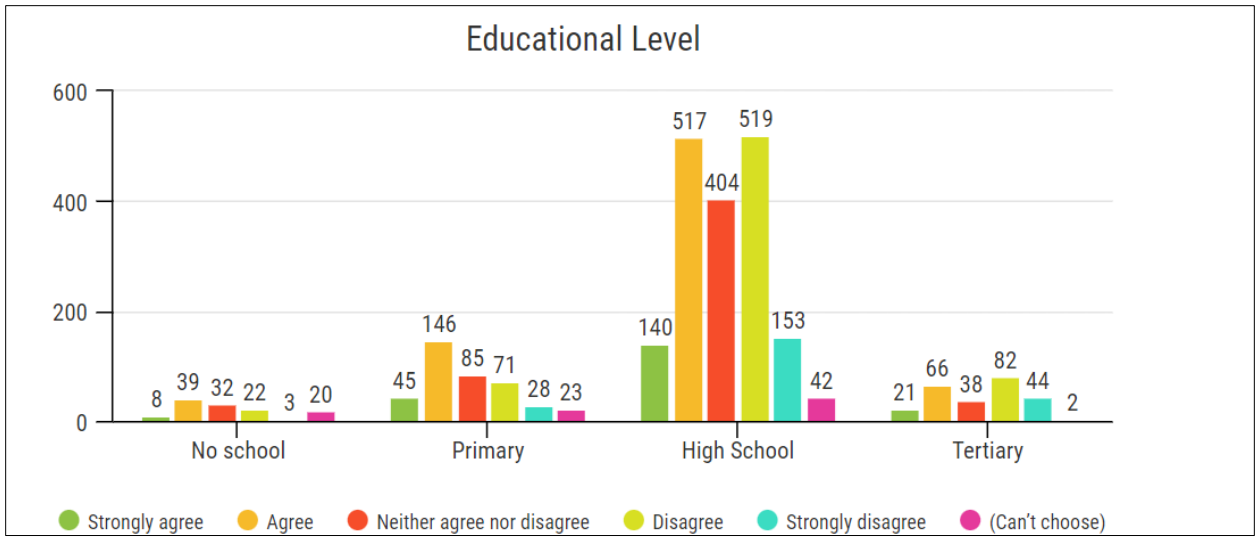


Figure 7.4: Importance of knowledge of science and technology by educational level

Cross-tabulation was employed to see how participants responded to this statement: **To what extent do you agree or disagree with the following statement? Schools prepare young people to work with new technology.** This was done to further gauge perceptions on science and technology, and I looked at this by age group (see Figure 7.5). The sentiment amongst all age groups was that young people were prepared for technology use at schools. A total of 323 participants from the 16-45-year age group agreed. A total of 536 people from the 46-60-year age group agreed. Lastly, 182 people from the 61-92-year age group agreed with the statement.

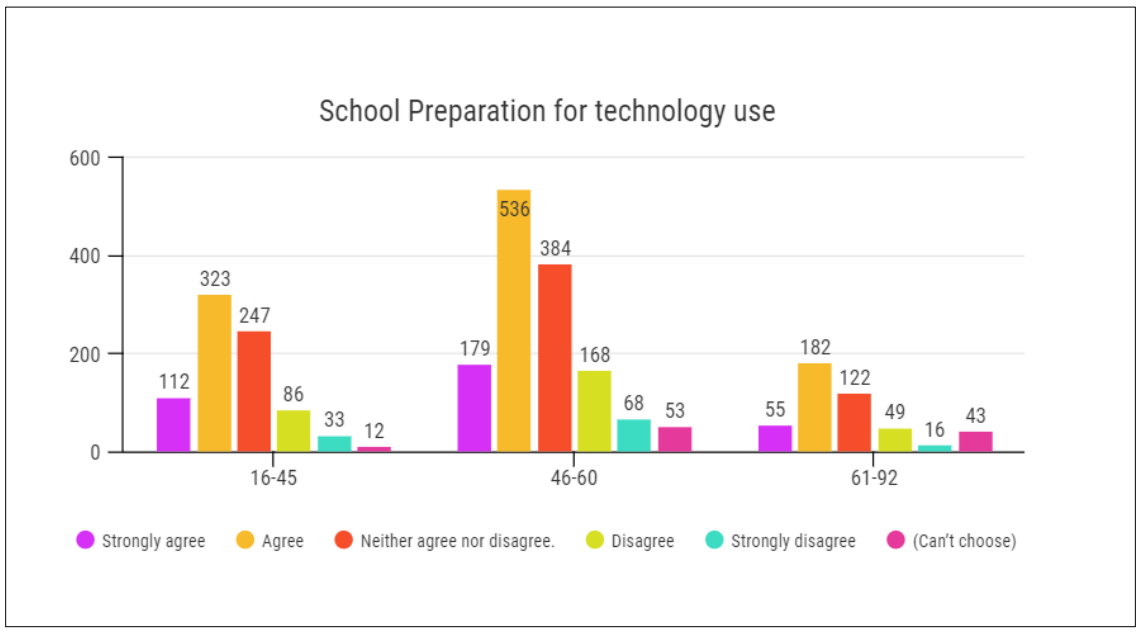


Figure 7.5: Schools prepare young people to work with new technology.

I then looked at the effect of social class on how technological advancements were viewed. I cross-tabulated according to social class (Figure 7.6) and race (Figure 7.7) and the statement they needed to respond to was: **Scientific advances tend to benefit the rich?**

The results in Figure 7.6 show that those belonging to the lower class agreed with this statement the most as n=493 participants agreed that this was the case. A further n=170 participants from this social class strongly agreed with the statement. A significant number from the working (n=268) and middle class (n=320) also agreed with this statement. There was quite a low number of people who disagreed with this statement from the lower class (n=91), the working class (n=90) and the middle class (n=137).

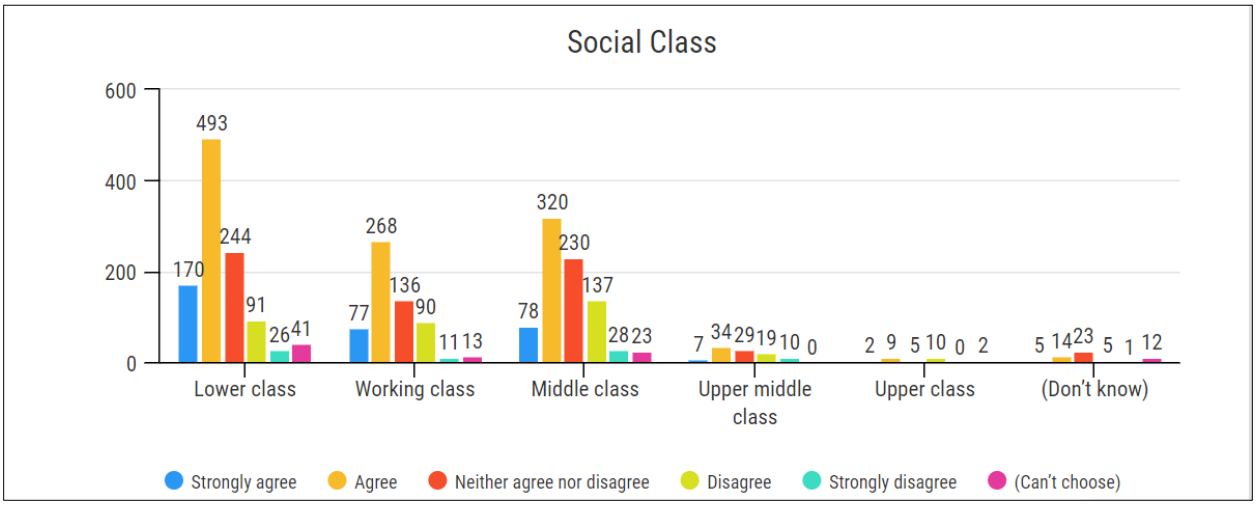


Figure 7.6: Science and technology benefits by social class

When the statement was analyzed by race, it was mostly black Africans that agreed with the statement (n=772), while a further n=215 strongly agreed with it. A total of n=199 black Africans disagreed with the statement. Coloureds and Indians also agreed with the statement, with n=164 and n=114 respectively (see Figure 7.7).

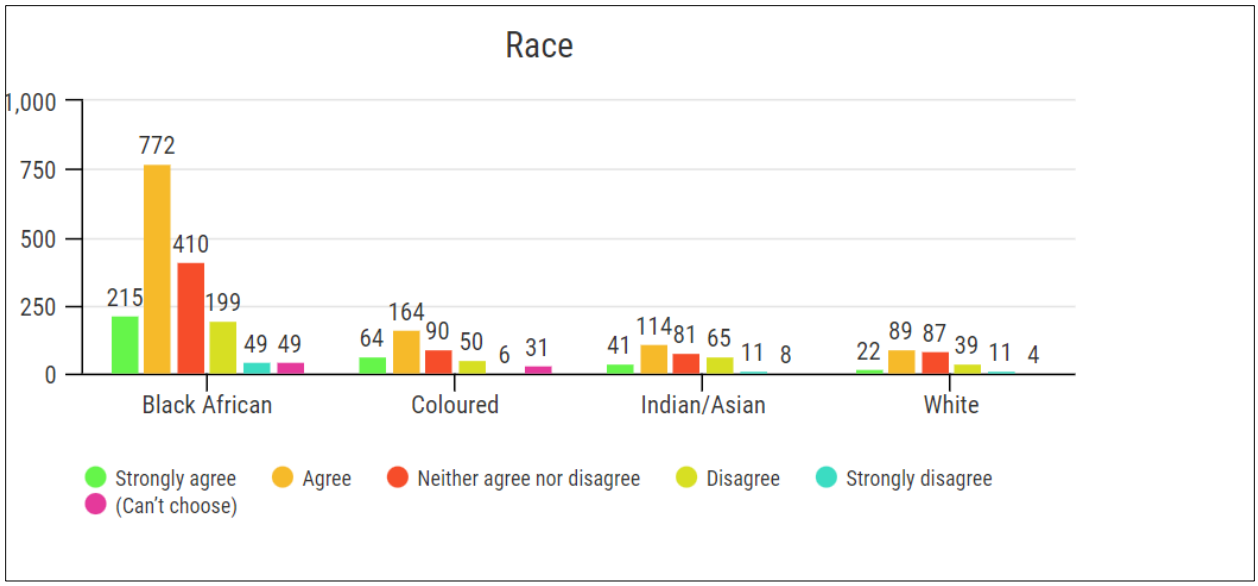


Figure 7.7: Science and technology benefits by race

Next, the level of concern regarding job security was examined among both employed and unemployed individuals. Although the question was answered by respondents from both groups, it was important to analyze the results for those classified as unemployed. This sub-group was particularly interesting to explore since some of these individuals could have income sources despite not being officially employed, and these alternative income sources could also be susceptible to the 4IR's potential threats. The statement responded to was: **How worried are you that in the next 10 years, your job might be done instead by machines or computer programmes?**

Of those employed, n=253 were very worried about this, while n=279 from the unemployed group were also very worried. A larger number of unemployed were thus very worried about jobs being replaced by machines or computers. A total of n= 92 employed people were not at all worried, and n=108 unemployed people were also not worried by this at all.

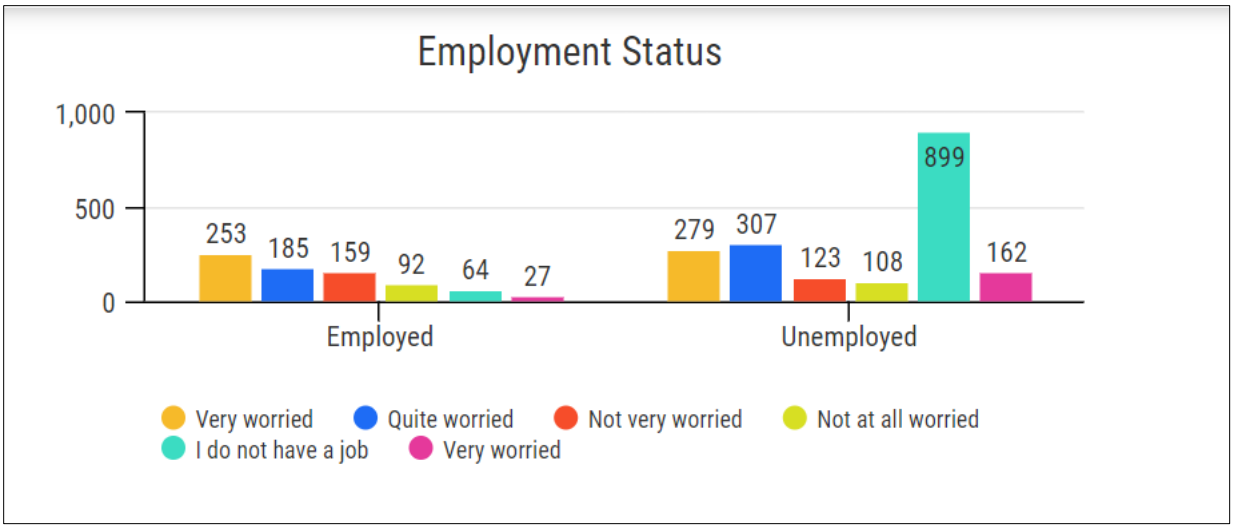


Figure 7.8: Level of worry for job security

Finally, cross-tabulations were conducted to examine the levels of confidence in the government based on political affiliation, race, and age. The respondents were asked to provide their views on the following statement: **How confident are you that the South African government can ensure that new technologies do not lead to job losses?**

A full list was provided of the political parties in South Africa in the survey, and the analysis focused on the four parties that were predominantly selected by the participants. These parties were chosen based on their higher association with a larger number of respondents. Results show that 98 people associated with the ANC were confident in the government's ability to protect jobs; while 388 people indicated that they were fairly confident; 343 were not very confident; and 253 were not confident at all in the government's ability to do so. Those affiliated with the DA responded as follows: Only 22 were very confident; 105 were fairly confident; 129 were not very confident and 111 not at all confident.

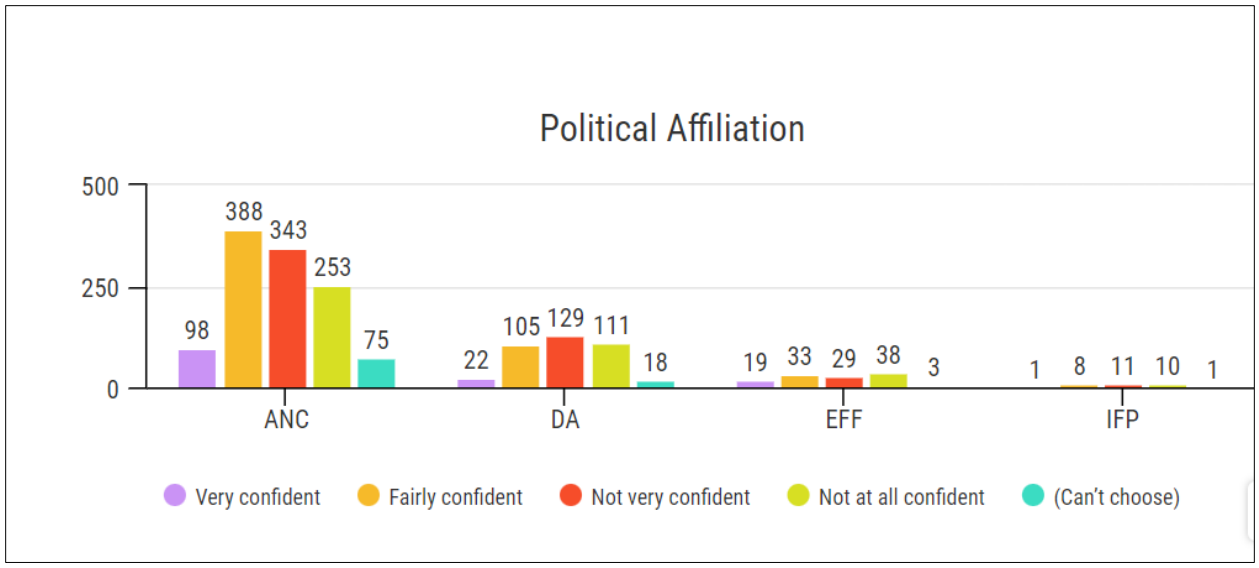


Figure 7.9: Confidence in government per political affiliation

When considering race group, black Africans were mostly fairly confident (n=517) that the government could protect jobs. Another n= 493 were not very confident, while n= 427 were not at all confident that the government could do this. The other races were not very confident that the government could do this: coloureds (123), Indians (120) and whites (80).

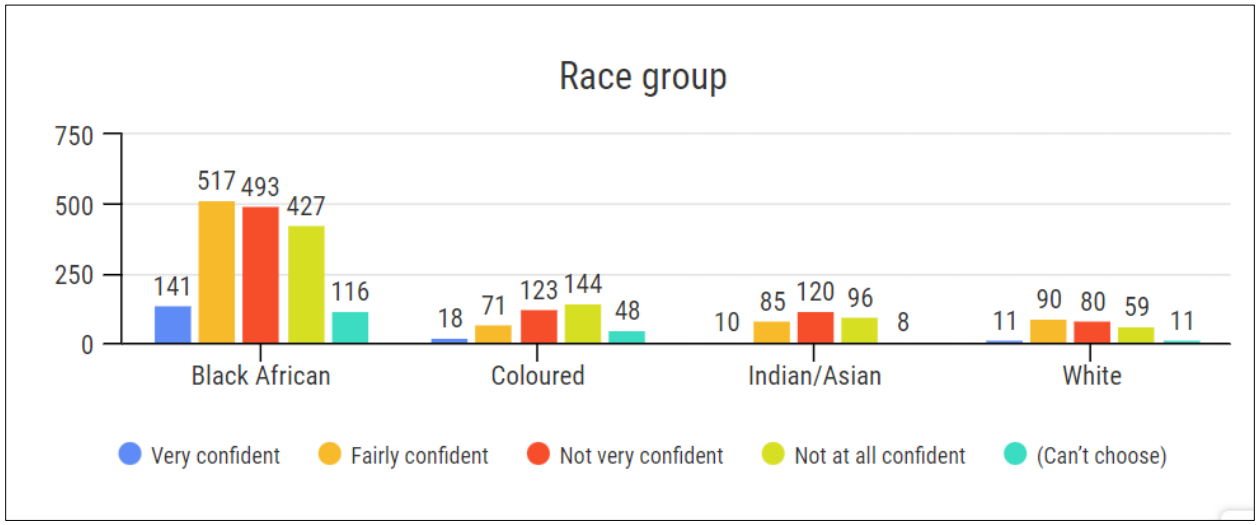


Figure 7.10: Confidence in government by race group

When examining the confidence in the government by age group (Figure 7.11), it was a close call. Of those who were middle aged (46-60), 423 were not very confident while 391 were fairly confident. From the younger group (16-45), 247 were fairly confident but 264 were not very confident that the government could protect jobs.

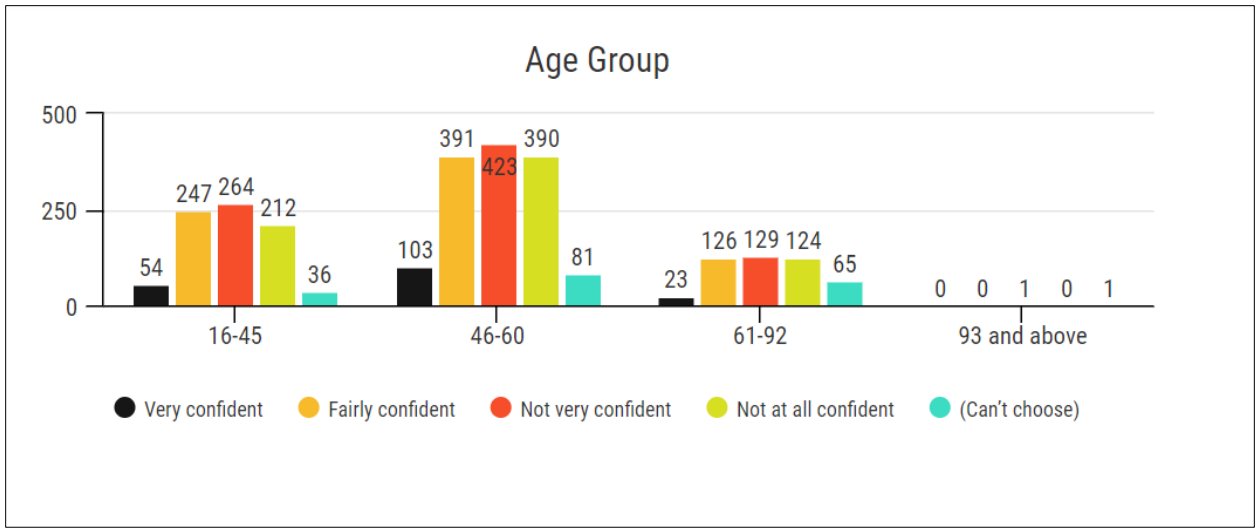


Figure 7.11: Confidence in government by age group

7.2.2 Discussion

One finding from the cross-tabulations was that younger individuals across the different racial groups, including black South Africans, perceived technology to make their lives easier. This finding aligned with the theory of Social Shaping of Technology, which posits that individuals' attitudes and experiences with technology are influenced by social factors. According to the theory, societal norms, cultural influences, and generational differences play a significant role in shaping people's perceptions of technology (Osembe, 2021). The finding that younger individuals, regardless of their racial background, shared a positive view of technology's ease of use supports the theory's notion that younger generations tend to embrace and adapt to technological advancements more readily than older generations.

Furthermore, considering the specific context of black South Africans, historical and socio-economic factors could also contribute to their agreement with the notion that technology simplified their lives. The advent of the fourth industrial revolution brings opportunities for increased access to information, communication, and services, which can potentially alleviate some of the historical inequalities and barriers faced by marginalized communities (Orthofer, 2016). This finding highlighted the reciprocal relationship between society and technology, as described by the Social Shaping of Technology theory. It suggested that the social context, in this case, age and race, influenced individuals' perceptions of technology's impact on their lives. The

theory of Social Shaping of Technology emphasizes that technology is not a neutral entity, but rather shaped by and shapes social factors, and this finding supported that perspective. This provided valuable insights into the alignment between the theory of Social Shaping of Technology and the perceptions of ease and convenience associated with technology among the different demographic groups.

The analysis also revealed that women participants had mixed responses, as a significant number agreed with the statement (importance of science and technology in everyday life), but a substantial number also disagreed with it. Similarly, participants in high school also exhibited a similar pattern, with notable numbers that agreed and disagreed with the statement.

These findings could be examined in the context of the theory of Social Shaping of Technology (SST), which emphasizes the influence of social factors on individuals' perceptions and attitudes toward science and technology. The theory suggests that gender and educational background are among the social factors that shape individuals' engagement with and understanding of science and technology (Kumar, Sahoo, Lim & Dana, 2022; Williams & Edge, 1996). Regarding gender, the mixed responses from the women participants aligned with the theory. Gender roles, societal expectations, and cultural influences can contribute to variations in women's perspectives on the importance of science and technology in their daily lives. Factors such as limited representation, stereotypes, and biases can influence women's perceptions and may explain why some agreed while others disagreed with the statement (Guenther, 2018).

In the case of the participants in high school, the diverse responses noted were also in line with the SST theory. Education plays a crucial role in shaping individuals' understanding of science and technology. The mixed responses from the high school participants could be attributed to differences in their educational experiences, the level of exposure to science and technology, and individual interests or aspirations. Factors like curriculum design, teaching methods, and access to resources could contribute to the variations in their agreement or disagreement with the statement (Oke & Fernandes, 2020). Given that the Department of Communications and Digital Technologies (DCDT) has stated that young people will need advanced levels of digital

proficiency, it was important to gauge views of how schools prepared young people to use technology (DCDT, 2020; Digital Business Tech, 2020).

These findings underscored the complex interplay between social factors and individuals' perceptions of science and technology. They suggested that the SST theory holds relevance as it explains the nuanced attitudes of the different demographic groups. The theory recognizes that social context, including gender and educational background, influences how individuals perceive the importance and relevance of science and technology in their daily lives.

The analysis of the level of confidence in the South African government's ability to prevent job losses caused by new technologies revealed that a significant portion of the respondents expressed a lack of confidence across the different political affiliations, age groups, and races. Notably, even individuals associated with the leading ANC party showed a significant lack of confidence in their party regarding this. The SST theory highlights the importance of inclusivity and access to technology. The lack of confidence may also have stemmed from concerns about unequal access to technological advancements and the potential exacerbation of existing inequalities (Gagné, Parker, Griffin, Dunlop, Knight, Klonek & Parent-Rocheleau, 2022). Individuals from marginalized communities or with limited access to education and resources may perceive that new technologies exacerbate job disparities and exacerbate the existing socio-economic gaps.

The cross-tabulations conducted in this analysis were highly valuable in the identification of patterns and trends related to how the adult South African population perceived the fourth industrial revolution. Examination of the responses based on political affiliation, age, race, educational level, and social class served as a strong foundation for the subsequent analysis in Chapter Eight, where multivariate regression will allow for a deeper exploration of the factors that serve as predictors for acceptance towards 4IR, and will consider the influence of multiple variables simultaneously. The following section provides an exploration and analysis of the responses to additional questions and/or statements related to the fourth industrial revolution (4IR). These statements could not be included in the cross-tabulations as they were multi-layered, which made it challenging to conduct straightforward cross-tabulation analyses. Instead, a more in-depth

examination is conducted to capture the complexities and nuances associated with these statements and their relationship to the research variables.

7.3Analyzing Additional Statements on the Fourth Industrial Revolution (4IR): Beyond Cross-Tabulations

This section details the questions and/or statements that measured the descriptive 4IR scale values to perform a quantitative analysis of the questionnaire data. The dedicated values for each point of the Likert scale were as follows: “strongly agree, agree, neutral, disagree, strongly disagree, and can’t (cannot) choose” (SASAS, 2018).

7.3.1 Science and technology

The analysis of Table 7.2 provides valuable insights into the respondents' perceptions and attitudes towards science and technology (S&T), and these findings can be further understood through the lens of the theory of Social Shaping of Technology. According to this theory, technology is not determined solely by its inherent features; it is also shaped by social factors, values, and power dynamics.

By consolidating positive statements as agreement and negative statements as disagreement, the analysis captured the respondents' overall agreement that S&T enhanced their quality of life (M=2.43) and that scientific advancements tended to benefit the wealthy more than the poor (M=2.68). These results aligned with the Social Shaping of Technology theory, as they suggested that societal perceptions and attitudes towards S&T were influenced by social contexts and power dynamics.

Table 7.2: Extent of agreement on the importance of science and technology

Statements		**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**	**Cannot choose**	**Mean (SD)**	**T**	**df**	**p-value**
Science and technology are making our lives healthier,	Q1	528 (20)	1307 (49)	483 (18.)	175 (6)	78 (3)	102 (4)	2.43 (1.446)	86.886	2672	0.000

easier, and more comfortable											
It is not important for me to know about science in my daily life	Q2	230 (9)	796 (30)	579 (22)	736 (27)	241 (9)	91 (3)	3.16 (1.451)	112.450	2672	0.000
Scientific advances tend to benefit the rich more than they benefit the poor	Q3	342 (12)	1141(42)	668 (25)	353 (13)	77 (3)	92 (3)	2.68 (1.394)	99.338	2672	0.000

Furthermore, the finding that some respondents disagreed and expressed that being knowledgeable about science was not crucial in their daily lives (M=3.16) could also be interpreted through the lens of the SST theory. This perspective reflected the influence of social factors on the shaping of technology. It suggested that certain individuals could have different values, interests, or priorities that led them to question the importance of science knowledge in their everyday lives.

The theory of Social Shaping of Technology reminds us that technology is not a neutral entity as it is shaped by society. In the context of the study, the theory prompts us to consider how societal factors, values, and power dynamics have influenced the respondents' perceptions and attitudes towards S&T. It encourages us to delve deeper into the social negotiations and interactions that have shaped their perspectives on the benefits and significance of science and technology in their lives. By incorporating the theory of Social Shaping of Technology, we gain a more nuanced understanding of the findings from Table 7.2. We recognize that societal factors and power dynamics have played a role in shaping the respondents' agreement or disagreement with the statements related to S&T. This analysis highlights the importance of considering the social context and the broader implications of these attitudes towards science and technology.

7.3.2 Knowledge of modern technologies and scientific developments

The question, **"Overall, would you say you are very knowledgeable, moderately knowledgeable, not very aware or not at all knowledgeable about new technologies and scientific advances?"** was meant to determine the respondents' level of knowledge about these topics. According to Figure 7.10, most respondents (43%) were just moderately informed about

new technologies and scientific advancements, while 12 per cent were extremely knowledgeable about them. Additionally, 18 per cent of the respondents were not very knowledgeable about them and 23 per cent of the respondents indicated that they knew nothing at all. Only 4 per cent of the people were unsure of their level of familiarity with emerging technology and scientific discoveries.

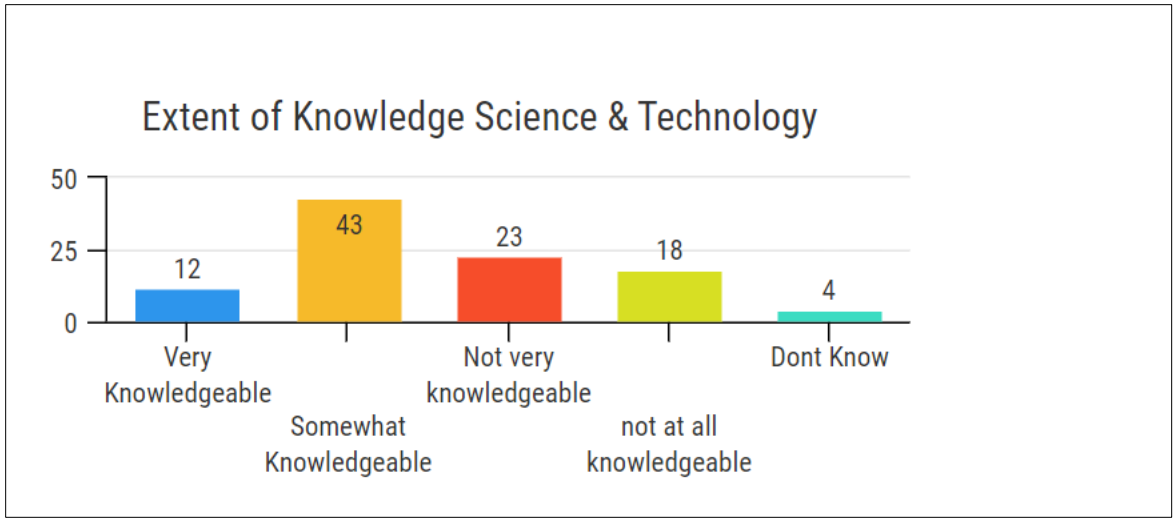


Figure 7.12: Knowledge about modern technologies and scientific development

Figure 7.13 depicts the level of familiarity with respect to driverless cars, AI and social media platforms such as YouTube, Facebook, and Twitter. The descriptive analysis indicated that most of the respondents (47%) had not heard about AI, and this was followed by 45 per cent who indicated that they had not heard of driverless cars. The data also showed that most of the respondents (34%) had heard of social media platforms such as Twitter, Facebook and YouTube,

but knew very little or nothing about them, while most (45%) knewenough about social media platforms.

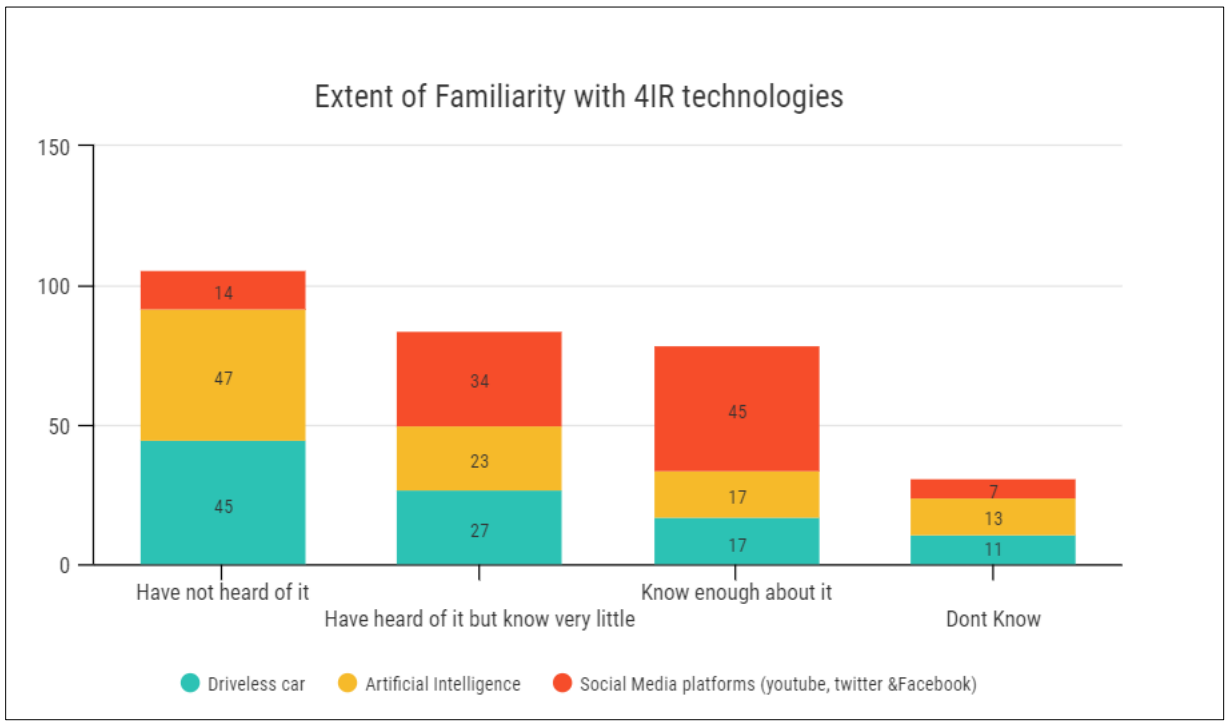


Figure 7.13: Familiarity with new scientific technologies and advances

This study's premise was that respondents' opinions about the 4IR would be more favourable if they had more information about technologies and scientific developments. Chapter Eight provides a description of the hypothesis testing for this investigation. However, it is argued in the literature that as technology has become more pervasive in our daily lives, so too has the public's interest in science. At the same time, scientific events have also started to appear on the news agenda occasionally (Bauer & Falade, 2021; Tartaruga, Cazarotto Martins, & Fukui, 2016). Most technological and scientific advancements are produced in universities or research facilities, but only a small portion of the findings and discussions around them are shared with the public, such as those pertaining to vaccines or novel medical treatments (Tartaruga et al., 2016). People have, however, always been interested in scientific information. These studies just cover these issues because the interplay between science and society encompasses a wide range of aspects. Two additional issues that need to be addressed are the significance of scientific knowledge in a democratic society and the part that the media plays in the process (Bauer & Falade, 2021). This holds great importance as existing literature suggests that familiarity with science and technology

increases the probability of embracing the fourth industrial revolution (4IR). These descriptions offer an overview of the evolving trends in knowledge, which will be contrasted with bivariate and multivariate analyses in Chapter Eight to establish tangible evidence regarding its validity within the context of my study.

Many research investigations were coordinated around the same axis, known as public comprehension of science, to address these problems and collect data to promote the development of tools to understand these relationships between science and society. This is defined as "measures of science literacy, interest, attitudes, and public engagement with science" (Bauer, Shukla & Allum, 2012, p. 1). Science literacy, the first paradigm, was widely used between the 1960s and the 1980s:

> The idea of scientific literacy sees science as an extension of the quest for reading, writing and numeracy. Furthermore, in a democracy, people make political decisions. However, the public voice can be effective only if citizens command relevant knowledge. [...] The idea of literacy attributes a knowledge deficit to the public. This deficit model of the public calls for increased efforts in science education (Bauer, 2009, pp. 222-223)

The saying, "the more you know, the more you love it" best describes the value of literacy, according to Bauer (2009, p. 224). In other words, it was believed that encouragement of a greater interest in science would encourage people to develop a favourable outlook on issues connected to the theme. There have been efforts made in that direction, however, the outcomes did not support any adjustments. The findings of national studies on the topic conducted in 1987, 2006, and 2010 in Brazil, as well as research by Castelfranchi (2013), demonstrate that the previously proposed theory was false.:

> Our most relevant result confirms a phenomenon already detected in other countries. The hypothesis that a higher level of educational attainment or information would generally lead to more positive attitudes to the role of S&T in society is refuted by empirical data. There is a consistent group of people (around 60 per cent of Brazilians) who expresses a high interest in themes of S&T but has a scarce knowledge of these themes of S&T and accesses a little scientific information. At least part of these people is ‘sincere’: they have a real interest in S&T (and also a general optimistic and positive posture); however, interest and attitude are not associated with an active and concrete search for more information in the area (Castelfranchi, 2013, p. 1180)

The findings demonstrate that people, irrespective of their level of education, are interested in science.

7.4 The Interplay between Computer Technologies and Attitudes Towards Robots

The impact of technology on society is a well-researched and widely discussed topic in literature. Numerous studies have explored the various ways in which technology influences and shapes different aspects of society, the economy and quality of life in the African context (Adam, 2020; Gwagwa, Kraemer-Mbula, Rizk, Rutenberg & De Beer, 2020; Solomon & Van Klyton, 2020). I gauged the repsondents' views on the impact of technology on society, the economy, and their quality of life (see Figure 7.14).

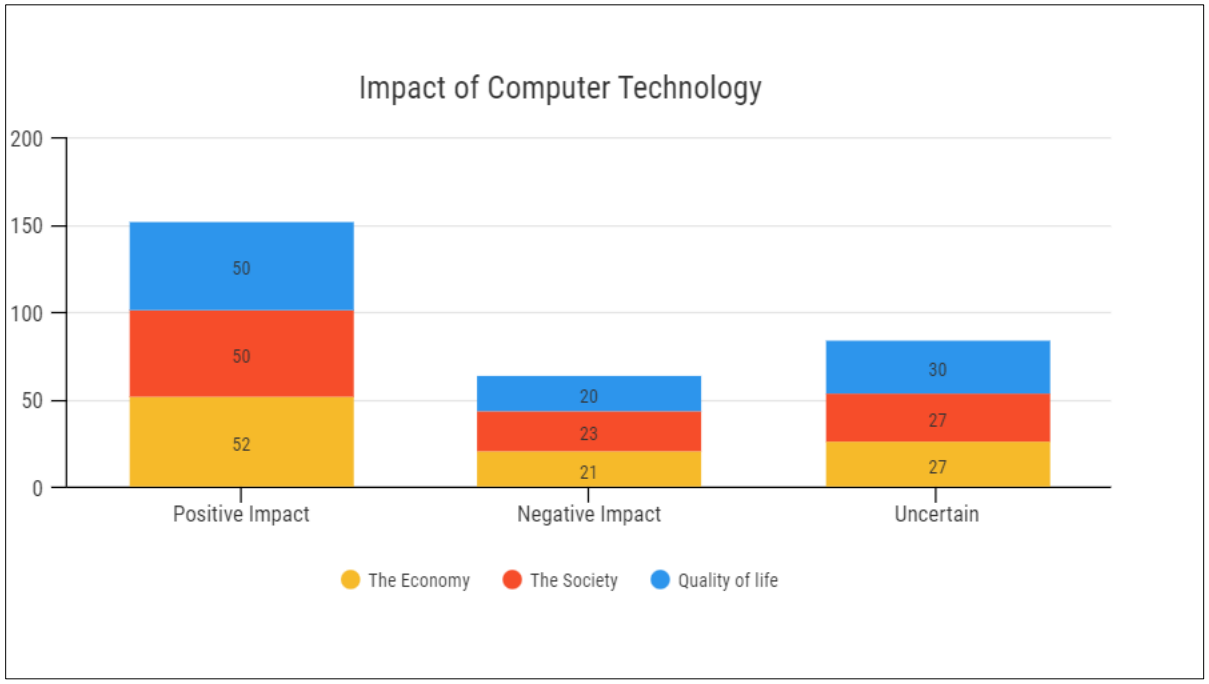


Figure 7.14: Views on the impact of computer technology

The overall impression was that technology had a positive impact on the economy, as 50 per cent of the participants indicated this. Fifty per cent of the participants also believed that technology had a positive effect on society and their quality of life.

I then gauaged the attitudes towards robots and it was discovered that awareness of the word "robot" was limited while the 4IR module for the SASAS was being piloted. This was partially

inspired by the word's widespread in reference to a traffic light. In order to prevent widespread misunderstanding in the “field, the module's questions on attitudes toward robotics were preceded by an introductory statement that was read aloud to responders” and provided a simple definition of a "robot" (SASAS, 2018). This definition that was used to define robots was derived from a study that looked at "Attitudes about the influence of digitization and automation on daily life". It was modified slightly to fit the context (European Commission, 2017, p. 2). The following was the statement that was given to the respondents:

> A ‘robot’ is an automated machine which can help people in everyday tasks without guidance or instruction, e.g., as a kind of co-worker helping on the factory floor or as a robot cleaner, or in activities which may be dangerous for humans, like in deep mines. Robots can come in many shapes or sizes, and some may be of human appearance (European Commission, 2017, p. 2).

Interviewers also presented participants with four robot images on a showcard in addition to this initial statement. Two of the images were from well-known 4IR-informed television commercials showcasing humanoid robots, and two showed fewer humanoid robots. These precautions were necessary to guarantee that responders to the robotics questions had comparable reference points. I initially looked at the survey responses to the levels of comfort or discomfort, with four scenarios involving the usage of automation in order to determine “the degree of cultural acceptance of technological progress among South Africans”. These were: “(i) having a medical operation performed on you by a robot; (ii) factories where workers are replaced by robots; (iii) receiving goods delivered by a drone or a robot; and (iv) shops where cashiers are replaced by robots” (SASAS, 2018).

Figure 7.15 shows that the participants were mostly uncomfortable with all of the scenarios: 70 per cent were uncomfortable with a medical operation being done by a robot; 69 per cent were uncomfortable with factory workers replaced by robots; 63 per cent were uncomfortable about receiving goods by drone; and 67 per cent were uncomfortable with shop cashiers being replaced by robots.

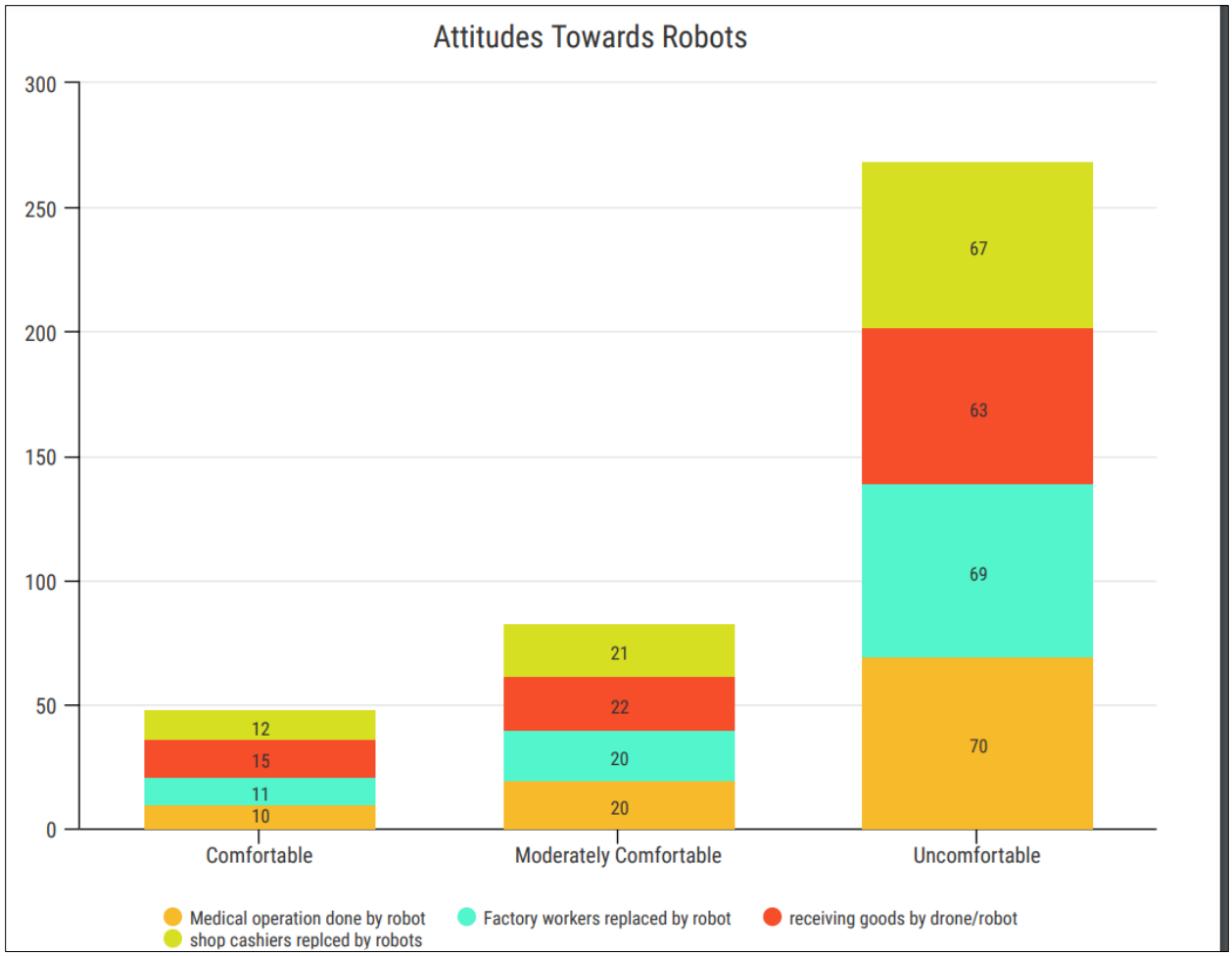


Figure 7.15: The respondents' attitudes towards robotic services

Note: "The survey question was framed as follows: 'I am going to read out a list of things that could be done by or with robots. For each of them, please tell me, using a scale from 1 to 10, how you would personally feel about it (1–10 scale)" (SASAS, 2018, p. 4).

The findings of the study revealed that participants expressed discomfort when considering various scenarios involving robotic services. Specifically, participants indicated discomfort regarding: (i) having a medical operation performed on them by a robot, (ii) the replacement of human workers by robots in factories, (iii) receiving goods delivered by drones or robots, and (iv) encountering cashier-less shops staffed by robots.

These findings could be justified by examining the existing literature and applying the theory of Social Shaping of Technology.

Literature suggests that discomfort with robotic services may stem from several factors. First, there may be concerns regarding the reliability and safety of robotic systems in critical contexts such as medical operations. Participants might perceive potential risks associated with relying solely on robotic technology for delicate procedures, highlighting the importance of human expertise and judgment in such situations.

Second, the replacement of human workers by robots in factories can evoke concerns related to job security and the socio-economic impact of automation. Participants may be uncomfortable with the potential loss of employment opportunities and the potential implications for their communities. This uneasiness aligns with the Social Shaping of Technology theory, which emphasizes that technological choices are influenced by social processes and power dynamics. The replacement of human labour by robots can raise questions about equity, income inequality, and the social consequences of technological advancements (Grybauskas et al., 2022).

Third, discomfort regarding receiving goods delivered by drones or robots might arise due to concerns about privacy, security, and the human touch in service interactions. Participants may feel uneasy about the lack of direct human interaction, perceiving it as impersonal or even intrusive. Additionally, the potential for technical malfunctions or errors in the delivery process may contribute to the discomfort participants experience (Jones, 2013).

Lastly, the discomfort surrounding cashier-less shops staffed by robots could stem from concerns about job displacement, reduced human interaction, and the potential impact on customer service experiences (Hlongwane, 2022). Participants may value the social interaction and personal touch provided by human cashiers, perceiving their presence as essential for a positive shopping experience.

Overall, the discomfort expressed by participants towards these robotic services aligned with both existing literature and the theory of Social Shaping of Technology. Understanding these concerns and factors can inform the design and implementation of robotic technologies, taking into consideration societal expectations, ethical considerations, and the need to address potential challenges associated with the integration of robots into various service domains.

7.5 Chapter Summary

Several statements were made in this chapter about the overall attitudes towards technology. The statements were presented to the participants to gauge their views on them. The following attitudes emerged, as per the literature in Chapter Three, where attitudes regarding technology were seen to range from negative, to positive to uncertain. These were the attitudes that emerged:

- **Techno-sceptic:** In this study, critical attitudes towards technology that assumed that it would cause harm or be bad under certain circumstances were summarized as scepticism. The degrees of scepticism depended on the statements made about technology and they could be sub-categorized. Neo-Luddism described the rejection of technology. A second sub-category was that of simple scepticism, where technology had to be proven not to be harmful. Simple scepticism regarding the potential societal impact was observed when respondents were asked about the impact that technology had on the economy, society and their quality of life, (refer to Figure 7.14). Neo-Luddite attitudes were observed when participants had to provide their views about jobs being replaced by AI. They were opposed to technology that could potentially replace human labour (refer to Figure 7.15). General scepticism was the prevailing attitude when technology was understood to have a direct impact on jobs due to the replacement of humans in these jobs.

- **Technological romanticism:** I mostly referred to this as ambivalence, as it presented attitudes towards technology that were a mix between uneasiness and ambivalence. When participants responded to the question about how much technology made their lives easier, there was an ambivalent attitude toward technology (refer to Table 7.2). This ambivalence towards technology was seen to a lesser extent, and this emphasized the potential for personal positive benefits from technology. When asked about whether scientific advances benefitted the poor or the rich, participants gravitated towards uneasiness.

- **Techno-optimist:** This was mostly associated with the idea that technology was inherently good. Attitudes that were associated with optimism occurred mostly where technology had a personal benefit to the participant. Social media platforms received inherently optimistic views, as they offered personal benefits (see Figure7.13); however, technologies that were

regarded as having the potential to cause harm to the economic well-being of participants were rejected. The 4IR technologies of driverless cars, AI and robots all had the potential to replace human duties and take over their jobs, hence the participants were least optimistic regarding these technologies.

This chapter presented the descriptive statistics related to the demographic profiles of the respondents of this study. The discussion in this chapter centred on the link between socio-economic profiles and the 4IR. Moreover, the chapter discussed the opinions of the respondents towards the 4IR, and established factors that contributed towards certain attitudes that were held. The potential job losses as a result of the advancement of AI posed a significant concern, considering the socio-economic conditions in South Africa, where unemployment rates, particularly among the youth and the majority African population, are already alarming. It is worth noting that a substantial portion of the respondents in this study were unemployed at the time of the study. The impact of replacement of jobs that are considered routine by AI could exacerbate the unemployment crisis in the country. Given the dire situation and the urgent need for job creation, South Africa cannot afford further job losses.

Respondents expressed the fear of replacement by robots, and when asked several questions regarding AI, hesitancy was the dominant attitude observed. This poses a challenge to the Government as it must foster policies that will ensure that the potential benefits of this revolution are harnessed. At the same time, the Government must take definitive steps to mitigate the negative impacts such as job losses/unemployment. This chapter helped to explore the level of knowledge about S&T and the 4IR and the results showed high levels of knowledge about science and social media platforms. However, low levels of knowledge were displayed by the respondents in terms of 4IR-related technologies such as driverless cars and robots. Examining the link between micro-level sociological indicators and the perceptions of the 4IR in South Africa was one of the research questions. The following chapter examines this connection and goes into detail on how the hypotheses were tested to determine which micro-level indicators were predictors of acceptance/rejection towards 4IR.

CHAPTER EIGHT: RELATIONSHIP BETWEEN MICRO-LEVEL SOCIOLOGICAL INDICATORS AND ATTITUDES TOWARDS THE 4IR IN SOUTH AFRICA

8.1 Introduction

Technology determinist explanations of the nature of technology, the relationship between a society's technologies and itself, as well as the foundations of social organization and the drivers of social development are fundamentally opposed to the notion that technology is socially formed. Many scholarly and popular discourses on technology and society have been dominated by such determinist views. They serve as the basis for common perceptions of social and economic development. They have typically been taken for granted in most technology policy frameworks up until recently. They portray technology as a largely autonomous entity that evolves according to its own logic and in a particular path before having specific effects on society, effectively moulding society to suit its demands. I have opted for the Social Shaping of Technology theory due to the limitations of Technology Determinism, as stated in my theoretical chapter, Chapter Three.

The idea that society has no choice but to accept the course of technological advancement and social change has become prevalent. This perspective limits the role of public policy to merely predicting and monitoring the progress of technology, providing the necessary resources, removing obstacles, and ensuring smooth integration of society with the changes it brings. Given that 4IR policies are less likely to be successful if met with resistance, this study proposes an integrated technology adoption approach that considers societal perspectives.

Most normative and empirical models of democracy in use today place a strong focus on how responsive government actions are to public preferences (Gordon, 2017). There is a long history of the notion that public opinion affects policy. According to Gordon (2017); and Wilson (2013), public opinion has been an "orderly force" influencing social and political life for thousands of years, considering the growth of public opinion research. According to Gordon (2017), the Ancient Athenian concept of citizen participation in political decision-making is where the concept of

public opinion first appeared. Public opinion and governmental action frequently coincide, which is morally correct and essential to democratic governance.

The relationship between policies and attitudes is not always straightforward, and it can occasionally be challenging to determine which factor causes which outcome. Studies have accepted this reality, but they continue to assert that there is a connection between public opinion and policy formulation in some democracies (Page & Shapiro, 1983; Soroka & Wlezien, 2010). One could contend that unlike in Western Europe or North America, popular opinion may not have the same impact on public policy in South Africa. Elections are uncompetitive, and the political landscape has been dominated by a single party for most of the nation's democratic existence. Most local and district municipalities in the nation are under the control of the ruling ANC, which also holds a commanding majority in the National Parliament. One can contend that when one party holds power, there is less opportunity for the general population to have an impact on legislation. There is evidence to support the idea that while making choices, the government must, at the very least, take the public's opinions into account.

Due to this, a portion of the study question examined how views about the 4IR in South Africa related to micro-level sociological factors. These micro-sociological indicators were used to inform the integrated technology adoption model developed for this study. The previous chapter presented the descriptive statistics related to the demographic profiles of the respondents of this study. The discussion in the chapter centred on the link between the socio-economic profiles and the 4IR. Moreover, the chapter discussed the opinions of the respondents towards the 4IR, to establish the factors that contributed towards certain attitudes held by the people. This chapter focuses on presenting the data on the relationship between the micro-sociological indicators and testing of the hypotheses of the study. This chapter builds from the preceding chapter by offering bivariate and multivariate analyses and a discussion of results.

8.2 Bivariate Analysis for Hypothesis Testing

In this study I have made the hypothesis that micro-sociological indicators influence how people see and experience 4IR technology. Those with a potential risk of losing their jobs due to automation were hypothesized as likely to develop negative attitudes towards the 4IR. SES was

used to assess the varying attitudes towards the 4IR per social class, education status and income. The assumptions I made were informed by literature. I begin this sub-section with a presentation of the bivariate tests I performed for each of the hypotheses I formulated.

H1: Younger people will be more accepting of robots than older people

Bivariate analyses were carried out to test the odds of younger people accepting robots more than older people. This involved the analysis of the two variables of age and attitude for the purpose of determining the empirical relationship between them. The Chi-square test indicated that younger people (45.7%) were more comfortable with robotic services when compared to older people (37.9%) (see Table 8.1).

Table 8.1: Bivariate analyses assessing the association between age and attitudes towards robotic services

			Attitude		Total
			Uncomfortable	Comfortable	
Age	**Young**	Count	740	623	1363
		% within age	54.3%	45.7%	100.0%
	Old	Count	812	496	1308
		% within age	62.1%	37.9%	100.0%
Total		Count	1552	1119	2671
		% of total	58.1%	41.9%	100.0%

The odds ratio in Table 8.2 shows that younger people were significantly more comfortable with robotic services when compared to the older ones (UOR: 0.726; 95% CI: 0.622–0.847; p<0.001).

Table 8.2: The odds ratio showing the perceived influence of age on 4IR acceptance

Variables	**Unadjusted OR**	**(95 % CI)**	**p-value**
Age ≤ 40 years vs > 40 years	0.726	0.622 – 0.847	0.001

8.2.1 Perceived confidence in South African Government intervention and attitudes towards the 4IR

H2: Confidence that South African Government intervention will produce more favourable attitudes towards the 4IR

Bivariate analyses were carried out to test the odds of those who were confident in the South African Government's intervention against those who were not confident to accept robotic services. The Chi-square test indicated that those who were confident in the South African Government's intervention (51.4%) were more comfortable with robotic services when compared to those who were not confident (36.7%).

Table 8.3: Bivariate analyses assessing the association between confidence in South African Government intervention and attitudes towards robotic services

			Attitude		Total
			Uncomfor-table	Comfor-table	
Level of confidence in South African Government intervention	Confident	Count	459	485	944
		% within confident	48.6%	51.4%	100.0%
	Not confident	Count	1093	633	1726
		% within confident	63.3%	36.7%	100.0%
Total		Count	1552	1118	2670
		% of total	58.1%	41.9%	100.0%

The odds ratio in Table 8.4 shows that people who were confident in the South African Government's intervention were significantly more comfortable with robotic services compared to those who were not confident in such intervention (UOR: 0.548; 95% CI: 0.467–0.644; $p<0.001$).

Table 8.4: Perceived influence of confidence in South African Government intervention and attitudes towards robotic services

Variables	Unadjusted OR	95% CI	p-value
Level of confidence Confident vs not confident	0.548	0.467 – 0.644	0.001

8.2.2. Perceived opposition to use of 4IR technology

H3: Employed people will be more opposed to automation than the unemployed (to test how accepting employed people are towards use of 4IR technology)

The Chi-square test indicated that those who were employed (77.4%) were more likely to oppose the use of automation compared to those who were unemployed (17.6%).

Table 8.5: Bivariate analyses assessing the association between employment status and support for robotic services

			Support		Total
			Support	Opposed	
Employment	**Employed**	Count	176	604	780
		% within employment	22.6%	77.4%	100.0%
	Unemployed	Count	1547	331	1878
		% within employment	82.4%	17.6%	100.0%
Total		Count	507	2151	2658
		% of total	19.1%	80.9%	100.0%

The odds ratio in Table 8.6 shows that unemployed respondents were significantly less likely to oppose the use of automation technologies compared to those who were employed (UOR: 1.362; 95% CI: 1.109–1.673; P=0.003).

Table 8.6: Perceived effect of employment status and opposition to automation technologies

Variables	Unadjusted OR	95 % CI	p-value
Employment status Unemployed vs employed	1.362	1.109 – 1.673	0.003

8.2.3 Perceived influence of the risks of job loss and support for computer technologies

H4: People would not support a private company introducing computer technologies that risk people losing their jobs

The Chi-square test indicated that those who thought there were risks of job loss (21.9%) were more likely to support the use of computer technologies when compared to those who thought it would not happen (12.5%).

Table 8.7: Bivariate analyses assessing the association between the risks of job loss and support for computer technologies

			Support		Total
			Support	Opposed	
Risks of job loss in the next 10 years	**Will happen**	Count	418	1494	1912
		% within loss	21.9%	78.1%	100.0%
	Will not happen	Count	95	663	758
		% within loss	12.5%	87.5%	100.0%
Total		Count	513	2157	2670
		% of total	19.2%	80.8%	100.0%

The odds ratio in Table 8.8 shows that respondents who thought computer technologies would perform humans' jobs were significantly less likely to support the use of automation technologies compared to those who thought it would not happen (UOR: 1.953; 95% CI: 1.535–2.484; p<0.001).

Table 8.8: Perceived effect of risks of job loss and support for computer technologies

Variables	Unadjusted OR	95 % CI	p-value
Risk of losing jobs Will happen vs will not happen	1.953	1.535 – 2.484	0.001

8.2.4 Perceived influence of the risks of job loss on attitude towards 4IR services

H5: People who will be displaced by automation will be more hostile towards technological change in society

The Chi-square test indicated that those who thought there were risks of job loss (57.2%) were less uncomfortable with robotic services compared to those who thought it would not happen (60.4%).

Table 8.9: Bivariate analyses assessing the association between risks of job loss and support for robotic services

			Attitude		Total
			Uncomfortable	Comfortable	
Risks of job loss in the next 10 years	**Will happen**	Count	1094	819	1913
		% within loss	57.2%	42.8%	100.0%
	Will not happen	Count	458	300	758
		% within loss	60.4%	39.6%	100.0%
Total		Count	1552	1119	2671
		% of total	58.1%	41.9%	100.0%

The odds ratio in Table 8.10 shows that the odds of being hostile towards automation technologies from fear of losing jobs were not different from those who thought it would happen and those who thought it would not happen (UOR: 1.953; 95% CI: 1.535–2.484; p<0.001).

Table 8.10: Perceived effect of risks of job loss and hostility towards service automation technologies

Variables	Unadjusted OR	95 % CI	p-value
Risks of losing jobs Will happen vs will not happen	1.953	: 1.535–2.484	p<0.001

8.2.5 Perceived belief that schools have not prepared young people to work with technology and attitude towards 4IR services

H6: People will believe schools have not prepared young people to work with technology

The Chi-square test indicated that those who believed that schools had not prepared young people to work with technology (61.2%) were more uncomfortable with service automation compared to those who disagreed (54.8%).

Table 8.11: Bivariate analyses assessing the association between belief in lack of school preparation and attitudes toward services automation

			Attitude		Total
			Uncomfortable	Comfortable	
School prepara-tion	**Agreement**	Count	849	538	1387
		% within school	61.2%	38.8%	100.0%
	Disagree-ment	Count	703	580	1283
		% within school	54.8%	45.2%	100.0%
Total		Count	1552	1118	2670
		% of total	58.1%	41.9%	100.0%

The odds ratio in Table 8.12 shows that respondents who agreed that schools had not prepared young people to work with technology were significantly more uncomfortable with automation technologies compared to those in disagreement with this (UOR: 1.302; 95% CI: 1.116–1.519; P=0.001).

Table 8.12: Perceived effect of the lack of school preparation and hostility towards service automation technologies

Variables	Unadjusted OR	95 % CI	p-value
Lack of school preparation Agreement vs disagreement	1.302	1.116 – 1.519	P<0.001

8.2.6 Bivariate analysis of familiarity with science & technology and attitudes towards 4IR

H7: Familiarity with science and technology will predict favourable attitudes towards the 4IR.

The Chi-square in Table 8.13 indicates the different levels of knowledge and how they varied in levels of comfortability and uncomfortability towards 4IR. Those very knowledgeable were comfortable (52%), while those not very knowledgeable were uncomfortable (62%). The odds ratio in Table 8.14 shows that respondents who were very knowledgeable were more comfortable than those who were not knowledgeable (UOR; 1.111; 95% CI; 1.087-1.162; P=0.001).

Table 8.13: Bivariate analysis assessing the association between knowledge of science and technology and attitudes towards 4IR

			Attitudes Towards 4IR		
			Uncomfortable	Comfortable	Total
Knowledge of science and technology	Very knowledgeable	Count	143	182	325
		%	44 %	56%	100%
	Somewhat knowledgeable	Count	585	571	1156
		%	51%	49%	100 %
	Not very knowledgeable	Count	382	238	620
		%	62%	38%	100%
	Not at all knowledgeable	Count	384	89	473
		%	81%	19%	100%
	(Don't know)	Count	58	39	97
		%	60%	40%	100%
Total		Count	1552	1119	2671

Table 8.14: Perceived effect of the knowledge of S&T and hostility towards service automation technologies

Variables	Unadjusted OR	95 % CI	p-value
Knowledge of science and technology Very knowledgeable vs Not at all knowledgeable	1.111	1.087-1.162	P<0.001

Bivariate analysis served as a valuable tool in my hypothesis testing process. It allowed me to assess the strength and significance of the association between individual variables, and provided a foundation for understanding their potential impact on the outcome variable. Moreover, bivariate analysis allowed me to gain insights into the preliminary patterns and trends in the data. By examining individual variable relationships, I could uncover initial indications of potential confounding factors or interactions that could warrant further investigation in the logistic regression model.

In addition to conducting bivariate analysis, I also employed binary logistic regression to enhance the depth of my analysis. While bivariate analysis provided me with valuable insights into the relationships between individual variables, logistic regression allowed me to delve deeper into understanding the complex interplay of the multiple predictors and their impact on the outcome (attitudes towards 4IR). However, I realized that bivariate analysis alone had certain limitations that restricted the extent of my analysis. One significant limitation of bivariate analysis is its assumption of linearity, which assumes that the relationship between the variables follows a straight line. Many relationships are more intricate and may exhibit non-linear patterns. By incorporating logistic regression into my analysis, I was able to capture and explore these complex relationships that may have otherwise remained hidden.

By combining the strengths of both bivariate analysis and logistic regression, I obtained a well-rounded understanding of the relationships among the variables and their impact on the outcome of interest. This is discussed further in section 8.3 in the multivariate regression modelling section.

8.3 Multivariate Regression Modelling and Analysis

I tested the predictive effect of the select micro-sociological indicators on the acceptance of the 4IR. I performed a binary logistic regression models, as my outcome variable was binary in nature. I used these models to analyze the relationships between the multiple independent variables and the dependent variable, and I present the three models in Table 8.15. The dependent variable, cultural acceptance of the 4IR index, and several independent variables were used for the models. Age, gender, employment status, race, education, and social class were the micro-sociological indicators that were hypothesized as influencing attitudes in the theoretical model developed in Chapter Three. Other control variables were used, such as geographical location and province, where participants were asked to illustrate if they lived in urban or rural areas, as this also had a bearing on Internet access, which was included in the models. I included self-rated 4IR knowledge and ICT proficiency as part of the predictive variables to see if they had an effect, since knowledge of science has been associated with a positive effect on technology. It was important to include whether employed South Africans whose jobs were at risk of replacement by technology would be accepting or non-accepting of the 4IR. Lastly, I used the respondents' confidence in the South African Government's ability to manage the 4IR as another predictor.

8.3.1 Models' specifications

- Model I: These independent variables were included in model I: "Gender", where male was the excluded reference category. "Race" was the second indicator, with black Africans as the excluded reference category. I included "age group", and those aged 50 and below were excluded as they were the reference group.
- Model II: I carried the variables of the 1st model to the second and in addition I added the following ones: "Subjective social class", where the lower class was the reference group. "Employed and very worried about the 4IR threat", with employed and not concerned about the 4IR threat as the reference group. Lastly, I added "not in the labour market and unconcerned about the 4IR threat".
- Model III: This model incorporated variables from the first and second models, then also included "education attainment, matric and tertiary level". No schooling and primary schooling formed the reference group. Those with "4IR knowledge, self-rated ICT

proficiency, belief in the Government's ability to manage the 4IR, and Internet access" were also included in the model. Those without were the reference group.

- Model IV: This was the ultimate model as it had all the variables enlisted from Models I-III and it only added political affiliation with the African National Congress (ANC) as the reference group.

8.3.2 Regression model results

Model I:

In this binary logistic regression analysis, I investigated the factors associated with the outcome variable, "acceptance of the fourth industrial revolution". This outcome variable was encoded as 0 for "uncomfortable" and 1 for "comfortable". The analysis included several predictor variables that were entered into Model I of the analysis. The results of the analysis showed that several variables were significantly associated with the comfort level towards the 4IR. For example, being older (old and very old) was associated with a lower likelihood of being comfortable with the 4IR. The coefficients were -.404 and -.428, which indicated that as the age of the respondent increased by one year, the log odds of feeling uncomfortable decreased by a factor of 0.67 (i.e., exp (-0.404) = 0.67). This coefficient was also statistically significant with a p-value of 0.001. Respectively, being female was also associated with a lower likelihood of being comfortable with the 4IR, with a coefficient of -.213, which indicated that being female was associated with a decrease in the log odds of feeling uncomfortable by a factor of 0.81 (i.e., exp (-0.213) = 0.81). This coefficient was statistically significant with a p-value of 0.009. In terms of race, being white was strongly associated with a higher likelihood of feeling comfortable, with a coefficient of 1.276. This means that being white, as compared to being black, was associated with an increase in the log odds of feeling comfortable by a factor of 3.58 (i.e., exp (1.276) = 3.58). The coefficient was statistically significant with a p-value of less than 0.001. Overall, this first binary logistic regression Model I suggested that age, gender, and race were important predictors of feelings of comfort and acceptance towards the 4IR.

Model II

Employed and quite worried was associated with a lower likelihood of being comfortable with the fourth industrial revolution, with a coefficient of -0.305 and an odds ratio of 0.737. This coefficient

was statistically significant, with $p<0.05$. The unemployed and not concerned about the 4IR threat respondents showed coefficients of -0.725, which showed a lower likelihood of being comfortable with the fourth industrial revolution, even though they were not in the labour market. The odds ratio was 0.485 and this was found to be statistically significant with $p<0.001$. When looking at the subjective social class, it indicated coefficients of 0.667 and an odds ratio of 1.949, which showed a positive association where people who belonged to the upper class had a higher likelihood of comfortability towards and acceptance of the fourth industrial revolution. In the second model, age (old), race (white), subjective social class (upper class), employed and worried about the 4IR, as well as those not working and not worried were important predictors for feelings of comfort and acceptability towards the 4IR as these variables were statistically significant in this model.

Model III

Education attainment was added to the model and it showed that those in matric were associated with the likelihood of being comfortable with the fourth industrial revolution, with a coefficient of 0.329 and an odds ratio of 1.389. This variable was statistically significant, with $p<0.05$. According to several researchers, receiving a formal education can influence opinions through a variety of different mechanisms (Hudson et al., 2017; Nomura et al., 2009; Taipale et al., 2015). It is therefore difficult to comprehend why educational attainment did not have the desired results when tertiary education was not found to be statistically significant. The 4IR knowledge index also had a positive coefficient of 0.228 and an odds ratio of 1.257, and it was statistically significant with $p<0.05$. The other measured value that was associated with a positive coefficient was the Govt's ability to manage the 4IR, where those who believed in the government's ability were associated with a high likelihood of being comfortable with the fourth industrial revolution. The coefficient was 0.460, the odds ratio was 1.584, and the p value was statistically significant at $p<0.05$. To explore the confidence in the government further, I performed another regression analysis which looked at whether there was a partisan effect. I included the well-known political parties mostly identified with by the participants (see Table 8.16). Internet access had a negative coefficient of -0.350 and an odds ratio of 0.704, and it was statistically significant $p<0.001$. This showed that those with Internet access felt less comfort towards the fourth industrial revolution.

Table 8.15: Binary logistic regression models on acceptance of the fourth industrial revolution among the adult population

Independent Variables	Model I					Model II					Model III				
	B	STD Error	Odds Ratio	95% CI for OR		B	STD Error	OR	95% CI for OR		B	STD Error	OR	95% CI for OR	
Female (Ref males)	-0.213	0.082	0.808*	0.688	0.949	-0.138	0.085	0.871	0.737	1.030	-.131	0.086	0.877	0.741	1.038
Population group (Ref black Africans)															
Coloured	-0.095	0.133	0.910	0.701	1.180	-0.125	0.138	0.883	0.673	1.157	-0.124	0.141	0.883	0.670	1.164
Indian	0.191	0.132	1.210	0.933	1.569	-0.089	0.141	0.915	0.694	1.206	-0.121	0.143	0.886	0.669	1.173
White	1.276	0.156	3.582***	2.637	4.866	0.897	0.165	2.452***	1.776	3.385	0.749	0.169	2.115***	1.518	2.947
Age group in years (Ref Young)															
Old (51-65 years)	-0.404	0.104	0.667***	0.545	0.818	-0.371	0.108	0.690***	0.558	0.854	-0.164	0.117	0.849*	0.675	1.067
Very old (66-90 years)	-0.428	0.131	0.652***	0.504	0.843	-0.346	0.138	0.708*	0.540	0.928	-0.035	0.154	0.965	0.714	1.305
Subjective social class						0.667	0.105	1.949***	1.586	2.394	0.605	0.108	1.832***	1.484	2.262
Employed & very worried 4IR threat						-0.305	0.124	0.737*	0.578	0.939	-0.369	0.125	0.691*	0.541	0.884
Not in the labour market unconcerned re 4IR threat						-0.725	0.112	0.485***	0.389	0.604	-0.772	0.114	0.462***	0.369	0.578
Education attainment															
Matric											0.329	0.127	1.389*	1.082	1.783
Tertiary											0.132	0.176	1.141	0.808	1.612
4IR knowledge											0.228	0.139	1.257*	0.956	1.652
Self-rated ICT proficiency											0.121	0.119	1.129	0.895	1.425
Govt ability to manage 4IR											0.460	0.172	1.584*	1.131	2.219
Internet access											-0.350	0.101	0.704***	0.578	0.859
Pseudo R^2	0.080					0.178					0.182				
N	2671					2671					2671				

Notes: (1) All models control for province of residence and level of urbanisation. (2) The models present the standardized beta coefficients and the statistical significance of the binary regression models. (3) Statistical significance is denoted as follows: *** p<0.001, **p<0.01, * p<0.05. (4) Positive coefficients indicate greater acceptance of robots and automation (5) The reference (excluded) category for the dummy variables in the models are, young (age 16-35) male, black African, employed and unconcerned about 4IR threat, and primary or no formal education, low class (for subjective class level), those without Internet access, those not confident in Govt's ability to manage 4IR

Model IV

In this model I tested to see if there was a partisan effect. The coefficients of those identfying as affiliated with the Economic Freedom Fighters (EFF) and the Inkatha Freedom Party (IFP) were negative, suggesting an inverse relationship between the variables. Those who identified with the Democratic Alliance (DA) had a positive coefficient, but these variables had a p-value above the significance level so the relationship observed was not strong enough to confidently conclude that there was a true negative effect or relationship in the population (see Table 8.16). In this final model, race also remained a significant predictor of technological acceptance, with white adults more likely to accept automation than other race groups. The significant gender effect in Model I, with women more negative towards robots on average than men, lost salience in the final model. This was due to the inclusion of subjective social class, employed and very worried about the 4IR threat, not in the labour market and unconcerned about the 4IR threat, 4IR knowledge, and confidence in the government to manage labour market disruption.

Table 8.16: Binary logistic model on partisan effect

Independent variables	Model IV				
	B	**STD Error**	**OR**	**95% CI for OR**	
Female (Ref males)	-0.133	0.086	0.875	0.739	1.037
Population group (Ref black Africans)					
Coloured	-0.135	0.146	0.874	0.656	1.164
Indian	-0.134	0.151	0.875	0.650	1.176
White	0.734	0.178	2.084***	1.470	2.954
Age group in years (Ref young)					
Old (51-65 years)	-0.168	0.117	0.846	0.673	1.064
Very old (66-90 years)	-0.040	0.154	0.961	0.711	1.300
Subjective social class middle	0.605	0.108	1.832***	1.483	2.262
Employed & very worried re 4IR threat	-0.366	0.126	0.693*	0.542	0.887
Not in the labour market unconcerned re 4IR threat	-0.773	0.114	0.461***	0.369	0.577
Education attainment					
Matric	0.329	0.127	1.389*	1.082	1.783
Tertiary	0.133	0.177	1.142	0.808	1.614
4IR knowledge index	0.232	0.140	1.261*	0.958	1.658
Self-rated ICT proficiency	0.120	0.119	1.127	0.893	1.423
Govt ability to manage 4IR	0.462	0.172	1.588*	1.133	2.225
Internet access	-0.352	0.101	0.703***	0.576	0.858
Political affiliation (ref ANC)					
DA	0.018	0.139	1.018	0.776	1.336
IFP	-0.265	0.396	0.767	0.353	1.668
EFF	-0.083	0.206	0.920	0.614	1.379
Pseudo R^2	0.182				
N	2671				

Notes: (1) All models control for province of residence and level of urbanization. (2) The models present the standardized beta coefficients and the statistical significance of the binary regression models. (3) Statistical significance is denoted as follows: *** p<0.001, **p<0.01, * p<0.05. (4) Positive coefficients indicate greater acceptance of robots and automation (5) The reference (excluded) category for the dummy variables in the models are, young (age 16-35) male, black African, employed and unconcerned about 4IR threat, and primary or no formal education, low class (for subjective class level), those without Internet access, those not confident in Govt's ability to manage 4IR and political affiliation, ANC as the reference.

The overall regression model was a relatively good fit, considering the variance in attitudes towards the 4IR (R^2= .182). While statistically a low R-squared value is usually frowned upon, the correct R^2 is determined by the study area. There are various levels of intrinsic unpredictability in different research questions. Human behaviour is difficult to anticipate, as evidenced by the fact that studies attempting to do so typically have R-squared values of less than 50 per cent (Cui & Gong, 2018; Frost, 2022).

I have cited a study that also demonstrated similar outcomes, and which used the SASAS data to examine how three major clusters of micro-level sociological indicators affected adult South African citizens' attitudes toward international migrants. The micro-level sociological indicators were (i) SES; (ii) group identities; and (iii) intergroup contact (Gordon, 2017). Studies that are based on perceptions and human behaviour tend to exhibit low R^2 values (Cheah & Phau, 2011; Shi et al., 2020). Despite this, I can still draw conclusions about how changes in the predictor values correspond to changes in the response value, even if I have statistically significant predictors but a low R-squared value. Regardless of the R-squared value, the significant coefficients display the mean change in the response for one unit of change in the predictor while holding the other predictors in the model constant (Frost, 2022).

8.3.3 Contribution to knowledge: Integrated Adoption Model

In this subsection I present the final model and the bivariate and multivariate results reported in sections 8.2 and 8.3 of this chapter. The model presented in Figure 8.1 shows the statistically significant relationship between the micro-sociological indicators and the outcome variable (acceptance towards the 4IR). It also shows a country level indicator which is the 'government's ability to manage the 4IR' and it was also statistically significant with the outcome variable. The model has two types of attitudes: techno-scepticism and techno-optimism. Techno-scepticism was explained in detail in the theoretical chapter (3) and it has two types of techno-scepticism: (i) Neo-Luddism and (ii) simple scepticism. Techno-sceptics are not trusting of technology and are sceptical of its effects. The second category of attitudes is techno-optimism, which also has two types: (i) technophilia and (ii) technocracy. The model below shows that micro-sociological indicators cut across both forms of attitudes. On the blue line we have those who were sceptics. When referring to the regression analysis, those belonging to the lower social class (reference group) were more sceptical towards the 4IR than

those from the higher class. This means that there were opposing attitudes towards the 4IR. The blue line represents those who opposed the 4IR, while the orange line represents those who were receptive towards it. The model showed a class effect, where white South Africans (orange line), were more receptive to the 4IR than black South Africans. As hypothesized, the model tested showed that micro-sociological indicators shaped the attitudes towards the 4IR. It would be ideal to test such a model in other countries that have inequality issues and socio-economic conditions like South Africa to see if it yields different results. Although race did not play a substantial role in studies that focussed on perceptions towards the fourth industrial revolution (4IR) in the global north, it emerged as a significant factor in the South African context. This was primarily due to the association of industrial advancements with elitism and social class, with race being closely intertwined with class dynamics in South Africa. It would be important to learn what factors shaped attitudes in other African contexts that did not have the same racial dynamics as those found in South Africa.

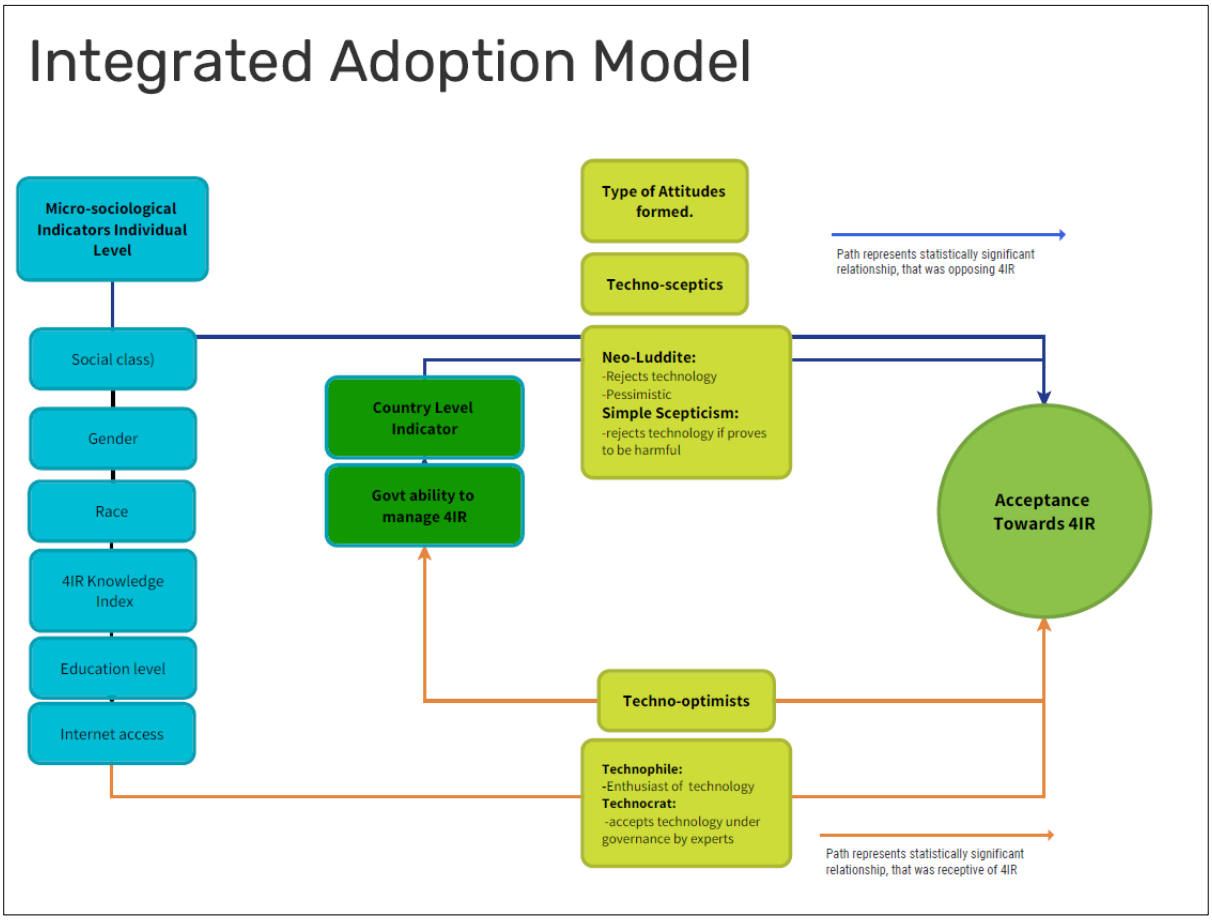


Figure 8.1: Final model tested with data: Integrated adoption model of attitudes towards the 4IR in South Africa

As I analyze my model's performance in predicting 4IR acceptance in South Africa, I must acknowledge its strengths as well as its limitations. The model has identified race, education, gender, social class, Internet access, and 4IR knowledge as strong predictors of 4IR acceptance in the country, which provides valuable insights into the factors that influence technology adoption. The model's strength lies in its ability to identify the key predictors of 4IR acceptance in South Africa, as it provides a starting point for further research. In this regard, the model's strength is that it provides valuable insight into how demographic and socio-economic factors such as race, education, gender, and Internet access influence the adoption of 4IR technologies in South Africa.

By identifying these predictors, the model can inform policy and decision-making related to 4IR technologies in the country. For example, the model suggests that addressing issues related to access to education and the Internet could be important in promoting the adoption of 4IR technologies in South Africa. This information could be used to design interventions that aim to address these issues and promote greater access to technology in the country.

Furthermore, the model's predictive power can be used to help identify potential barriers to technology adoption and inform strategies to overcome them. For instance, the model could be used to identify demographic groups that are less likely to adopt 4IR technologies, and interventions could be designed to target these groups specifically to promote greater technology adoption and reduce the digital divide. Overall, the strength of the model is that it provides valuable insights into the factors that influence technology adoption in South Africa, which can inform policy and decision-making related to 4IR technologies in the country.

Despite identifying important predictors, the limitations of my model should be acknowledged in light of the Social Shaping of Technology theory. The model does not take the broader social and cultural factors that can influence the adoption of 4IR technologies in South Africa into account, such as religious or linguistic barriers that could prevent technology from being accessible in all languages. It is important to note that Africa is not a homogenous continent, and race may not be a relevant factor in other contexts. Therefore, while my model has provided valuable insights into the predictors of 4IR acceptance in South Africa, it is important to acknowledge its limitations and the need for further research that considers the broader social and cultural factors that shape technology adoption in other contexts.

8.4 Discussion

The findings of this study provide ample evidence that public views regarding the 4IR or any other technical advancement are significantly influenced by micro-sociological factors. In literature, women, and young workers between the ages of 18 and 24 are more likely than men or workers over the age of 24 to experience job losses owing to automation. This is according to quantitative studies from the north of India (a2i, 2019).

The results of the hypothesis testing in the bivariate analysis section 8.2 (Hypothesis 6) show that many young people do not feel that the education system has prepared them enough to engage with the 4IR. This is because young people were historically best prepared for the workforce through school systems around the world. However, there is a growing gap between the skill-based, fast evolving modern workplace and the content-driven education approach, which was mostly built in the 19th century (Lee & Clark 2020). This gap creates a potential mismatch between the educational landscape and the workforce that is being employed for these evolving abilities. Since many of these systems, which were established more than a century ago, are centred on theories and educational models related to youth development but do not prioritize team-based projects and problem solving, they frequently contribute to educational gaps (Butler-Adam, 2018; Schwab, 2017).

The regression modelling results in Table 8.15 show a relatively good relationship between the micro-sociological factors and varying attitudes towards the 4IR among the respondents. Where people were susceptible to job losses as a result of the 4IR, they did not show positive attitudes towards it. These findings were consistent with a global public opinion study on automation and AI, where the demographics of age, educational attainment, employment level, etc. were the factors that affected the varying degrees of acceptance towards the fourth industrial revolution (Roberts et al., 2021;). The regression model did not yield the expected results where tertiary educational attainment would yield positive attitudes towards the 4IR, since it had a p-value above the significance level. The relationship observed was not strong enough to conclude confidently that there was a true negative effect or relationship in the population. Instead, those who had attained a matric were more associated with positive attitudes towards the 4IR than those who had no education and those with a primary school education as they were the reference category.

In literature it is noted that the future of higher education will be influenced by digital capabilities in the 4IR, which also cover cognitive and practical skills required in a changing environment (Lee et al., 2018; Xing & Marwala, 2017). Various academics claim that graduates need to have abilities outside the narrow concentration on institutions' skills and knowledge to succeed in the 21st century (Schwab, 2017; Ebewo & Sirayi, 2018). The *Fourth Industrial Revolution (4IR) in Higher Education* explores and tackles the skills required for occupations and includes courses for teaching institutions and students about management, entrepreneurship, and work-integrated learning (Butler-Adam, 2018). These abilities close the skills gap in the higher education system in South Africa and strengthen the 4IR (Butler-Adam, 2018; Gibbs, 2017; Xing & Marwala, 2017).

Higher education institutions currently function in a world that has undergone a digital transition, and the 4IR will be implemented in South Africa's higher education system, improving the linkages and networks between urban and rural institutions, and boosting social cohesion (Serdyukov, 2017). Consequently, the 4IR will strengthen South Africa's rural-based institutions considerably (Serdyukov, 2017). As a result, South African higher education has fervently argued for the revision of the curriculum to make it pertinent to the world's accelerating change.

According to my research findings of the bivariate and multivariate analysis, social class, gender, age, worker vulnerability, race, and Internet access are more important drivers of attitudes than educational attainment and geographic location. This is in line with past investigations, which found a significant age effect on robot judgment (Gnambs & Appel, 2019). This could be an instance of what is frequently referred to as a "generation effect". People who were exposed to or encountered technologies when they were younger may later display more favourable attitudes toward them (Sackmann & Winkler, 2013).

Considering that different generations have experienced technological progress differently; we could contend that they have varied relationships with technology. Because they come from a different "technology generation", elderly people may find it harder to embrace robots. In South Africa, technophobia has been connected to anxiety, tension, and depression (Anthony et al., 2000). Anxiety might lessen a person's capacity for change acceptance. The stress brought on by societal marginalization may help to explain partially the association between societal status and acceptance that was shown in this study. According to the Integrated Theoretical Model

(see Figure 8.1), these results place older people more as techno-sceptics while younger people are techno-optimists.

Instead of looking at the mental model that people use to judge robots, as outlined in Chapter Seven, I looked at specific applications of robotics. However, there are many different types of robots that this study did not examine. According to several North American researchers (Phillips et al., 2017), when people talk about robots and their effects on society, they typically conceptualize them as having strong anthropomorphic characteristics. Uncertainty exists on whether this would be the case in South Africa and how various segments of the population see robots. Gaining a deeper grasp of what South Africans anticipate from their robotic counterparts is crucial given the expanding number of robots that are infiltrating human environments. The way that robots and automation are portrayed in the media should have an impact on the public's perception of the risks associated with this type of technological change.

Currently, it is uncertain about how much media material affects how people view automation and robots. One could argue that the way robots are now portrayed in the media overemphasizes their potential drawbacks while underplaying their advantages. However, there is still a dearth of systematic data regarding the representation of robots in the South African media. This could be an important survey topic using the SASAS, which stands out as a critical tool for tracking changes in South Africans' social, economic, and political values. The SASAS is of utmost importance, given its potential as an anticipatory or predictive mechanism that can guide decision- and policy-making processes. Additionally, if more and more varied autonomous robotic systems (like drones) start are widely publicized through a variety of media outlets, sentiments may change. Given the correlation between awareness and acceptance found in this study, it is likely that acceptability will increase as people become more accustomed to robotic systems. However, increasing media coverage of the possible drawbacks of robotics, such as job loss due to automation, could cause a change in public perception. To comprehend the relationship between media and attitudes in the domestic environment, it will be necessary to continue monitoring public opinion and media portrayals.

A lot of aspects of society are about to change because of advancements in autonomous robotic systems. A lot of foresight and money will need to be invested on the parts of the government, businesses, and individuals to ensure that the social pathways of human lives from childhood to old age are positively impacted by the rapid technological development (Roberts et al.,

2021). This extends beyond the development and wealth that the 4IR is typically portrayed as bringing about (Roberts et al., 2021). “This will need new models of ‘agile governance’ and moral leadership that encourage an inherently multi-stakeholder approach to policymaking”. These must be “adaptive human centered, inclusive and sustainable” (Gilwald, 2019; Nam, 2019; Roberts et al., 2021, p. 7).

This will be crucial for controlling the rapid pace of technological change in a way that encourages positive outcomes while minimizing undesirable side effects, is adequately controlled, and fosters public confidence in robotics and AI. If the South African government wants to stop inequalities from getting worse, it will be crucial to remove the current obstacles to technology diffusion and digital inclusion. Furthermore, the government will have to lower the human cost by putting social policies and social protection plans in place that adapt to changes in the labour market (Gillward, 2019; Roberts et al., 2021; Schwab, 2017). In the face of such societal change, failure to adopt new paradigmatic methods appropriately is likely to promote precarity rather than promise, amplify concerns about the effects of technology, and ultimately increase the likelihood that people will reject automation and robotics.

In the results, those who had confidence in the government’s ability to manage the 4IR were positively associated with a higher likelihood of accepting the 4IR. Whilst the study did not find any partisan effect, literature notes the important relationship between trust in the government and more positive attitudes. An observational study revealed that support for governmental control is positively correlated with general societal suspicion, even when the public thinks the government is dishonest (Zhang & Dafoe, 2020). A subsequent study using more comprehensive survey data concluded that the public favours governmental control if they have more faith in it than they do in huge enterprises (Zhang & Dafoe, 2020).

It is still necessary to research how social and political trust relate to one another. While academics like Uslaner (2017) contend that trust in people and faith in organizations or actors have nothing in common, some polls only reveal a minimal association between the two (Newton, 2001). However, it makes sense to infer that these are connected for several reasons (World Bank, 2017; Van der Meer & Zmerli 2017; Zmerli & Newton, 2017). According to Zmerli and Newton (2017), social and political trust are in a hierarchical connection because social trust is a requirement for political trust. According to Braithwaite (1998), they form a relationship that is mutually constitutive. People may have faith in an institution because they

believe in its representatives, and they may have faith in those representatives because they believe in the institution. In addition, some academics contend that positive individual experiences foster interpersonal trust, which in turn fosters governmental trust (Van Ingen & Bekkers, 2015). Many academics disagree with conflating social and political trust, even though some share this opinion.

Multiple causes contribute to the decline of public faith in the government. Researchers discovered a direct link between corruption and the deterioration of confidence (World Bank, 2017). Some claim that factors influencing the level of trust in the government include the effectiveness and efficiency of the government. Changing citizen ideals and expectations, according to Dalton (2004), are to blame for the decline in public trust in the government. People's faith in governments and institutions is influenced by both political and personal expectations (such as past experiences, anticipated hazards like unemployment, and financial and economic volatility). The key relationship examined in the literature is that between individuals' desire to abide by rules, regulations, and tax requirements and their trust in their government. There is evidence that a lack of public trust in the government can damage the social compact and cause residents and businesses to disengage from the state in numerous important ways (Arizti et al., 2010).

When I examined the socio-economic position of the participants it became clear that issues of privilege, power, control, and unequal access to resources were evident. The findings of my study revealed a positive association between acceptance of the fourth industrial revolution and those who ranked themselves as belonging to the higher/upper middle class and above. Furthermore, race was a significant and strong predictor, with white adult South Africans more likely to accept the fourth industrial revolution compared to the reference group of black South Africans. The cross-tabulation presented in Chapter Seven also indicated that participants felt that technological advancements tended to benefit the rich, perpetuating perceptions of class and status associated with development. It is important to note that these findings are specific to the context of the study and may not apply universally due to variations in socio-economic position and race across different settings..

Whilst assessing social rank I considered looking at employment vulnerability, where both the bivariate and multivariate results indicated that employed South Africans exhibited a fear of losing their jobs to automation. Research in the quantitative public opinion literature indicates

that by 2041, 40 per cent of all jobs in Bangladesh could be mechanized (a2i, 2019). By 2041, technological advancement and automation may result in the loss of 60 per cent of jobs in Bangladesh's ready-to-wear apparel and furniture industries. A further 40 per cent of jobs in the agro-processing industry, 35 per cent of jobs in the leather industry, and 20 per cent of jobs in the tourism industry are also at risk (a2i, 2019). There has been an overwhelming fear of job losses and replacement of human duties displayed in the results of this study and the literature. An important task that the government has is to ensure that introduction of these technologies does not mean depression of the already fractured labour market. While the prospects of the 4IR to create new jobs in a few years' time have been praised, it is also important to consider whether each country would be able to yield the promised results.

The literature in Chapters Four and Five revealed how the 4IR unfolds differently in developed and developing countries. It shows that what can be a norm in one country can be frowned upon in another. Therefore, the important argument relayed in this study is the importance of considering the cultural setting and socio-economic conditions in which these technologies are introduced. This will surely assist in determining the type of technologies that could be useful and relevant for each country. Moreover, 4IR technologies that will be introduced in the South African context need buy-in from the people. That is why it was imperative for me to consider this, as explained in Chapters Seven and Eight. I assessed how comfortable citizen were with having robots performing different human activities (such as surgery and having different workers replaced by robots). There was generally a high level of discomfort with robots performing these tasks. Such information is useful as it exposes the type of acceptance or rejection that different innovations would receive.

Importantly, this chapter served to confirm the main hypothesis of this study, which is the central role played by micro-sociological indicators towards shaping attitudes towards industrialization. The contribution of this study is to endorse micro-sociological indicators as an aspect to be considered in adoption models. Most of the adoption models discussed in Chapter Three considered attitudes based on the perceived ease of use of that technology and are based on the needs of the working environment and not personal use of technology. They also do not consider general citizens. There is quite a shift in society, the labour market, and the business world with the introduction of the 4IR and the concerns and impact that it will have beyond the scope provided by the adoption models discussed. Hence, it is vital to consider technology appropriation in the conversation of adoption models. The strength of this study is

that the scope covers an array of individuals (unemployed, employed, young, old, uneducated, and educated). Adoption models have often focused on the working class and the needs of organizations for certain technologies.

The framework recently developed by Olaitan et al. (2021) to test South Africa's readiness for the 4IR looked at the two aspects of fit and viability. These dimensions (fit and viability) looked at economic and technological resources to determine the country's readiness for the 4IR. The scope of this framework was to look at the country's resources as a means of readiness; while the integrated model I presented in this current study looked at citizens' skills, attitudes, knowledge, worker vulnerability and education as a lens to determine appropriateness. While one model emphasizes the need for readiness in terms of resources, my integrated model argues for the need for readiness among citizens too. After all, they will be the main users of these technologies and they will be affected by them. The proposed integrated framework of this study harmonizes the attitudinal theories by adding another dimension (micro-sociological indicators). These have been shown to have an impact on the attitudes towards technology in this chapter.

8.5 Chapter Summary

This chapter has demonstrated the importance of considering public opinion on policymaking regarding technology by using bivariate and multivariate testing and analysis. The historical influence of public opinion on social and political life highlights the need for alignment with governmental action to ensure democratic governance. While the relationship between public opinion and policy outcomes may not always be straightforward, numerous studies have shown a connection between the two in certain democracies. This study's examination of micro-level sociological factors and their relationship to views about the fourth industrial revolution (4IR) was essential to develop an Integrated Technology Adoption model that incorporates societal perspectives. This chapter has highlighted the limitations of technology determinist explanations and the need for an integrated approach by shedding light on the complex relationship between technology adoption and societal factors, particularly in the South African context,. Overall, this study has provided valuable insights into the factors contributing to certain attitudes towards the fourth industrial revolution, paving the way for more informed and inclusive technology policies. The results of this study have important implications for policymakers, particularly in terms of ensuring that technology policies are responsive to public

preferences. While the political landscape in South Africa may limit the impact of popular opinion on public policy, it is important for the government to take the public's opinions into account when making decisions about technology adoption.

Overall, this chapter contributed to our understanding of the complex relationship between technology and society and highlights the need for further research that takes into account broader social and cultural factors that shape technology adoption in South Africa. It is hoped that this study will stimulate further discussion and research in this important area, and ultimately contribute to the development of technology policies that are more responsive to the needs and preferences of all members of society. The last chapter looks at the recommendations and conclusion for the study.

CHAPTER NINE: CONCLUSION AND RECOMMENDATIONS

9.1 Overview of the Study

The goal of this study was to evaluate the degree to which micro-sociological indicators were associated with attitudes toward the 4IR and to use that information to support the Integrated Adoption Model that this study suggested. The study examined the effects of important micro-level sociological indicators on adult South African members of the public's views about the 4IR and found that six were good predictors: *social class, age, gender, educational level, 4IR knowledge index, and Internet access.* The *government's ability to manage the 4IR* was a good predictor at the country level. Each of the empirical chapters (7 & 8) included a presentation of the dataset used in this investigation. The numerous issues raised were inherent to the method of public opinion surveying rather than the dataset itself.

Even though it is occasionally an indirect effect, attitudes have a significant influence on social behaviour. Therefore, policymakers in a democracy should be deeply concerned with how citizens feel about important social and political issues. Democratic governments should represent their constituents' wishes, according to Dahl (1973), a democratic theory proponent, Soroka and Wlezien, 2010; and Wilson (2013). The formulation and execution of public policy may be influenced by public opinion. Beyond these factors, I believe that public opinion is significant in and of itself because of what it reveals about the attitudes of common people on significant subjects. The 4IR is a phenomenon that impacts everyone, and hence I thought it important to do a study that represents the views of ordinary people too, as far too many studies focus technological development at the organizational level. This thesis used data to demonstrate that a large portion of South Africans have unfavourable attitudes regarding automation, but that a sizeable portion also have positive, tolerant, and progressive attitudes toward some aspects of the technological revolution.

Scholars debated that South Africa is not a suitable location for the 4IR, given that its economy is still dependent on agriculture, mining, and the unorganized sector (see Sutherland, 2020; Guenther, Reif, Taddicken, & Weingart, 2022). It has a high unemployment rate and most of

its people lack sophisticated and frequently even basic skills (Olaitan et al., 2021; Roberts et al., 2021; Sutherland, 2020). South Africa's relationship with industrial policies has been complex and frequently troublesome given its history, both under the National Party and the ANC (Sutherland, 2020). The 4IR serves as a rallying cry and rhetorical instrument for those attempting to forge economic and commercial futures to ride the waves of Schumpeterian economic upheaval brought on by "extreme automation and extreme connection".

Section 9.2 presents and summarizes the study's findings. This section of the chapter will also show how this thesis' several empirical chapters are connected to one another. Section 9.3 summarizes and briefly discusses the study's contributions to the literature, and the concluding section identifies prospective areas for more research.

9.2 Summary of the Findings

My research helps us comprehend the degree to which theories created in American and European can be applied to the South African context . For instance, major fears of the 4IR shown in public opinion data for America and Europe are the same in South Africa. The fear of job losses and of humans being replaced by robots is the major shared emotion that has led to negative attitudes towards automation. This section will summarize the research findings and identify the micro-sociological variables that shape national opinions. The report has brought to light how pervasive South Africans' opposition to the 4IR is.

9.2.1 Attitudes towards the fourth industrial revolution (robotics)

One must be certain that the respondents have a rough idea of what 4IR technologies are in their minds before asking them to describe their opinions about them. It was reported that there was little understanding of the word "robot" during the piloting of the 4IR module for the SASAS. An opening remark that gave respondents a basic definition of a "robot" was read out before the module questions on the respondents' opinions regarding robotics as a result of this lack of understanding. This was partially inspired by the word's widespread use as a colloquialism for "traffic light" in South Africa. Additionally, interviewers showed four robot

images to participants on a showcard. These metrics were crucial to ensure that the responders to the robotics questions had comparable reference points.

Chapter Seven investigated the pattern of replies to the survey questions used to address the levels of comfort or discomfort towards automation/industrialization. Participants were shown four images of examples of the use of automation "in order to determine the degree of cultural acceptance of technological change among South Africans" (SASAS, 2018, p. 4). Participants were given four scenarios: "(i) having a medical operation performed on you by a robot; (ii) factories where workers are replaced by robots; (iii) receiving goods delivered by a drone or a robot; and (iv) shops where cashiers are replaced by robots". The responses were captured using a scale ranging from one to them , where one meant "totally uncomfortable" and ten meant "totally comfortable" (SASAS, 2018, p.4). It is important to note that the overall pattern of scores on the index measuring the cultural acceptability of robots tended to fall in the lower half of the scale (more unfavourable/uncomfortable, technologically sceptic). There were significant disparities in the attitudes toward robotic applications, and this involved varied degrees of hostility toward task-related uses of robots.

9.2.2 Determinants of public opinion towards the 4IR in South Africa

Participants were asked several questions about S&T because previous research on public perceptions of S&T was motivated by the notion that innovation in S&T is crucial to national success and that innovation needs a receptive public (Besley, 2013). The relationship between knowledge of science and attitudes toward S&T has generally been disputed for a long time. Researchers have long held to the so-called deficit hypothesis, which holds that if people were just more scientifically informed, their views toward science would improve and scepticism would disappear. Due of this, Western nations have implemented numerous educational initiatives. However, the overall terminology as well as the success of such programs have been questioned. Additionally, cross-cultural studies in Europe have demonstrated that, in contrast to post-industrial nations, there is a lesser association between scientific literacy and attitudes toward science and technology (S&T) in industrially developing nations. The argument goes that only a small elite in industrial countries possess information (due to significant socio-economic stratification), and that more knowledge promotes a more optimistic outlook. My

study results indicated that the 4IR knowledge index was associated with a high likelihood of acceptance towards the 4IR.

9.2.3 Worker vulnerability

In Chapter Seven, respondents expressed their fear of being replaced by robots when asked several questions regarding AI; hesitancy was the dominating attitude. This poses a challenge to the South African Government to foster policies that will ensure that the potential benefits of this revolution are harnessed while mitigating the negative impacts such as job losses/unemployment.

The findings of this study are in line with those of the literature, which indicates that contextual factors such as worker vulnerability have the greatest impact on negative opinions (techno-scepticism). Daily life changes brought on by technology can elicit strong and occasionally violent opposition. In the past, common people have resisted the implementation of modern technologies. Consider the Luddite movement in the early 19th century, when workers rebelled against ongoing technological development by destroying machinery and interfering with novel manufacturing techniques. Workers believed that the capitalist class was utilizing new technologies to exploit the working class, which led to the emergence of this opposition. South African workers are susceptible to automation replacing them. It's conceivable that people may automatically oppose automation technology because of this vulnerability. Regardless of their work situation, the poor and marginalized in society may be concerned about technological development.

9.2.4 Micro-level sociological indicators

The results shown in Chapter Eight support the hypothesis outlined in the introduction, that there is a relationship between micro-sociological indicators and attitudes towards the 4IR. This study has hypothesized that SES does influence how people see and experience 4IR technology. Those with a potential risk of losing jobs due to automation were hypothesized as likely to develop negative attitudes towards the 4IR. The analysis shows how attitudes about robotics varies noticeably across contexts and how they differ for various people, depending on their social class and demographic disparities. It was hypothesized that a variety of

characteristics, including expertise, societal class, age, and labour market vulnerability, would influence how the public will react to the robot's revolution.

The analysis demonstrated how demographic predictors play a significant role in the development of attitudes toward the 4IR in South Africa, with white people found to be more accepting than black Africans and higher levels of perceived socio-economic class found to be more accepting than those with lower class self-perceptions. As people with Internet access exhibit higher levels of acceptance than those without, the digital gap is also notable. However, because there is little public awareness of concepts connected to robots and automation, attitudes about 4IR technologies are created in a context of low awareness.

9.3 Theoretical Contribution of the Study

In accordance with the Social Shaping of Technology theory, micro-sociological indicators, which were shown in the empirical chapters, affect attitudes towards technology. This study offers important insights into the social dimensions of the fourth industrial revolution (4IR). Through cross-tabulation, trends were identified on the type of micro-sociological indicators that shape attitudes. The bivariate analysis tested the hypothesis of this study to ascertain the association between the micro-sociological indicators and the outcome variable. Ultimately, the multivariate analysis affirmed and gave a robust testing of these indicators to show the predictors of acceptance towards the 4IR. Through this analysis the Integrated Adoption Model incorporated the tested variables which were statistically significant in the model.

There are so many dimensions that other scholars have used to gauge the country's readiness for the 4IR. They did this by examining its economic and technological resources and focussed mostly on the macro level. Whereas the focus of most models is on resources as indicators of preparedness, my integrated model takes a different perspective. In my current study, I presented an integrated model that examines citizens' skills, attitudes, knowledge, worker vulnerability, and education as a means of determining appropriateness (see Figure 8.1 in Chapter 8). While one model stresses the importance of readiness in terms of resources, my integrated model emphasizes the need for readiness among citizens, who will be the primary users of these technologies and will be affected by them. By introducing a dimension (micro-

sociological indicators) that has been demonstrated in this chapter to have an impact on attitudes toward technology, my proposed integrated framework harmonizes attitudinal theories.

Through this model the thesis shows the value of researching South African citizens' perceptions of the 4IR in this regard. Understanding the patterns of new technology acceptance and diffusion in industrialized countries has been the focus of most of the literature. The effects of SES and other sociological factors on people's attitudes toward adopting new technologies have not been considered by traditional models of technology adoption and diffusion (see Chapter Three). As a result, there is a scarcity of academic study on the elements that encourage or inhibit technology adoption and spread in underdeveloped countries with slow economic progress.

Most studies on public opinion on the 4IR concern attitudes found in industrialized nations like Europe, North America, and others. By choosing South Africa as the study setting, this thesis has provided tested results that, as opposed to that were established outside of the continent, can be more applicable to the socio-economic realities of sub-Saharan African countries. My research created tried-and-true hypotheses that can be put into practice more quickly and re-evaluated in other countries. This will advance the growing field of non-Western quantitative attitudinal research on the 4IR technologies, particularly in sub-Saharan Africa. There might be repercussions for nations outside of sub-Saharan Africa as well, who might gain from a different point of view.

Importantly, this thesis served to confirm the main hypothesis of this study, which is the central role of micro-sociological indicators towards shaping attitudes to industrialisation. The contribution of this study was to endorse micro-sociological indicators as an aspect to be considered in adoption models. Most of the adoption models discussed in Chapter Three consider attitudes based on the perceived ease of use of that technology, and they are based on the needs of the working environment and not the personal use of technology, and do not consider general citizens. The concerns and impact that the introduction of the 4IR will have go beyond the scope provided by the discussed adoption models. There is quite a shift in society, the labour market and business, and hence it is vital to consider technology

appropriation in the conversation of adoption models. The strength of this study is that the scope covers an array of individuals (unemployed, employed, young, old, uneducated, and educated). Adoption models have often focused on the working class and the need of organizations for certain technologies.

9.4 Reflection on Hypotheses

As I weave through the tapestry of data collected and hypotheses tested in this study, a nuanced narrative of South Africa's embrace of 4IR technologies unfolds. Beyond the explicit hypotheses, the interplay of micro-sociological factors with attitudes towards the 4IR is richly textured, presenting a multifaceted understanding that extends beyond the binary realms of acceptance and rejection.

H1: Age and Acceptance of Technology

From the outset, I posited that younger individuals would display a more positive reception of robots compared to their older counterparts. The data indeed aligns with this expectation, revealing a noticeable generational divide. Younger participants consistently exhibit higher levels of acceptance, underlining a distinct openness to technological change within this demographic.

H2: Government Intervention and Attitudes towards 4IR

The second hypothesis suggested a positive correlation between confidence in South African government intervention and favorable attitudes towards the 4IR. The findings, however, paint a more nuanced picture. While confidence in government intervention influences attitudes, it is not the exclusive determinant. Socioeconomic status and employment concerns emerge as equally influential factors, emphasizing the need for a multifaceted approach when examining the impact of government policies on societal attitudes.

H3: Employment Status and Opposition to Automation

Contrary to the third hypothesis, which anticipated that employed individuals would display more resistance to automation, the results reveal a more complex relationship. Employment

status alone does not dictate attitudes; instead, factors such as job security, awareness of 4IR implications, and perceptions of personal vulnerability play pivotal roles.

H4: Opposition to Private Company-Induced Job Loss

Hypothesis four anticipated resistance to private companies introducing technologies risking job losses. The study confirms this expectation, highlighting societal apprehension towards corporate-driven technological shifts. The findings underscore the significance of ethical considerations in technological advancements within a societal context.

H5: Worker Displacement and Hostility towards Technology Change

The hypothesis that workers facing displacement due to automation would harbor more hostility towards technological change finds empirical validation. The study identifies a palpable connection between impending job displacement and heightened skepticism towards technological evolution.

H6: Perceptions of Educational Preparedness

The sixth hypothesis suggested that individuals would believe schools inadequately prepare young people to work with technology. The findings confirm this hypothesis, shedding light on a prevalent perception gap regarding the effectiveness of educational institutions in equipping the younger generation for the demands of the 4IR.

H7: Familiarity with Science and Technology

The final hypothesis proposed that familiarity with science and technology would predict favorable attitudes towards the 4IR. The study validates this expectation, highlighting a positive correlation between scientific literacy and openness to technological advancements.

In essence, this study transcends conventional boundaries, unraveling the intricate web of social, economic, and educational factors that collectively shape attitudes towards the 4IR in the South African context. As I reflect on these findings, it is clear that societal attitudes are

dynamic, emphasizing the need for nuanced policy interventions and educational reforms to navigate the evolving landscape of technology acceptance.

9.5 Recommendations

9.5.1 Recommendations at policy level

All indications point to the fact that South Africa has a low level of technical readiness, which is very unfortunate. The South African Government should create new approaches to policy so as to embrace the 4IR, harness its promise, and minimize its negative effects. Societal opposition will arise if the reservations shown by citizens are not considered and this will result in 4IR policies that are less likely to be successful. It is important to supplement earnings during the technological shift, so the Government should test options and assess the feasibility of doing so. Such options include extensive minimum wage laws or a universal basic salary as other countries adopting such technologies are doing this.

It is essential to solve the current obstacles to digital inclusion and technology dissemination if we are to stop inequalities from growing. Additionally, it will be necessary to reduce the human cost by implementing social policies and social protection programs that can adjust to changes in the labour market. The study has shown that young people are vulnerable, and it is crucial to establish private and public partnerships between key stakeholders who will finance job re-training to help people learn new skills to make them more employable. Such partnerships are crucial because this will be a difficult task for an already overworked school system.

The rising variety of mobile digital devices mean that computational thinking, problem-solving, data literacy, analytical skills, and mobile literacy need to be considered when reviewing and building courses. The study’s results showed that most participants believed that their education had not prepared them sufficiently for involvement in industrialization. It's critical to review the curriculum in the educational sector given the low percentage of computer capability reported by the participants.

From a traditional telecommunications standpoint, a crucial policy change is needed so that people will stop seeing "digitalization" as something that only affects a single industry or is only a problem at a national level. Instead, it is a complex ecosystem that encompasses the entire economy and society at the national and local level, and it is intricately tied to and dependent upon international markets and governmental processes. The availability of skills and competencies among individuals and institutions at each ecosystem node, as well as their capacity to capitalize on the benefits of integrated networks for social and political engagement and economic development, determine the levels of efficiency and innovation that support the ecosystem's evolution. The kinds and quantities of investment as well as the success of competition regulation to improve consumer welfare and foster innovation are determined by the institutional endowments of the nation. This includes the design and capacity of the institutions. Digital technological advancement is expected to increase inequality rather than lead to more opportunities and shared wealth if governance institutions are unable to adapt and deal with the growing complexity of the digital ecosystem. We need effective governance and players who can make it happen if we are to ensure that more employment opportunities are created as a result of this innovation.

9.5.2 Recommendations for future research

I have conducted a thorough positivist investigation on public perceptions of the 4IR in South Africa for this thesis, and examined contextual factors and micro-sociological indicators. I have proposed areas for future research that I was unable to conduct due to data and time limitations. As we conclude this chapter, it would be helpful to consider some of these prospective future study areas that I was unable to investigate because of the restrictions of the readily available public opinion datasets.

I mentioned this dissertation's findings on educational achievement as one of its key contributions in the previous section. According to various academics, exposure to formal education may have an impact on views through a variety of different processes (Hudson et al., 2017; Nomura et al., 2009; Roberts et al., 2021; Taipale et al., 2015). It is therefore challenging to understand why educational achievement did not lead to the outcomes I had hoped for and additional quantitative research is needed to better understand the education effect found in this study. Getting more information on people's educational levels could make it possible to

determine the link between exposure to formal education and attitudes more precisely. In future investigations of South African views toward the 4IR, quasi-experimental manipulation of education levels could be another tool that could be of significant benefit.

Studying how the views about the 4IR were influenced by micro-sociological factors has enabled this thesis to add to the body of knowledge in a significant manner. However, the technical developments that were the focus of this thesis were analyzed using common methodologies that were applied to numerous global surveys. Robots and automation, which are more widely accepted as indicators of industrialization in South Africa, may need the creation of new survey tools to capture the range of emerging attitudes. This thesis found quite a low understanding among respondents of concepts like AI, automation, and the robotic features of technology – and it becomes difficult to ascertain attitudes to something you do not understand or have exposure to.

The quantitative research presented in this dissertation has contributed significantly to the body of knowledge. I do admit, though, that the study's findings have prompted inquiries that a quantitative analysis will not be able to resolve. The potential of positivist data to generate knowledge has limitations, which I have specifically highlighted in this dissertation's methodology chapter (Chapter Six). The responses people give to surveys are inexorably constrained by a fixed subjectivity, and this methodology reduces the researcher's leeway for many shifting self-understandings. These issues may be addressed through non-quantitative research, which can also assist the researcher to find answers to topics that quantitative research is unable to. A more qualitative methodological approach could be adopted to "find" new subject areas that the researcher has not previously examined, as this will add new insight into the challenging subject of the 4IR in South Africa.

REFERENCES

a2i. (2019). *Future skills: Finding emerging skills to tackle the challenges of automation in Bangladesh*. https://a2i.gov.bd/wp-content/uploads/2022/08/4IR.pdf.

Acemoglu, D., & Restrepo, P. (2016). *The race between machine and man: Implications of technology for growth, factor shares and employment*. (NBER Working Paper Series 22252). National Bureau of Economic Research.

Acemoglu, D., & Autor, D. (2011). Skills, tasks and technologies: Implications for employment and earnings. In D. Card, & O. Ashenfelter (Eds.), *Handbook of Labor Economics* (vol. 4, part B). Elsevier, 1043-1071.

Adalbert Hampel, K. (2015). The dark(er) side of "state failure": State formation and socio-political variation. *Third World Quarterly, 36*(9), 1629-1648. https://doi.org/10.1080/01436597.2015.1045862

Adam, H. (2019). The digital revolution in Africa: Opportunities and hurdles. In …… Proceedings of 10th International Conference on Digital Strategies for Organizational Success. https://dx.doi.org/10.2139/ssrn.3307703.

Adam, I. O. (2020). Examining e-government development effects on corruption in Africa: The mediating effects of ICT development and institutional quality. *Technology in Society, 61*, 101245.

Adams, R. (2021). The gendered impact of artificial intelligence and the fourth industrial revolution in South Africa: Inequality, accessibility and skills development. In: W. Pearson Jr., & V. Reddy (Eds.), *Social justice and education in the 21st century. Diversity and inclusion research*. Springer. https://doi.org/10.1007/978-3-030-65417-7_19

Adebisi, A. P. (2017) Xenophobia: healing a festering sore in Nigerian-South African Relations. *Journal of International Relations and Foreign Policy, 5*(1), 83-92. https://doi.org/10.15640/ jirfp.v5n1a6

Adekunle, A., Osazuwa, P., & Raghavan, V. (2016). Socio-economic determinants of agricultural mechanisation in Africa: A research note based on cassava cultivation. *Mechanisation. Technological Forecasting and Social Change, 112*, 313-319.

Adendorff, C. & Putzier, M. (2018). *A causal layered analysis of South Africa's readiness for the fourth industrial revolution towards 2035*. Institute of Municipal Engineering of Southern Africa. https://www.imesa.org.za/wp-content/uploads/2018/11/paper-1-page-55-66.pdf.

Adenle, A. A., Azadi, H., & Manning, L. (2018). The era of sustainable agricultural development in Africa: Understanding the benefits and constraints. *Food Reviews International, 34*(5), 411-433.

Adler, N. J. (2006). The arts & leadership: Now that we can do anything, what will we do? *Academy of Management Learning & Education, 5*(4), 486-499.

African Development Bank, World Bank Group, & World Economic Forum. (2017). *The Africa competitiveness report, 2017. Addressing Africa's demographic dividend*. www.weforum.org/acr.

African Development Fund. (2008). *Ghana country gender profile*. African Development Fund & Human Development Department (OSHD). https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/ADF-BD-IF-2008-237-EN-GHANA-COUNTRY-GENDER-PROFILE.PDF

African Union. (2014). *Agenda 2063*. https://au.int/en/agenda2063.

African Union. (2018). *Continental free trade area*. https://au.int/en/ti/cfta/about.

African Union Commission & Organisation for Economic Cooperation and Development. (2018). *Africa's development dynamics 2018: Growth, jobs and inequalities*. African Union Commission & Organisation for Economic Cooperation and Development.

Agarwal, H. & Agarwal, R. (2017). First industrial revolution and second industrial revolution: Technological differences and the differences in banking and financing of the firms. *Saudi Journal of Humanities and Social Sciences, 2*(11A), 1062-1066.

Aguera, P., Ahmed, S., Calandro, E., Matanga, C., Rens, A., & Van Der Spuy, A. N. R. (2020). *The digital economy and society*. https://researchictafrica.net/wp/wp-content/uploads/2020/11/digital-economy-report_04.pdf.

Aghion, P., Algan, Y., Cahuc, P., & Shleifer, A. (2010). Regulation and distrust. *The Quarterly Journal of Economics, 125*(3), 1015-1049.

Ajzen, I. (2020). The theory of planned behavior: Frequently asked questions. *Human Behavior and Emerging Technologies, 2*(4), 314-324.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211.

Ajzen, I., & Fishbein, M. (2000). Attitudes and the attitude-behaviour relation: Reasoned and automatic processes. *European Review of Social Psychology 11*(1), 1-33. https://doi.org/10.1080/14792779943000116

Ajzen, I., & Fishbein, M. (2005). The influence of attitudes on behaviour. In D. Albarracin, B. T. Johnson, & M. P. Zanna (Eds.), *The handbook of attitudes*. Erlbaum, 173-221.

Akanle, O. & Adésìnà, J. O. (Eds.). (2018). *Introduction: The development of Africa: Issues, diagnoses and prognoses*. Springer, 1-8.

Akinlo, A. E. (2004). Foreign direct investment and growth in Nigeria: An empirical investigation. *Journal of Policy Modeling 26*(5), 627-639. https://doi.org/10.1016/j.jpolmod.2004.04.011

Alabi, A. O., & Mutula, S. M. (2022). Human development for the fourth industrial revolution: Which way for Sub-Saharan Africa?. *Development Southern Africa, 39*(4), 528-542.

Alam, S., & Dhamija, P. (2022). Human resource development 4.0 (HRD 4.0) in the apparel industry of Bangladesh: A theoretical framework and future research directions. *International Journal of Manpower, 43*(2), 263-285.

Albarracin, D., & Shavitt, S. (2018). Attitudes and attitude change. *Annual Review of Psychology, 69*(1), 299-327.

Aliyev, H. (2017). Precipitating state failure: Do civil wars and violent non-state actors create failed states? *Third World Quarterly, 38*(9), 1973-1989. https://doi.org/10.1080/01436597.2017.1319276

Aliyu, A. A., Bello, M. U., Kasim, R., & Martin, D. (2014). Positivist and non-positivist paradigm in social science research: Conflicting paradigms or perfect partners? *Journal of Management and Sustainability, 4*(3), 79-95. https://doi.org/10.5539/jms.v4n3p79

Allen, R. C. (1992). *Introduction: Agrarian fundamentalism and English agricultural development. Enclosure and the Yeoman*. Clarendon Press.

Allport, G. W. (1935). Attitudes. In C. Murchison (Ed.), *A handbook of social psychology*. Clark University Press, 798-844.

Allum. N., Sibley, E., Sturgis, P., & Stoneman, P. (2014). Religious beliefs, knowledge about science and attitudes towards medical genetics. *Public Understanding of Science, 23*(7), 833-849. https://doi.org/10.1177/0963662513492485

Allum, N., Sturgis, P., Tabourazi, D., & Brunton-Smith, I. (2008). Science knowledge and attitudes across cultures: A meta-analysis. *Public Understanding of Science, 17*(1), 35-54.

Almeida, F., Santos, J. D., & Monteiro, J. A. (2020). The challenges and opportunities in the digitalization of companies in a post-COVID-19 world. *IEEE Engineering Management Review, 48*(3), 97-103.

Alonso-Borrego, C. & Collado, D. (2002). Innovation and job creation and destruction. *Recherches Économiques de Louvain, 68*, 148-168.

Alter, S. (2008). Defining information systems as work systems: Implications for the IS field. *European Journal of Information Systems, 17*, 448-469.

Amankwah-Amoah, J. (2018). Revitalising serial entrepreneurship in sub-Saharan Africa: Insights from a newly emerging economy. *Technology Analysis & Strategic Management, 30*(5), 499-511.

Amankwah-Amoah, J., Osabutey, E. L. C., & Egbetokum, A. (2018). Contemporary challenges and opportunities of doing business in Africa: The emerging roles and effects of technologies. *Technological Forecasting and Social Change, 131*, 171-174.

America, C. & Le Grange, L. (2019). Decolonising the curriculum: Contextualising economics and business studies teaching [Dekolonisering van die kurrikulum: 'n

kontekstualisering van ekonomieen besigheid studieonderrig]. *Tydskrif vir Geesteswetenskappe*. https://doi.org/10.17159/2224-7912/2019/v59n1a7

Anakpo, G. & Kollamparambil, U. (2022). Effect of automation on unemployment: The case of Southern Africa. *Development Southern Africa, 39*(4), 516-527.

Andrews, J. (2006). Broadband technologies in Australia 1993–98: Developing the social shaping of technology approach. *Prometheus, 24*(2), 169-188.

Andreoni, A., & Tregenna, F. (2020). Escaping the middle-income technology trap: A comparative analysis of industrial policies in China, Brazil and South Africa. *Structural Change and Economic Dynamics, 54*, 324-340.

Ang, M. C., Ramayah, T., & Amin, H. (2015). A theory of planned behavior perspective on hiring Malaysians with disabilities. *Equality, Diversity and Inclusion, 34*(3), 186-200.

Anthony, L. M., Clarke, M. C., & Anderson, S. J. (2000). Technophobia and personality subtypes in a sample of South African university students. *Computers in Human Behaviour, 16*(1), 31-44.

Antràs, P. & Voth, H.-J. (2003). Factor prices and productivity growth during the British industrial revolution. *Explorations in Economic History, 40*(1), 52-77. https://doi.org/10.1016/S0014-4983(02)00024-4

Arizti, P., Brumby, J., Manning, N., Senderowitsch, R., & Thomas, T. (2010). *Results, performance budgeting, and trust in government*. World Bank.

Armitage, C. J., & Conner, M. (1999). The theory of planned behaviour: Assessment of predictive validity and perceived control. *British Journal of Social Psychology, 38*(1), 35-54.

Arntz, M., Gregory, T., & Zierahn, U. (2016). *The risk of automation for jobs in OECD countries: A comparative analysis*. (OECD Social, Employment and Migration Working Paper, No. 189). OECD Publishing. https://doi.org/10.1787/5jlz9h56dvq7-en

Arterton, F. C. (1987). *Teledemocracy: Can technology protect democracy?* Sage.

Aruleba, K., & Jere, N. (2022). Exploring digital transforming challenges in rural areas of South Africa through a systematic review of empirical studies. *Scientific African*, , 16, 2-13 https://doi.org/10.1016/j.sciaf.2022.e01190

Ashton, T. S. (1948). *The industrial revolution (1760–1830)*. Oxford University Press.

Atkeson, A., & Kehoe, P. J. (2001). *The transition to a new economy after the second industrial revolution*. (National Bureau of Economic Research Working Paper Series No. 8676). https://doi.org/10.3386/w8676.

Autor, D. H. (2015). Why are there still so many jobs? The history and future of workplace automation. *Journal of Economic Perspectives, 29*(3), 3-30.

Autor, D. H., & Dorn, D. (2013). The growth of low-skill service jobs and the polarization of the US labor market. *American Economic Review, 103*(5), 1553-1597.

Autry, C. W., Grawe, S. J., Daugherty, P. J., & Richey, R. G. (2010). The effects of technological turbulence and breadth on supply chain technology acceptance and adoption. *Journal of Operations Management, 28*(6), 522-536.

Awodele, O., Ngige, O., & Balogun, T. (2021, November). Industry 4.0: The impact of technology on the output potentials of skilled and unskilled workforce in developing countries. In *ECIAIR 2021 3rd European Conference on the Impact of Artificial Intelligence and Robotics*. Academic Conferences and Publishing Limited, 10.

Aydin, B. (2019). Public acceptance of drones: Knowledge, attitudes, and practice. *Technology in Society, 59*, 101180.

Ayentimi, D. T. (2018). *Multinationals' HRM policies and practices: Do national institutions in less developed countries really matter?* Rainer Hampp Verlag.

Ayentimi, D. T. & Burgess, J. (2019). Is the fourth industrial revolution relevant to sub-Sahara Africa? *Technology Analysis & Strategic Management, 31*(6), 641-652.

Ayentimi, D. T., Burgess, J., & Brown, K. (2018). A conceptual framework for international human resource management research in developing economies. *Asia Pacific Journal of Human Resources, 56*(2), 216-237.

Bachewe, F. N., Berhane, G., Minten, B., & Taffesse, A. S. (2018). Agricultural transformation in Africa? Assessing the evidence in Ethiopia. *World Development, 105*, 286-298.

Baccini, L., & Weymouth, S. (2021). Gone for good: Deindustrialization, white voter backlash, and US presidential voting. *American Political Science Review, 115*(2), 550-567.

Badat, S. (2020). Reproduction, transformation and public South African higher education during and beyond Covid-19. *Transformation: Critical Perspectives on Southern Africa, 104*(1), 24-42.

Bagozzi, R. P., Davis, F. D., & Warshaw, P. R. (1992). Development and test of a theory of technological learning and usage. *Human Relations, 45*(7), 659-686.

Baldwin, J. A. (1976). Black psychology and black personality: Some issues for consideration. *Black Books Bulletin, 4*(3), 6-11.

Bam, W., & De Bruyne, K. (2019). Improving industrial policy intervention: The case of steel in South Africa. *The Journal of Development Studies, 55*(11), 2460-2475.

Bandiera, O., Elsayed, A., Smurra, A., & Zipfel, C. (2022). Young adults and labour markets in Africa. *Journal of Economic Perspectives, 36*(1), 81-100.

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education and Behavior, 31*(2), 143– 164.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychology Review, 84*, 191-215.

Bang, H., & Marsh, D. (2018). Populism: A major threat to democracy? *Policy Studies, 39*(3), 352-363.

Bantwini, B. (2017). Analysis of teaching and learning of natural sciences and technology in selected Eastern Cape province primary schools, South Africa. *Journal of Education, 67*, 39-64.

Barker, N., & Jewitt, C. (2022). Future touch in industry: Exploring sociotechnical imaginaries of tactile (tele) robots. *Futures, 136*, 102885.

Barnard, Y., Bradley, M. D., Hodgson, F., & Lloyd, A. D. (2013). Learning to use new technologies by older adults: Perceived difficulties, experimentation behaviour and usability. *Computers in Human Behavior, 29*(4), 1715-1724.

Bashange, L. (2015). *Assessment of the risk awareness for mobile banking users in Tanzania, a case of CRDB Mbagala branch Temeke Municipality Dar Es Salaam*. Macmillan.

Basu, S. (2022). Three decades of social construction of technology: Dynamic yet fuzzy? The methodological conundrum. *Social Epistemology*, 37 (3), 1-17.

Bauer, M. W. (2009). The evolution of public understanding of science—discourse and comparative evidence. *Science, Technology & Society, 149*(2), 221-240.

Bauer, M. W., Allum, N., & Miller, S. (2007). What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. *Public Understanding of Science, 16*, 79-95. https://doi.org/10.1177/0963662506071287

Bauer M.W. & Falade BA .(2020). Public understanding of science: survey research around the world. In: Bucchi M, Trench B, Routledge *handbook of public communication of science and technology*. Routledge, pp 156–175.Bauer, M. W., Shukla, R., & Allum, N. (2012). Towards cultural indicators of science with global validity. In M. W. Bauer, R. Shukla, & N. Allum (Eds.), *The culture of Science: How the public relates to science across the globe*. Routledge, 1-17.

Bhanu, B., Donovan, P., Haefele, M., Siddiqi, L. & Smiles, S. (2016). *Extreme automation and connectivity: The global, regional, and investment implications of the fourth industrial revolution*. UBS.

Bell, J., Goga, S., Mondliwa, P., & Roberts, S. (2018). *Structural transformation in South Africa: Moving towards a smart, open economy for all*. Industrial Development Think Tank. University of Witswatersrand.

Bell, J. F., Goga, S., & Robb, N. (2021). *Emerging issues for industrial policy in South Africa*. (CCRED-IDTT Working Paper No. 6). https://static1.squarespace.com/static/52246331e4b0a46e5f1b8ce5/t/61555be52d16705413d770dc/1632984042929/IDTT+4_WP_Emerging_Issues_for_Industrial_Policy_in_South_Africa_202107.pdf.

Bem, D. J. (1972). Self-perception theory. *In Advances in experimental social psychology* (Vol. 6). Academic Press, 1-62.

Benbasat, I. & Barki, H. (2007). Quo vadis, TAM? *Journal of the Association for Information Systems, 8*, 218-221.

Benbasat, I. & Weber, R. (1996). Research commentary: Rethinking 'diversity' in information systems research. *Information Systems Research, 7*, 389-399.

Benbasat, I. & Zmud, R. (2003). The identity crisis within the IS discipline: Defining and communicating the disciplines core properties, *MIS Quarterly, 27*, 183-194.

Benioff, M. R. (2017). *4 Ways to close the inequality gap in the fourth industrial revolution*. https://www.weforum.org/agenda/2017/01/4-ways-to-close-theinequality-gap-in-the-fourth-industrial-revolution/.

Benyera, E. (2021). *The fourth industrial revolution and the recolonisation of Africa: The coloniality of data.* Taylor & Francis, 200.

Benyera, E., Francis, R., & Jazbhay, A. H. (2020). Challenging discourse and searching for alternative paths: Justice, human rights and leadership in Africa. *Reimagining justice, human rights and leadership in Africa: Challenging discourse and searching for alternative paths*. Springer, 3-20.

Berlanstein, L. R. (Ed.) (1992). *The industrial revolution and work in nineteenth-century Europe*. Routledge.

Berriman, R., & Hawksworth, J. (2017). *Will robots steal our jobs? The potential impact of automation on the UK and other major economies. UK Economic Outlook*. https://www.pwc.co.uk/economic-services/ukeo/pwc-uk-economic-outlook-full-report-march-2017-v2.pdf.

Besley, J. C. (2013). The state of public opinion research on attitudes and understanding of science and technology. *Bulletin of Science, Technology and Society, 33*(1/2), 12-20. https://doi.org/10.1177/0270467613496723

Bhattacharyya, S. (2020). *A history of global capitalism*. Springer International Publishing.

Bhattacherjee, A., & Sanford, C. (2006). Influence processes for information technology acceptance: An elaboration likelihood model. *MIS Quarterly, 30*, 805-825.

Bhorat, H., Oosthuizen, M., Lilenstein, K., & Steenkamp, F. (2017). *Firm-level determinants of earnings in the formal sector of the South African labour market*. (United Nations University WIDER Working Paper No. 2017/25). https://www.wider.unu.edu/publication/firm-level-determinants-earnings-formal-sector-south-african-labour-market.

Bijker, W. E., Hughes, T. P., & Pinch, T. J. (Eds.). (1987). *The social construction of technological systems: New directions in the sociology and history of technology*. MIT Press.

Bijker, W. (1993). Do not despair: There is life after constructivism. *Science, Technology and Human Values, 18*(4), 113-138.

Bimber, B. (2003). *Information and American democracy: Technology in the evolution of political power*. Cambridge University Press.

Binswanger, M. (2001). Technological progress and sustainable development: What about the rebound effect? *Ecological Economics, 36*(1), 119-132.

Blankley, W., & Arnold, R. (2001). Public understanding of science in South Africa –-aiming for better intervention strategies: Science education. *South African Journal of Science, 97*(3), 65-69.

Blit, J., Amand, S. S., & Wajda, J. (2018). *Automation and the future of work: Scenarios and policy options*. (CIGI Papers No. 174). Center for International Governance Innovation.

Blok, V. (2022). The ontology of technology beyond Anthropocentrism and determinism: The role of technologies in the constitution of the (post) Anthropocene world. *Foundations of Science* (2022), 1-19. https://doi.org/10.1007/s10699-022-09829-1

Booysen, S. (2016). *Fees must fall: Student revolt, decolonisation and governance in South Africa*. Wits University Press.

Bourdieu, P. (1993). Public opinion does not exist. In P. Bourdieu (Ed.), *Sociology in question*. Sage Publications, 149-57.

Bourguignon, F., & Morrisson, C. (2002). Inequality among world citizens: 1820-1992. *American Economic Review, 92*(4), 727-744. https://doi.org/10.1257/00028280260344443

Bouten, M. P. L. (2008). *Compatibility and technology acceptance: Consolidating, validating and extending concept*. Maastricht University.

Bowden, J. J., Bowden, S. A., Ruess, L., Adler, B. H., Hu, H., Krishnamurthy, R., & Krishnamurthy, R. (2022). Validation of automated bone age analysis from hand radiographs in a North American pediatric population. *Pediatric Radiology, 52*(7), 1347-1355.

Bowie, A. (2022). "Not our revolution": A thematic review of fourth industrial revolution criticism. *Communicatio, 48*(3), 1-19.

Bowles, J. (2014). *Chart of the week: 54% of EU jobs at risk of computerisation*. Bruegel. http://bruegel.org/2014/07/chart-of-the-week-54-of-eu-jobs-at-risk-of-computerisation/.

Boyer, K. K., & Olson, J. R. (2002). Drivers of internet purchasing success. *Production and Operations Management, 11*(4), 480-498.

Bracking, S. (2018). Corruption & state capture: What can citizens do? *Daedalus, 47*(3), 169-183.

Braithwaite, J. (1998). Institutionalizing distrust, enculturing trust. In V. Braithwaite, & M. Levi (Eds.), *Trust and governance.* Russell Sage Foundation, 343-375.

Brandt, L., & Rawski, T. G. (Eds.). (2008). *China's great economic transformation*. Cambridge University Press.

Bratianu, C., & Vasilache, S. (2009). Evaluating linear-nonlinear thinking style for knowledge management education. *Management & Marketing, 4*(3), 3-18.

Bridgman, B. (2014). *Is labor's loss capital's gain? Gross versus net labor shares.* (BEA Working Papers). Bureau of Economic Analysis. https://ideas.repec.org/p/bea/wpaper/0114.html.

Broadberry, S. N., & Gupta, B. (2005). *Cotton textiles and the great divergence: Lancashire, India and shifting competitive advantage, 1600-1850*. (Discussion Paper No. 5183). Centre for Economic Policy Research.

Broers, A. (2005). *The triumph of technology: Reith Lectures 1, transcript*. BBC. http://www.bbc.co.uk/radio4/reith2005/lecture1.shtml.

Browning, G. (2002). *Electronic democracy: Using the internet to transform American politics* (2nd ed.). CyberAge.

Brunham, J. (1941). *The managerial revolution*. John Day.

Brynjolfsson, E., McAfee, A., & Manyika, J. (2014). Will your job disappear? *New Perspectives Quarterly, 31*(2), 74-77.

Burnette, J. (1997). An investigation of the female-male wage gap during the industrial revolution in Britain. *Economic History Review, 50*(2), 257-281.

Business Tech. (2019). How AI is being used in South Africa. https://businesstech.co.za/news/enterprise/322505/how-ai-is-being-used-in-south-africa/.

Butler-Adam, J. (2018). The fourth industrial revolution and education. *South African Journal of Science, 114*(5), 1–1. https://doi.org/10.17159/sajs.2018/a0271

Cacioppo, J. T., Semin, G. R., & Berntson, G. G. (2004). Realism, instrumentalism, and scientific symbiosis: Psychological theory as a search for truth and the discovery of solutions. *American Psychologist, 59*(4), 214.

Cacciatore, M. A., Scheufele, D. A., & Corley, E. A. (2011). From enabling technology to applications: The evolution of risk perceptions about nanotechnology. *Public Understanding of Science, 20*(3), 385-404.

Cai, F., Park, A., & Zhao, Y. (2008). *The Chinese labor market in the reform era. China's Great Economic Transformation*. Cambridge University Press, 167–214.

Calitz, A. P., Poisat, P., & Cullen, M. (2017). The future African workplace: The use of collaborative robots in manufacturing. *SA Journal of Human Resource Management/SA Tydskrif vir Menslikehulpbronbestuur, 15*, a901. https://doi.org/10.4102/sajhrm.v15i0.901

Cameron, R., & Neal, L. (2003). *A concise economic history of the world: From Paleolithic times to the present*. Oxford University Press.

Carillo, K. D. (2010). Social cognitive theory in is research–literature review, criticism, and research agenda. In Information Systems, Technology and Management: 4th International Conference, ICISTM 2010, Bangkok, Thailand, March 11-13, 2010. Proceedings 4 (pp. 20-31). Springer Berlin Heidelberg. https://link.springer.com/chapter/10.1007/978-3-642-12035-0_4

Carrión, J. F., & Kaufman, S. J. (2018). Public opinion and the end of apartheid. *International Area Studies Review, 21*(2), 97-113.

Carter, L., & Bélanger, F. (2005). The utilization of e-government services: citizen trust, innovation and acceptance factors. *Information Systems Journal, 15*(1), 5-26.

Carvalho, J. (2000). Information system - which one do you mean? In E. Falkenberg, K. Lyytinen, & A. Verrijn-Stuart (Eds.), Information systems concepts: An integrated discipline emerging

(*Proceedings of the ISCO 4 Conference, Leiden, Holanda, 20-22 September 1999*). (259-280). Kluwer Academic Publishers.

Caselli, F., & Coleman II, W. J. (2006). The world technology frontier. *American Economic Review, 96*, 499-522.

Casey, J., & Hughes, K. (2016). *Technology & the future of work: Final report*. http://www.wiego.org/sites/default/files/publications/files/Final%20Joint%20Report%20Technology%20and%20the%20Future%20of%20Work.pdf.

Castelfranchi, Y., Vilela, E. M., Lima, L. B. D., Moreira, I. D. C., & Massarani, L. (2013). As opiniões dos brasileiros sobre ciência e tecnologia: o 'paradoxo'da relação entre informação e atitudes. *História, Ciências, Saúde-Manguinhos, 20*, 1163-1183.

Castells, M. (2001). *The internet galaxy: Reflections on the internet, business, and society*. Oxford University Press.

Castells, M. (2014). *Technopoles of the world: The making of 21st century industrial complexes*. Routledge.

Caughey, D., & Warshaw, C. (2018). Policy preferences and policy change: Dynamic responsiveness in the American states, 1936–2014. *American Political Science Review, 112*(2), 249-266.

Chaiken, S., & Baldwin, M. W. (1981). Affective-cognitive consistency and the effect of salient behavioral information on the self-perception of attitudes. *Journal of Personality and Social Psychology, 41*(1), 1.

Chakravarty, S., Lundberg, M., Nikolov, P., & Zenker, J. (2016). *The role of training programs for youth employment in Nepal: Impact evaluation report on the employment fund. Social protection and labor global practice group and the gender cross-cutting solutions*. The World Bank. https://openknowledge.worldbank.org/bitstream/handle/10986/24232/The0role0of0tr00the0employment0fund.pdf?sequence=1.

Chakravorti, B., Tunnard, C., & Chaturvedi, R. S. (2015). Harvard business review: Where the digital economy is moving the fastest. *Haettu, 14*, 2016.

Chandler, D. (2000). *Technological or media determinism*. Aberystwyth University. http://www.aber.ac.uk/media/Documents/tecdet/tecdet.html.

Chandler, D. (1995). *Technological or media determinism*. MCS.

Chandrasekhar, C. P., Ghosh, J., & Roychowdhury, A. (2006, December 9). The 'demographic dividend' and young India's economic future. *Economic and Political Weekly*, 5055-5064. https://s3.amazonaws.com/academia.edu.documents/31154818/The_Demographic_Dividend_and_Young_Indias_Economic_Future.pdf?response-content-disposition=inline%3B%20filename%3DTheDemographic_Dividendand_Young_Indias.pdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-C.

Chang M. K., & Cheung, W., Chang, J.-H., & Huynh, P. (2016). *The future of jobs at risk of automation*. (Working Paper 9). Bureau for Employers' Activities. International Labour Office.

http://www.ilo.org/public/english/dialogue/actemp/downloads/publications/2016/asean_in_transf_2016_r2_future.pdf.

Chatterjee, R., & Acharya, S. K. (2021). Dynamics of conservation agriculture: A societal perspective. *Biodiversity and Conservation, 30*(6), 1599-1619.

Cheah, I., & Phau, I. (2011). Attitudes towards environmentally friendly products: The influence of ecoliteracy, interpersonal influence and value orientation. *Marketing Intelligence & Planning, 29*(5), 452-472.

Christopher, A. J. (2009. Delineating the nation: South African censuses 1865-2007. *Political Geography, 28*(2), 101-109. https://doi.org/10.1016/j.polgeo.2008.12.003

Chua, S. L., Chen, D. T., & Wong, A F. (1999). Computer anxiety and its correlates: A meta-analysis. *Computers in Human Behavior, 15*(5), 609-623.

Chui, M., Manyika, J., & Miremadi, M. (2017). The countries most (and least) likely to be affected by automation. *Harvard Business Review*. https://hbr.org/2017/04/the-countries-most-and-least-likely-to-be-affected-by-automation

Cilliers, J. (2021). *The future of Africa: Challenges and opportunities*. Springer.

Cislaghi, B., & Heise, L. (2020). Gender norms and social norms: Differences, similarities and why they matter in prevention science. *Sociology of Health & Illness, 42*(2), 407-422.

Clark, G. (2007). *A farewell to alms: A brief economic history of the world*. Princeton University Press.

Clark, G. (2010). Industrial revolution. In S. N. Durlauf, & L. E. Blume (Eds.), *Economic growth. The new Palgrave economics collection*. Palgrave Macmillan. https://doi.org/10.1057/9780230280823_22

Clark, G. (2010). The macroeconomic aggregates for England, 1209–2008. *Research in Economic History, 27*, 51-140.

Cleeve, E. A., Debrah, Y., & Yiheyis, Z. (2015). Human capital and FDI inflow: An assessment of the African case. *World Development, 74*, 1-14.

Clegg, S. (2011. Academic identities re-formed? Contesting technological determinism in accounts of the digital age. *Contemporary Social Science, 6*(2), 175-189.

Cobb, M. D., & Macoubrie, J. (2004). Public perceptions about nanotechnology: Risks, benefits and trust. *Journal of Nanoparticle Research, 6*(4), 395-405.

Coble, P. M. (2007). China's "new remembering" of the anti-Japanese war of resistance, 1937–1945. *The China Quarterly, 190*, 394–410. https://doi.org/10.1017/S0305741007001257

Commission of Inquiry into State Capture. (2019). *Commission of inquiry into state capture*. https://www.sastatecapture.org.za/.

Corfe, S. (2018). *4IR in the workplace: Ensuring employers and employees benefit*. The Social Market Foundation, 11.

Cortina, J. M. (1993). What is coefficient alpha? An examination of theory and applications. *Journal of Applied Psychology, 78*(1), 98.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.

Creswell, J. W. (1994). *Research design: Qualitative & quantitative approaches*. Sage.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297-334.

Czaja, S. J., Guerrier ,J. H., Nair, S. N., & Landauer, T. (1993). Computer communication as an aid to independence for older adults. *Behavior and Information Technology, 12*, 197-207.

Cui, Z., & Gong, G. (2018). The effect of machine learning regression algorithms and sample size on individualized behavioral prediction with functional connectivity features. *Neuroimage, 178*, 622-637.

Dahl, R. A. (1973). *Polyarchy: Participation and opposition*. Yale University Press.

Dalton, R. J. (2004). *Democratic challenges, democratic choices: The erosion of political support in advanced industrial democracies*. Oxford University Press.

Daly, H. E. (1992). Is the entropy law relevant to the economics of natural resource scarcity? – Yes, of course it is! *Journal of Environmental Economics and Management, 23*(1), 91-95.

Damas, R. D. (2014). *Economia chinesa*. Saint Paul.

Danaher, J. (2022). Techno-optimism: an analysis, an evaluation and a modest defence. *Philosophy & Technology, 35*(2), 54.

Davis, C. P., Altmann, G. T., & Yee, E. (2020). Situational systematicity: A role for schema in understanding the differences between abstract and concrete concepts. *Cognitive Neuropsychology, 37*(1-2), 142-153.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two. *Management Science, 35*, 982.

Davis, R. (2005). *Politics online: Blogs, chatrooms, and discussion groups in American democracy*. Routledge

Davis, S., Elin, L., & Reeher, G. (2002). *Click on democracy: The internet's power to change political apathy into civic action*. Westview.

Dawley, A. (2000). *Class and community: The industrial revolution in Lynn, with a new preface*. Harvard University Press.

De Houwer, J., Van Dessel, P., & Moran, T. (2020). Attitudes beyond associations: On the role of propositional representations in stimulus evaluation. *Advances in Experimental Social Psychology, 61*, 127-183.

De Juan, A., & Pierskalla, J. H. (2014). Civil war violence and political trust: Microlevel evidence from Nepal. *Conflict Management and Peace Science, 33*, 67-88.

De Klerk, V., & Gough, D. (2002). 1 DEFINING BLACK SOUTH AFRICAN ENGLISH. language in South Africa, 356.

De Schryver, G. M. (2015). *Oxford bilingual school dictionary: Isizulu and English*. Oxford University Press Southern Africa.

Debrah, Y. A. (2007). Promoting the informal sector as a source of gainful employment in developing countries: Insights from Ghana. *The International Journal of Human Resource Management, 18*(6), 1063-1084.

Debrah, Y. A., Oseghale, R. O., & Adams, K. (2018). Human capital, innovation and international competitiveness in sub-Saharan Africa. In I. Adeleye, & M. Esposito (Eds.), *Africa's competitiveness in the global economy. AIB sub-Saharan Africa (SSA) Series,* 219-248. Palgrave Macmillan.

Decanio, S. (2016). Robots and humans – complements or substitutes? *Journal of Macroeconomics, 49*, 280-291.

Defor, S., Kwamie, A., & Agyepong, I. A. (2017). Understanding the state of health policy and systems research in West Africa and capacity strengthening needs: Scoping of peer-reviewed publications trends and patterns 1990–2015. *Health Research Policy and Systems, 15*(55), 101-138.

De la Piedra-Vindrola, S. E., Berbel-Pineda, J. M., & Palacios-Florencio, B. (2022). Fair trade and consumer valuation: Purchase intentions in an emerging economy. *Business Strategy & Development, 5*(3), 245-258.

Deloitte. (2014). *Agiletown: The relentless march of technology and London's response. London futures*. https://www.google.com/search?q=Deloitte.+2014.+Agiletown%3A+The+Relentless+March+of+Technology+and+London%E2%80%99s+Response%2C+(London%2CFutures&rlz=1C1CHZN_enZA955ZA955&oq=Deloitte.+2014.+Agiletown%3A+The+Relentless+March+of+Technology+and+London%E2%80%99s+Response%2C+(London%2CFutures&aqs=chrome..69i57.971j0j7&sourceid=chrome&ie=UTF-8.

Deng, H., Duan, S. X., & Wibowo, S. (2023). Digital technology driven knowledge sharing for job performance. *Journal of Knowledge Management, 27*(2), 404-425.

Department of Basic Education. (2020). *ICT rollout*. Portfolio committee presentation. Department of Basic Education. https://pmg.org.za/files/200317ICT_ROLL-OUT.pptx.

Department of Communications and Digital Technologies. (2020). *Coursera to provide digital skills training opportunities to young people.* Department of Communications and Digital Technologies. https://www.gov.za/speeches/minister-ndabeni-abrahams-10-nov-2020-0000/.

Department of Economic and Social Affairs. (2017). The impact of the technological revolution on labour markets and income distribution. *Frontier Issues*, 31 July 2017. UN Department of Economic and Social Affairs.

Department for Telecommunications and Postal Services. (2018). *Invitation to nominate candidates for the presidential commission on fourth industrial revolution*. Department for

Telecommunications and Postal Services. https://www.gov.za/sites/default/files/gcis_document/201812/42078gen764.pdf.

Department of Science and Technology. (2018). *Fourth industrial revolution and the digital economy: Brief by Department of Science and Technology*. https://pmg.org.za/committee-meeting/26554/.

Department of Trade and Industry [DTI]. (2018). *Industrial policy action plan 2018/19 2020/21*. Department of Trade and Industry. https://www.gov.za/sites/default/files/gcis_document/201805/industrial-policy-action-plan.pdf.

Department of Justice and Constitutional Development. (2013). *Protection of Personal Information Act No. 4 of 2013*. https://www.saica.co.za/Portals/0/Technical/LegalAndGovernance/37067_26_11_Act4of2013ProtectionOfPersonalInfor_correct.pdf.

DeSanctis, G. (2003). The social life of information systems research. *Journal of the Association for Information Systems, 4*, 360-376.

Despeisse, M., Baumers, M., Brown, P., Charnley, F., Ford, S. J., Garmulewicz, A., ... & Rowley, J. (2017). Unlocking value for a circular economy through 3D printing: A research agenda. *Technological Forecasting and Social Change*, *115*, 75-84.

Dev, S. M., & Venkatanarayana, M. (2011). *Youth employment and unemployment in India*. Indira Gandhi Institute of Development Research. https://pdfs.semanticscholar.org/4337/7629f26f8d6863024d26b3564f2f7e.

Di John, J. (2011). *'Failed states' in Sub-Saharan Africa: A review of the literature*. Real Instituto Elcano. https://www.realinstitutoelcano.org/en/analyses/failed-states-in-sub-saharan-africa-a-review-of-the-literature-ari/

Dihel, N., & Goswami, A. G. (2016). *The unexplored potential of trade in services in Africa*. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Dihel%2C+Nora%2C+and+Arti+Grover+Goswami.+2016.+The+Unexplored+Potential+of+Trade+in+Services&btn.

DiMaggio, P., Hargittai, E., Neuman, W. R., & Robinson, J. P. (2001). Social implications of the internet. *Annual Review of Sociology, 27*(1), 307-336.

Dinkelman, T., & Ngai, L. R. (2022). Time use and gender in Africa in times of structural transformation. *Journal of Economic Perspectives, 36*(1), 57-80

Donovan, J. J. (1997). *The second industrial revolution: reinventing your business on the web*. Prentice-Hall, Inc.

Dorji, L., & Kinga, S. (2005). *Youth in Bhutan: Education, employment, development*. The Centre for Bhutan Studies. http://crossasiarepository.ub.uni-heidelberg.de/304/1/YouthBhutan.pdf.

Drengson, A. R. (1982). Four philosophies of technology. *Philosophy Today, 26*(2), 103-117.

Du Preez, P., Simmonds, S., & Chetty, D. (2017). Critical transformation in higher education: Ethical reflections on#. *South African Journal of Higher Education, 31*(6), 96-112.

Dubin, R. (1978). *Theory building*. Free Press.

Durdukoca, S. F. (2019). Identifying the attitudes and views of social sciences teachers toward values education in Turkey. *World Journal of Education, 9*(1), 103-117.

Durrheim, K., Foster, D., & Dixon, J. (2011). Historical trends in South African race attitudes. *South African Journal of Psychology, 41*(3), 263-278.

Duus, P., Myers, R. H., & Peattie, M. R. (Eds.). (2014). *The Japanese informal empire in China, 1895–1937*. Princeton University Press.

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Harcourt Brace Jovanovich College Publishers.

Ebewo, P. J., & Sirayi, M. (2018). Curriculum transformation in a post-apartheid South African university: The Arts Faculty, Tshwane University of Technology. *Africa Education Review, 15*(2), 82-95.

Ehlers, M. H., & Kerschner, C. (2013). *A framework of attitudes towards technology in sustainability studies, applied to instructors of ecological economics*. IPA.

Ekine S. (2010). *SMS uprising: Mobile activism in Africa*. https://www.pambazuka.org/activism/sms-uprising-mobile-activism-africa.

Elmi, N., & Davids, N. (2018). *How governance is changing in the 4IR*. World Economic Forum. https://www.weforum.org/agenda/2018/01/agile-governance-changing4ir-public-private-emerging-technologies/.

Engelman, R. (2015). *The second industrial revolution, 1870-1914.* US History Scene, 10. https://ushistoryscene.com/article/second-industrial-revolution/.

Ernens, S., Delcourt, C., Dessart, L., & Baiwir, L. (2022). Frontline employees' attitude toward embodied social robots in customer service: An integrative framework and empirical test. *SMR-Journal of Service Management Research, 6*(4), 262-274.

Estevadeordal, A., & Robot-lución, C. M. (2017). The future of work in Latin American integration 4.0. *Integration and Trade Journal, 21*(42).

Etzioni, A. (2017). Job collapse on the road to New Athens. *Challenge, 60*(4), 327-346.

European Commission. (2017). *Attitudes towards the impact of digitisation and automation on daily life. Special Eurobarometer 460*. European Commission. https://ec.europa.eu/jrc/communities/sites/jrccties/files/ebs_460_en.pdf.

Evans, M. D., & Kelley, J. (2004). Subjective social location: Data from 21 nations. *International Journal of Public Opinion Research, 16*(1), 3-38.

Fagerberg, J., & Srholec, M. (2017). Capabilities, economic development, sustainability. *Cambridge Journal of Economics, 41*(3), 905-926.

Fairclough, J. (1992). Sizzling start for the white heat. *The Times Higher Education Supplement* (23 October), 17.

Fazio, R. H. (1990). Multiple processes by which attitudes guide behaviour: The mode model as an integrative framework. In G. Meurant (Ed.), *Advances in experimental social psychology* (pp. 75-109). Academic Press.

Feenberg, A. (1992). Subversive rationalization: Technology, power, and democracy. *Inquiry: An Interdisciplinary Journal of Philosophy, 35*(3-4), 301-302. https://doi.org/10.1080/00201749208602296

Feldmann, H. (2013). Technological unemployment in industrial countries. *Journal of Evolutionary Economics, 23*, 1099-1126.

Fernandes, J. V. (2022). Robot citizenship and gender (in) equality: the case of Sophia the robot in Saudi Arabia. *Observare - Janus.Net e-journal of International Relations - Thematic dossier 2: The Middle East. Local dynamics, regional actors, global challeges, 12*(2), 51-64.

Fiertz, C., & Messner, J. (2019). *Fragile states index annual report 2019*. The Fund for Peace.

Dhawan, B. (2021, January 12). WhatsApp issues clarification over new privacy policy, says individual chats to remain 'private' even after update. *Financial Express*. https://www.financialexpress.com/business/blockchain-whatsapp-issues-clarification-over-new-privacy-policy-says-individual-chats-to-remain-private-even-after-update-2169283/.

Finkel, A. (2017). *Finkel's law: Robots won't replace us because we still need that human touch*. The Conversation. https://theconversation.com/finkels-law-robots-wont-replace-us-because-we-still-need-that-human-touch-82814.

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., & Combs, B. (1978). How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. *Policy Sciences, 9*(2), 127-152.

Fishbein, M. (1967). A behaviour theory approach to the relations between beliefs about an object and the attitude toward the object. In M. Fishbein (Ed.), *Readings in attitude theory and measurement* (pp. 389-400). John Wiley & Sons.

Fishbein, M. & Ajzen, I. (1975). *Belief, attitude, intention, and behaviour: An introduction to theory and research*. Addison-Wesley Publisher Company.

Fisher, J. (2019). AMISOM and the regional construction of a failed state in Somalia. *African Affairs, 118*(471), 285- 306. https://doi.org/10.1093/ afraf/ ady040

Fiske, S., & Taylor, S. E. (1991). *Social cognition: From brains to culture. Social cognition*. (2nd ed.). McGraw-Hill. https://doi.org/10.1016/B978-012088566-4/50012-X

Fleck, J. (1988). *Innofusion or diffusation? The nature of technological development in robotics*. (Edinburgh PICT Working Paper No. 7). Edinburgh University.

Floridi, L., & Cowls, J. (2019). A unified framework of five principles for AI in society. *Harvard Data Science Review, 1*(1).

Ford, M. (2015). *Rise of the robots technology and the threat of a jobless future*. Basic Books.

Foroudi, S., Gupta, P. Sivarajah, U., & Broderick, A. (2018). Investigating the effects of smart technology on customer dynamics and customer experience. *Computers in Human Behaviour, 80*, 271-282.

Fox, L., & Signé, L. (2021). *The fourth industrial revolution (4IR) and the future of work: Could this bring good jobs to Africa*. Evidence Synthesis, Paper Series, No. 6. https://includeplatform.net/publications/the-fourth-industrial-revolution-4ir-and-the-future-of-work-could-this-bring-good-jobs-to-africa/.

Fraser, C. (1994). Attitudes, social representations, and widespread beliefs. *Papers in Social Representations, 3*(1), 13-25.

Frey, C., & Osborne, M. (2015). *Technology at work: The future of innovation and employment, Citi GPS Reports*. University of Oxford.

Frey, C. B., & Osborne, M. (2013). *The future of employment: How susceptible are jobs to computerisation?* (Working Paper, Oxford Martin Programme on Technology and Employment). http://www.oxfordmartin.ox.ac.uk/publications/view/1314.

Frey, C. B., & Osborne, M. (2017). The future of employment: How susceptible are jobs to computerization? *Technological Forecasting and Social Change, 114*, 254-280.

Frost, J. (2022). *How high does R-squared need to be*. https://statisticsbyjim.com/regression/how-high-r-squared/.

Funk, C., & Kennedy, B. (2016). *The new food fights: US public divides over food science*. Pew Research Center.

Gagné, M., Parker, S. K., Griffin, M. A., Dunlop, P. D., Knight, C., Klonek, F. E., & Parent-Rocheleau, X. (2022). Understanding and shaping the future of work with self-determination theory. *Nature Reviews Psychology, 1*(7), 378-392.

Gagnon, M. P., Sánchez, E., & Pons, J. (2006). From recommendation to action: Psychosocial factors influencing physician intention to use health technology assessment (HTA) recommendations. *Implementation Science, 1*(1), 1-11.

Galati, F., & Bigliardi, B. (2019). Industry 4.0: Emerging themes and future research avenues using a text mining approach. *Computers in Industry, 109*, 100-113.

Galbi, D. A. (1994). Child labor and the division of labor in the early English cotton mills. *Journal of Population, 10*(4), 357-375.

Gall, M. D., Gall, J. P., & Borg, W. R. (2007). *Educational research: An introduction* (8th ed.). Allyn & Bacon.

Garud, R., Rattan Nayyar, P., & Shapira, Z. B. (1997). *Technological innovation: Oversights and foresights*. Cambridge University Press. ISBN 0-521-55299-0.

Gastrow, M., Roberts, B., Reddy, V., & Ismail, S. (2018). Public perceptions of biotechnology in South Africa. *South African Journal of Science 114*(1-2), 1-9.

Gibbs, M. (2017). *How is new technology changing job design?* IZA World of Labor. https://doi.org/10.15185/izawol.344

Gillward, A. (2019, July 04). 4IR in SA is too important to remain the domain of the elite. *BusinessLIVE*. https://www.businesslive.co.za/bd/opinion/2019-07-04-4ir-in-sa-is-too-important-to-remain-the-domain-of-the-elite/.

Ginsberg, B. (1982). *The consequences of consent: Elections, citizen control, and popular acquiesence*. Addison-Wesley.

Gittings, J. (2005). *The changing face of China: From Mao to market*. Oxford University Press.

Giuliani, D. (2018). *Africa: A look at the 442 active tech hubs of the continent*. https://www.gsma.com/mobilefordevelopment/programme/ecosystem-accelerator/ africa-a-look-at-the-442-active-tech-hubs-of-the-continent/.

Gnambs, T., & Appel, M. (2019). Are robots becoming unpopular? Changes in attitudes towards autonomous robotic systems in Europe. *Computers in Human Behaviour, 93*, 53-61.

Goertzel, B., Mossbridge, J., Monroe, E., Hanson, D., & Yu, G. (2017). *Humanoid robots as agents of human consciousness expansion*. https://arxiv.org/pdf/1709.07791.pdf.

Goga, S., Bosiu, T., & Bell, J.F. (2019). Linking IDC finance to structural transformation and inclusivity in post-apartheid South Africa. *Development Southern Africa 36*(6), 821–38.

Goga, S., & Bosiu, T. (2019). *Governance of poultry value chains - A comparative perspective on developing capabilities in South Africa and Brazil*. (CCRED Working Paper Series 10/2019). https://static1.squarespace.com/static/52246331e4b0a46e5f1b8ce5/t/5d8092735ca124794137409e/1568707200102/IDTT+2+Poultry+Research+Report+8.pdf.

Goga, S. & Mondliwa, P. (2021). forthcoming. Structural transformation, economic power, and inequality in South Africa. In: A. Andreoni, P. Mondliwa, S. Roberts, & F. Tregenna (Eds.), *Structural transformation in South Africa: The challenges of inclusive industrial development in a middle-income country*. Oxford University Press.

Goos, M., Manning, A., & Salomons, A. (2009). Job polarization in Europe. *American Economic Review, 99*(2), 58-63.

Gordon, S.L. (2017). *Understanding hostility towards so-called "barbarians": a quantitative analysis of public attitudes towards foreign nationals in post-apartheid South Africa* (Doctoral dissertation, UKZN). https://ukzn-dspace.ukzn.ac.za/handle/10413/15773.

Govender, D. W. (2012). A model to predict educators' attitudes towards technology adoption. *Africa Education Review, 9*(3), 548-568. https://doi.org/10.1080/18146627.2012.741101

Graetz, G., & Michaels, G. (2015). *Robots at work*. (CEPR Discussion Paper. DP10477). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2575781##.

Gramlich, J. (2019). *Looking ahead to 2050, Americans are pessimistic about many aspects of life in U.S*. Pew Research Centre. https://www.pewresearch.org/fact-tank/2019/03/21/looking-ahead-to-2050-americans-are-pessimistic-about-many-aspects-of-life-in-u-s/.

Green, L. (2001). Technoculture: Another term that means nothing and gets us nowhere?. *Media International Australia, 98*(1), 11-25.

Green, S. B., Lissitz, R. W., & Mulaik, S. A. (1977). Limitations of coefficient alpha as an index of test unidimensionality. *Educational and Psychological Measurement, 37*(4), 827-838.

Greenwald, A. G. (1989). Why attitudes are important: Defining attitude and attitude theory 20 years later. In A. R. Pratkanis, S. J. Breckler, & A. G. Greenwald (Eds.), *Attitude structure and function* (pp. 429-440). Psychology Press.

Greiffenhagen, C., Mair, M., & Sharrock, W. (2016). From methodology to methodography: A study of qualitative and quantitative reasoning in practice. *Methodological Innovations Online, 6*(3), 93-107. https://doi.org/10.4256/mio.2011.009

Griffin, L. J., & Bollen, K. A. (2009). What do these memories do? Civil rights remembrance and racial attitudes. *American Sociological Review, 74*(4), 594-614.

Grimes, M. (2017). Procedural fairness and political trust. In S. Zmerli, & T. W. G. van der Meer (Eds.), *Handbook on political trust* (pp. 256-259). Edward Elgar Publishing.

Grimm, S., Lemay-Hébert, N., & Nay, O. (2014) "Fragile states": Introducing a political concept. *Third World Quarterly, 35*(2), 197-209 https://doi.org/10.1080/ 01436597.2013.878127

Groves, R. M. (2011). Three eras of survey research. *Public Opinion Quarterly, 75*(5), 861-871. https://doi.org/10.1093/poq/nfr057

Grubler, A. (1995). *Industrialization as a historical phenomenon*. (Working Paper 95-29). International Institute for Applied Systems Analysis.

Grybauskas, A., Stefanini, A., & Ghobakhloo, M. (2022). Social sustainability in the age of digitalization: A systematic literature review on the social implications of industry 4.0. *Technology in Society*, 101997.

Guenther, L., & Weingart, P. (2016). A unique fingerprint? Factors influencing attitudes towards science and technology in South Africa. *South African Journal of Science, 112*(7-8), 1-4.

Guenther, L., & Weingart, P. (2018). Promises and reservations towards science and technology among South African publics: A culture-sensitive approach. *Public Understanding of Science, 27*(1), 47-58.

Guenther, L., Reif, A., Taddicken, M., & Weingart, P. (2022). Positive but not uncritical: Perceptions of science and technology amongst South African online users. *South African Journal of Science, 118*(9-10), 1-8.

Gunderson, J. (2008). *Realism*. The Creative Company.

Gwagwa, A., Kraemer-Mbula, E., Rizk, N., Rutenberg, I., & De Beer, J. (2020). Artificial intelligence (AI) deployments in Africa: Benefits, challenges and policy dimensions. *The African Journal of Information and Communication, 26*, 1-28.

Haddock, G., & Maio, G. R. (2008). Attitudes: Content, structure and functions. In M. Hewstone, W. Stroebe, & K. Jonas (Eds.), *Introduction to social psychology: A European perspective* (pp. 112-133). BPS Blackwell.

Haddock, G., & Zanna, M. P. (1999). Cognition, affect, and the prediction of social attitudes. *European Review of Social Psychology, 10*(1), 75-99.

Hagger, M. S., Chatzisarantis, N. L. D., & Biddle, S. J. H. (2002). A meta-analytic review of the theories of reasoned action and planned behaviour in physical activity: Predictive validity and the contribution of additional variables. *Journal of Sport and Exercise Psychology, 24*(1), 3-32.

Hahm, S. (2018). Attitudes and performance of workers preparing for the fourth industrial revolution. *KSII Transactions on Internet and Information Systems (TIIS), 12*(8), 4038-4056.

Halbwachs, M. (1992). *On collective memory. Heritage of sociology series.* University of Chicago Press.

Hancock, M. (2015). *Artificial intelligence: Opportunities and implications for the future of decision making*. Government Office for Science.

Hanf, T., Weiland, H., & Vierdag, G. (1981). *South Africa, the prospects of peaceful change: An empirical enquiry into the possibility of democratic conflict regulation*. Rex Collins.

Hansen, M. W., Pedersen, T., & Petersen, B. (2009). MNC strategies and linkage effects in developing countries. *Journal of World Business, 44*(2), 121-130.

Hara, N., & Huang, B.Y. (2011). Online social movements. *Annual Review of Information Science & Technologies, 45*, 2097-2108. https://scholarworks.iu.edu/dspace/bitstream/handle/2022/18718/ARISTFeb28-2010-final.pdf;sequence=1.

Harambee. (2020). *Mapping of digital and ICT roles and demands in South Africa*. Report commissioned by Harambee youth employment accelerator. http://digital.harambee.co.za/wp-content/uploads/2020/11/HAR964-ICT-Roles-and-Demand-Support-R2.pdf.

Harayama, Y. (2017). *Report on artificial intelligence and human society*. Advisory Board on AI and Human Society, Council for Science, Technology and Innovation, The Cabinet Office of Japan. https://www8.cao.go.jp/cstp/tyousakai/ai/summary/aisociety_en.pdf.

Harrison, F. V. (2005). *Resisting racism and xenophobia: Global perspectives on race, gender, and human rights*. Altamira.

Hartwick, J., & Barki, H. (1994). Explaining the role of user participation in information system use. *Management Science, 40*(4), 440-465.

Harvey, R. (2019). *Mining for a circular economy in the age of the fourth industrial revolution: The case of South Africa*. South African Institute of International Affairs.

Hasan, M. N. (2016). Positivism: To what extent does it aid our understanding of the contemporary social world? *Quality and Quantity, 50*(1), 317-325. https://doi.org/10.1007/s11135-014-0150-4

Heath, A., Fisher, S., & Smith, S. (2005). The globalization of public opinion research. *Annual Review of Political Science, 8*, 297-333.

Heidegger, M. (2009). The question concerning technology. In C. Hanks (Ed.), *Technology and values: Essential readings*. Blackwell Publishing.

Heidtman, J., Wysienska, K., & Szmatka, J. (2000). Positivism and types of theories in sociology. *Sociological Focus, 33*(1), 1-26. https://doi.org/10.1080/00380237.2000.10571154

Heleta, S. (2016). Decolonisation of higher education: Dismantling epistemic violence and Eurocentrism in South Africa. *Transformation in Higher Education, 1*(1), a9. https://doi.org/10.4102/the.v1i1.9

Hensengerth, O. (2018). South-south technology transfer: Who benefits? A case study of the Chinese-built Bui Dam in Ghana. *Energy Policy, 114*(C), 499-507.

Herrera, J., Kuépié, M., Nordman, C. J., Oudin, X., & Roubaud, F. (2012). *Informal sector and informal employment: Overview of data for 11 cities in 10 developing countries*. (Wiego Working Paper No. 9). http://www.wiego.org/sites/wiego.org/files/publications/files/Herrera_WIEGO_WP9.pdf.

Heywang, W., & Zaininger, K. H. (2018). Evolution and future of a technology. *Journal of Science and Technology, 5*(4), 984-993.

Hill, C. (1969). *Reformation to industrial revolution*. Penguin Books.

Hirschi, A. (2018). The fourth industrial revolution: Issues and implications for career research and practice. *Career Development Quarterly, 66*(3), 192-204.

Hirschey, R., Bryant, A. L., Macek, C., Battaglini, C., Santacroce, S., Courneya, K. S., … Sheeran, P. (2020). Predicting physical activity among cancer survivors: Meta-analytic path modeling of longitudinal studies. *Health Psychology, 39*(4), 269-280.

Hirst, W., Yamashiro, J. K., & Coman, A. (2018). Collective memory from a psychological perspective. *Trends in Cognitive Sciences, 22*(5), 438-451.

Hlongwane, T. (2022). *Experiences and responses of bank tellers within 4IR processes of digitalisation at a South African bank in Johannesburg* (Doctoral dissertation, University of Johannesburg). https://ujcontent.uj.ac.za/esploro/outputs/graduate/Experiences-and-responses-of-Bank-Tellers/9916309807691.

Hobsbawm, E. C. (1968). *Industry and empire*. Pantheon Books.

Holdstock, T. L. (2000). *Re-examining psychology: Critical perspectives and African insights*. Routledge.

Howarth, C., Foster, J., & Dorrer, N. (2004) Exploring the potential of the theory of social representations in community-based health research. *Journal of Health Psychology, 9*(1), 229-243.

Huang, Y. (2000). Gender, hukou, and the occupational attainment of female migrants in China (1985–1990). *Environment and Planning A, 33*(2), 257-280.

Huberman, M., Meissner, C. M., & Oosterlinck, K. (2017). Technology and geography in the second industrial revolution: New evidence from the margins of trade. *The Journal of Economic History, 77*(1), 39-89.

Hudson, J., Orviska, M., & Hunady, J. (2017). People's attitudes to robots in caring for the elderly. *International Journal of Social Robotics, 9*(2), 199-210.

Human Sciences Research Council. (2018). *South African social attitudes survey (SASAS) round 16 module on attitudes towards the fourth industrial revolution – question design final module in template*. HSRC.

Hussain, M. A., Elyas, T., & Nasseef, O. A. (2013). Research paradigms: A slippery slope for fresh researchers. *Life Science Journal, 10*(4), 2374-2381.

Hutchings, P., Parker, A., & Jeffrey, P. (2016). The political risks of technological determinism in rural water supply: A case study from Bihar, India. *Journal of Rural Studies, 45*, 252-259.

Igbaria, M., Schiffman, S. J., & Wieckowski, T. J. (1994). The respective roles of perceived usefulness and perceived fun in the acceptance of microcomputer technology. *Behaviour and Information Technology, 13*, 349-361.

International Energy Agency. (2019). *SDG7: Data and projections*. International Energy Agency. https://www.iea.org/reports/sdg7-data-and-projections.

International Labour Organization. (2015). *Background note for the panel on "employment and new technologies: Opportunities for Africa's youth"*. 13th African Regional Meeting, Addis Ababa, Ethiopia. https://www.ilo.org/wcmsp5/groups/public/---ed_norm/---relconf/documents/meetingdocument/wcms_418014.pdf.

International Labour Organization. (2015). *Wages and income inequality. Global wage report, 4.2014/15*. ILO. http://www.ilo.org/global/publications/books/WCMS_324678/lang--en/index.htm.

International Labour Organization. (2016). *ASEAN in transformation: How technology is changing jobs and enterprises*. ILO.

International Monetary Fund. (2020). Six charts explain South Africa's inequality. https://www.imf.org/en/News/Articles/2020/01/29/na0128 20six-charts-on-south-africas-persistent-and-multi-faceted-inequality.

International Monetary Fund. (2017). Understanding the downward trend in labor income shares. In *Gaining momentum? World economic outlook, 2017*. International Monetary Fund. http://www.imf.org/en/Publications/WEO/Issues/2017/04/04/world-economic-outlook-april-2017#Chapter 3. in Bangladesh. a2i - Innovate for All.

Internet Society. (2017). A policy framework for enabling Internet access. https://www.internetsociety.org/wp-content/uploads/2017/08/bp-EnablingEnvironment-20170411-en.pdf

Irwin, B., & Paul, L. (2003). Exploring differences in internet adoption and usage between historically advantaged and disadvantaged groups in South Africa. *Journal of Global Information Technology Management, 6*(4), 6-26.

Jacob, M. C. (1997). *Scientific culture and the making of the industrial west.* Oxford University Press.

Jacob, J., & Pattusamy, M. (2020). Examining the inter-relationships of UTAUT constructs in mobile internet use in India and Germany. *Journal of Electronic Commerce in Organizations (JECO), 18*(2), 36-48.

Jaffe, A. J., & Stewart, C. D. (1951). *Manpower resources and utilization: Principles of working force analysis*. John Wiley & Sons.

Jamieson, M. K., Govaart, G. H., & Pownall, M. (2022). Reflexivity in quantitative research: A rationale and beginner's guide. *Social and Personality Psychology Compass*, e12735.

Jazbhay, A. H. (2019). African powerhouses: A decolonial critique of Nigeria and South Africa's perceived economic and political strengths in the modern world-system. In O. Tella (Ed.), *Nigeria-South Africa relations and regional hegemonic competence* (pp. 25-42). Springer https://doi.org/10.1007/978-3-030-00081-3

Jodelet, D. (1991). *Madness and social representations*. Harvester Wheatsheaf.

Johnston, M. P. (2014). Secondary data analysis: A method of which the time has come. *Qualitative and Quantitative Methods in Libraries, 3*, 619-626.

Johnson, M. S. (2018). Thurstone scaling. In B. B. Frey (Ed.), *SAGE encyclopedia of educational research, measurement, and evaluation* (pp. 1699-1701). SAGE. https://doi.org/10.4135/9781506326139

Jones, S. E. (2013). *Against technology: From the Luddites to neo-Luddism*. Routledge.

Joshua, M., James, M., & Titos, K. (2022). Coalition governance and service delivery in South Africa: A case study of Tshwane, Johannesburg and Ekurhuleni Metropolitan Municipalities. *Journal of Public Administration, 57*(2), 272-283.

Juan, A., Reddy, V., Zuze, T. L., Wokadala, C., & Hannan, S. (2016). *Does it matter whether students enjoy learning science?: Exploring student attitudes towards science in South Africa*. HSRC Press. http://wwwdocs.hsrc.ac.za/uploads/pageContent/7535/HSRC%20Policy%20Brief%2008%20-%20Student%20Attitudes_PRESS.pdf.

Jubber, K. (2006). Reflections on canons, compilations, catalogues and curricula in relation to sociology and sociology in South Africa. *African Review, 37*(2), 321-342. https://doi.org/10.1080/21528586.2006.10419161

Kaisara, G., Mare, A., & Peel, C. (2021, March). *Haven't we been here before? A critical analysis of the fourth industrial revolution*. In 2021 Conference on Information Communications Technology and Society (ICTAS) (pp. 67-72). IEEE.

Kaivo-Oja, J., Roth, S., & Westerlund, L. (2017). Futures of robotics. Human work in digital transformation. *International Journal of Technology Management, 73*(4), 176-205.

Kaplan, D. (2019). *South Africa's industrial policy: Time for a review and a rethink*. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=south+africa%27s+industrial+policy&oq=South+Africa%27s+industrial+.

Karabarbounis, L., & Neiman, B. (2014). The global decline of the labor share. *The Quarterly Journal of Economics, 129*(1), 61-103. https://doi.org/10.1093/qje/qjt032

Katz, J. E., & Rice, R. E. (2002). *Social consequences of internet use: Access, involvement, and interaction*. MIT Press.

Katz, A. N. (2018). On interpreting statements as metaphor or irony: Contextual heuristics and cognitive consequences. In Mio S & Katz AN (Eds) *Metaphor: Implications and applications* (pp. 1-22). Psychology Press.

Kaul, V. (2018). Populism and the crisis of liberalism. *Philosophy and Social Criticism, 44*(4), 346-352.

Kavanaugh, A. L. (2002). Community networks and civic engagement: A social network approach. *Good Society, 11*(3), 17-24.

Kayembe, C., & Nel, D. (2019). Challenges and opportunities for education in the fourth industrial revolution. *African Journal of Public Affairs, 11*(3), 79-94.

Kefale, A., & Mohammed, Z. (2015). *Ethiopian labour migration to the Gulf and South Africa*. Forum for Social Studies Monograph No. 10. Forum for Social Studies. https://doi.org/10.2307/j.ctvh8r1f8

Kekana, M. (2018, October 26). Pledges worth r134bn committed at investment conference. *Mail & Guardian*. https://mg.co.za/article/2018-10-26-pledges-worth-r134bn-committed-atinvestment- conference.

Kelly, L. (2022). Re-politicising the future of work: Automation anxieties, universal basic income, and the end of techno-optimism. *Journal of Sociology*, 14407833221128999.

Kempen, A. (2019). The 4th industrial revolution-hidden threats to human and cybersecurity?. *Servamus Community-based Safety and Security Magazine, 112*(10), 10-12.

Kerschner, C. (2013). *A multimethod analysis of the phenomenon of peak-oil*. Universitat Autònoma de Barcelona.

Kesharwani, A. (2020). Do (how) digital natives adopt a new technology differently than digital immigrants? A longitudinal study. *Information & Management, 57*(2), 103170.

Kettl, D. F. (2017). *Can governments earn our trust?* Polity Press.

Khatun, F., & Saadat, S. Y. (2020). Fourth industrial revolution, technological advancement and youth employment: A South Asian perspective. *South Asia Economic Journal, 21*(1), 58-75.

Kim, J. (2018). Are countries ready for the new meso revolution? Testing the waters for new industrial change in Korea. *Technological Forecasting & Social Change, 132*, 34-39.

King, G., Keohane, R. O., & Verba, S. (2021). Designing social inquiry: Scientific inference in qualitative research. Princeton university press.

King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. *Information & Management, 43*(6), 740-755.

Kish, L. (1994). Multipopulation survey designs: Five types with seven shared aspects. *International Statistical Review, 62*(2), 167-186.

Kivunja, C., & Kuyini, A. B. (2017). Understanding and applying research paradigms in educational contexts. *International Journal of Higher Education, 6*(5), 26–41. https://doi.org/10.5430/ijhe.v6n5p26

Komiak, S., & Benbasat, I. (2006). The effects of personalization and familiarity on trust and adoption of recommendation agents. *MIS Quarterly, 30*, 941-960.

Kroknes, V. F., Jakobsen, T. G., & Gronning, L.-M. (2016). Economic performance and political trust: The impact of the financial crisis on European citizens. *European Societies, 17*(5), 700-723.

Kruglanski, A. W. (1989). *Lay epistemics and human knowledge: Cognitive and motivational bases. Perspectives in Social Psychology*. Plenum Publishers.

Kumar, S., Sahoo, S., Lim, W. M., & Dana, L. P. (2022). Religion as a social shaping force in entrepreneurship and business: Insights from a technology-empowered systematic literature review. *Technological Forecasting and Social Change, 175*, 121393.

Kuo, B. C., Roldan-Bau, A., & Lowinger, R. (2015). Psychological help-seeking among Latin American immigrants in Canada: Testing a culturally-expanded model of the theory of reasoned action using path analysis. *International Journal for the Advancement of Counselling, 37*(2), 179-197.

Kuklinski, J. H., & Quirk, P. J. (2000). "Reconsidering the rational public: Cognition, heuristics, and mass opinion." In A. Lupia, M. D. & S. L. Popkin (Eds.), *Elements of reason: Cognition, choice and the bounds of rationality* (pp. 153–182). Cambridge University Press.

Kurzweil, R. (1999). *The age of spiritual machines: When computers exceed human intelligence*. Viking Books.

Kurzweil, R. (2005). *The singularity is near: When humans transcend biology*. Viking Books.

Kuznets, S. (1957). Quantitative aspects of the economic growth of nations. *Economic Development and Cultural Change, 11*(2), part 2, 1- 80.

La Porta, R., & A. Shleifer. (2014). Informality and development. *Journal of Economic Perspectives, 28*(3), 109-126.

Ladwig, M. A., Vazou, S., & Ekkekakis, P. (2018). "My best memory is when I was done with it": PE memories are associated with adult sedentary behaviour. *Translational Journal of the American College of Sports Medicine, 3*(16), 119-129.

Landa, N., Zhou, S., & Marongwe, N., 2021. Education in emergencies: Lessons from COVID-19 in South Africa. *International Review of Education, 67*(1), 167-183.

Lannegren, O., & Ito, H. (2017). The end of the ANC era: An analysis of corruption and inequality in South Africa. *Journal of Politics and Law, 10*(4), 55–59.

Lang, J. T., & Hallman, W. K. (2005). Who does the public trust? The case of genetically modified food in the United States. *Risk Analysis: An International Journal, 25*(5), 1241-1252.

Larson, D. F., Muraoka, R., & Otsuka, K. (2016). Why African rural development strategies must depend on small farms. *Global Food Security, 10*, 39-51.

Laurian, L. (2009). Trust in planning: Theoretical and practical considerations for participatory and deliberative planning. *Planning Theory & Practice, 10*(3), 369-391.

Law, J., & Callon, M. (1992). The life and death of an aircraft: A network analysis of technological change. In W. Bijker, & J. Law (Eds.), *Shaping technology/building society: Studies in sociotechnical change* (pp. 29-52). MIT Press.

Lazard, L., & McAvoy, J. (2020). Doing reflexivity in psychological research: What's the point? What's the practice? *Qualitative Research in Psychology, 17*(2), 159–177. https://doi.org/10.1080/14780887.2017.1400144

Lee, A., & Baskerville, R. L. (2003). Generalizing generalizability in information systems research. *Information Systems Research, 14*, 221-243.

Lee, J. (2014). Where imperialism could not reach Chinese industrial policy and Japan, 1900–1940. *Enterprise & Society, 15*(4), 655-671.

Lee, M. H. & Clark, A. (2020). Partisanship does not tell the full story: The complexities of public opinion and fracking in the United States. *Energy Research & Social Science, 70*, 101686.

Lee, D., & Hess, D. J. (2022). Public concerns and connected and automated vehicles: Safety, privacy, and data security. *Humanities and Social Sciences Communications, 9*(1), 1-13.

Lekhanya, L. M. (2019). Public outlook on creative methodologies for the 4th industrial revolution in South Africa. *International Journal of Entrepreneurship, 23*(3), 1-13.

Lenert, E. (2004). A social shaping perspective on the development of the world wide web: The case of iCraveTV. *New Media & Society, 6*(2), 235-258.

Lent, R. W. (2018). Future of work in the digital world: Preparing for instability and opportunity. *The Career Development Quarterly, 66*(3), 205-219.

Leonardi P. M., & Jackson, M. H. (2004). Technological determinism and discursive closure in organizational mergers. *Journal of Organizational Change Management, 17*(6), 615-631.

Le Roux, D. B. (2018). Automation and employment: The case of South Africa. *African Journal of Science, Technology, Innovation and Development, 10*(4), 507-517.

Lim, S. (2020). Embedding technological transformation: The welfare state and citizen attitudes toward technology. *European Political Science Review, 12*(1), 67-89.

Lin, J. Y. (2017). Industrial policies for avoiding the middle-income trap: A new structural economics perspective. *Journal of Chinese Economic and Business Studies, 15*(1), 5-18.

Limayem, M., Khalifa, M., & Chin, W. W. (2004). Factors motivating software piracy: A longitudinal study. *IEEE Transactions on Engineering Management, 51*, 414-425.

Liso, N., & Leoncini, R. (2011). *Internationalization, technological change and the theory of the firm*. Routledge. ISBN 978-1-203-84641-4

Listhaug, O., & Jakobsen, T. G. (2017). Foundations of political trust. In E. M. Uslaner (Ed.), the oxford handbook of social and political trust, part VIII. Oxford University Press.

Liu, B., & Zhang, L. (2012). A survey of opinion mining and sentiment analysis. In Arggawal,C & Zhai C (Eds) *Mining text data* (pp. 415-463). Springer.

Loewenstein, G. F., Weber, E. U., Hsee, C. K., & Welch, N. (2001). Risk as feelings. *Psychological Bulletin, 127*(2), 267.

Lopes, C., & te Velde, D. W. (2021). *Structural transformation, economic development and industrialization in post-COVID-19 Africa*. Institute for New Economic Thinking.

Lourie, G. (2018). *President Ramaphosa to create digital industrial revolution commission*. https://techfinancials.co.za/2018/02/16/president-ramaphosa-to-create-digital-industrial-revolutioncommission/.

Luo, F. L. (2008). *Mobile multimedia broadcasting standards: Application handbook*. Springer.

Luz Tortorella, G., Cauchick-Miguel, P. A., Li, W., Staines, J., & McFarlane, D. (2022). What does operational excellence mean in the fourth industrial revolution era?. *International Journal of Production Research, 60*(9), 2901-2917.

Lyytinen, K., & King, J. L. (2004). Nothing at the centre? Academic legitimacy in the information systems field. *Journal of the Association for Informatics Systems, 5*, 220-264.

MacGregor, D. (1991). Worry over technological activities and life concerns. *Risk Analysis, 11*(2), 315-324.

Mackay, H., & Gillespie, G. (1992). Extending the social shaping of technology approach: Ideology and appropriation. *Social Studies of Science, 22*(4), 685-716.

MacKenzie, D., & Wajcman, J. (1999). *The social shaping of technology* (2nd ed.). Open University Press.

MacKenzie, D., & Wajcman, J. (Eds.) (1985). *The social shaping of technology: How the refrigerator got its hum*. Open University Press.

Magistro, B., Loewen, P. J., Bonikowski, B., Borwein, S., & Lee-Whiting, B. (2023). *Attitudes toward automation and the demand for policies addressing job loss: The effects of information about trade-offs*. SSRN 4353929.

Magwentshu, N., Rajagopaul, A., Chui, M., & Singh, A. (2019). *The future of work in South Africa: Digitisation, productivity and job creation*. McKinsey & Company.

Maisiri, B. G. C. (2020). *The idea of the 4th industrial revolution: Attitudes of academic leaders at an urban South African University and its implications for university practice* (Doctoral dissertation,University of the Witwatersrand).

Makamase, M. (n.d.). The fourth industrial revolution: Impact on unemployment and inequality in South Africa. https://www.igd.org.za/infocus/12080-the-fourth-industrial-revolution-impact-on-unemployemnet-and-inequality-in-south-africa.

Makhado, M. P., & Tshisikhawe, T. R. (2021). How apartheid education encouraged and reinforced tribalism and xenophobia in South Africa. In Mafukata MA (ed) *Impact of immigration and xenophobia on development in Africa* (pp. 131-151). IGI Global.

Makhaya, G., & Roberts, S. (2013). Expectations and outcomes: Considering competition and corporate power in South Africa under democracy. *Review of African Political Economy, 40*(138), 556-571.

Makridakis, S. (2017). The forthcoming artificial intelligence (AI) revolution: Its impact on society and firms. *Futures, 90*, 46-60.

Makulilo, A. (2016). *African data privacy laws*. Springer.

Malhotra, M. K., Heine, M. L., & Grover, V. (2001). An evaluation of the relationship between management practices and computer-aided design technology. *Journal of Operations Management, 19*(3), 307-333.

Malthus, T. R. (2008). (First edition 1820). *Principles of political economy* (J. Pullen, Ed.). Cambridge University Press.

Manji, F. (2008). Mobile activism, mobile hype. *Media Studies Diversity Journal, 4*, 125-132.

Manyika, J., Lund, S., Chui, M., Bughin, J., Woetzel, J., Batra, P., Ko, R., & Sanghvi, S. (2017). *Jobs lost, jobs gained: Workforce transitions in a time of automation*. McKinsey Global Institute.

Marais, H. (2011). *South Africa pushed to the limit: The political economy*. Zed Books.

Maré, G. (2011). 'Fear of numbers': Reflections on the South African case. *Current Sociology, 59*(5), 616-634. https://doi.org/10.1177/0011392111408677

Margolis, M., & Resnick, D. (2000). *Politics as usual: The cyberspace*. Sage.

Marques, M. D., Critchley, C. R., & Walshe, J. (2015). Attitudes to genetically modified food over time: How trust in organizations and the media cycle predict support. *Public Understanding of Science, 24*(5), 601-618.

Maruping, L. M., Bala, H., Venkatesh, V., & Brown, S. A. (2017). Going beyond intention: Integrating behavioral expectation into the unified theory of acceptance and use of technology. *Journal of the Association for Information Science and Technology, 68*(3), 623-637.

Marutlulle, N. K. (2022). Critical analysis of the role played by apartheid in the present housing delivery challenges encountered in South Africa. *Africa's Public Service Delivery & Performance Review, 10*(1), 12.

Marwala, T. (2019). Preparing Africa for the fourth industrial revolution. *WIPO Magazine*, Special issue 11.

Masheleni, C. I. (2022). *Fourth industrial banking: Case studies into digitising banking models and the foreseeable effects in South Africa* (Master's thesis, University of Cape Town https://open.uct.ac.za/handle/11427/36483.

Masiya, T., Davids, Y. D., & Mangai, M. S. (2019). Assessing service delivery. *Theoretical and Empirical Researches in Urban Management, 14*(2), 20-40.

Matereke, K., & El Moghazy, N. (2015) Mugabe and the military alliance: Zimbabwe's prospects of democratic transition. In S. J. Ndlovu-Gatsheni (Ed.), *Mugabeism? History, politics, and power in Zimbabwe* (pp. 249–272). Palgrave Macmillan. https://doi.org/10.1017/CBO9781107415324.004

Mathieson, K. (1991). Predicting user intentions: Comparing the technology acceptance model with the theory of planned behaviour. *Information Systems Research, 2*(3).

Mattes, R. (2012). Opinion polls and the media in South Africa. *Opinion polls and the media: Reflecting and shaping public opinion*, 175-197.

Mattes, R. (2013). Systematic, quantitative political science in South Africa: The road less travelled. *Politikon, 40*(3), 479-499. https://doi.org/10.1080/02589346.2013.853948

Matthess, M., & Kunkel, S. (2020). Structural change and digitalization in developing countries: Conceptually linking the two transformations. *Technology in Society, 63*, 101428.

Matuzeviciute, K., Butkus, M., & Karaliute, A. (2017). Do technological innovations affect unemployment? Some empirical evidence from European countries. *Economies, 5*(4), 48.

Maylam, P. (2017). *South Africa's racial past: The history and historiography of racism, segregation, and apartheid*. Routledge.

McDermott, M. S., Oliver, M., Svenson, A., Simnadis, T., Beck, E. J., Coltman, T., … Sharma, R. (2015). The theory of planned behaviour and discrete food choices: A systematic review and meta-analysis. *International Journal of Behavioural Nutrition and Physical Activity, 12*(1), 162.

McKinsey & Company. (2015). *The four global forces breaking all the trends*. McKinsey.

McKinsey Global Institute. (2017). A future that works: Automation, employment, and productivity. http://www.mck¬insey.com/global-themes/digital-disruption/harnessing-automation-for-a-future-that-works.

McKinsey Global Institute. (2018). *Skill shift: Automation and the future of the workforce*. McKinsey & Co.

McLean, G., Osei-Frimpong, K., Wilson, A., & Pitardi, V. (2020). How live chat assistants drive travel consumers' attitudes, trust and purchase intentions: The role of human touch. *International Journal of Contemporary Hospitality Management, 32*(5), 1795-1812.

McNeil, I. (1990). *An encyclopedia of the history of technology*. Routledge.

Medina, L., Jonelis, A., & Cangul, M. (2017). *The informal economy in sub-Saharan Africa: Size and Determinants*. (IMF Working Paper, WP/17/156). IMF.

Melenhorst, A. S., Rogers, W. A., & Bouwhuis, D. G. (2006). Older adults' motivated choice for technological innovation: Evidence for benefit-driven selectivity. *Psychology and Aging, 21*(1), 190-195.

Merton, R. (1968). *Social theory and social structure*. Free Press.

Mfanafuthi, M., Nyawo, J., & Mashau, P. (2019). Analysis of the impact of artificial intelligence and robotics on human labour. *Gender & Behaviour, 17*(3), 13877-13891.

Mhaka, S. (2020). *Perceptions on the fourth industrial revolution and agricultural economics-the case of the University of Pretoria alumni* (Msc dissertation, University of Pretoria)https://repository.up.ac.za/bitstream/handle/2263/77850/Mhaka_Perceptions_2020.pdf?sequence=1&isAllowed=y .

Mhlanga, D. (2021). Artificial intelligence in the industry 4.0, and its impact on poverty, innovation, infrastructure development, and the sustainable development goals: Lessons from emerging economies?. *Sustainability, 13*(11), 5788.

Milanović, B. (2016). *Global inequality: A new approach for the age of globalization*. The Belknap Press of Harvard University Press.

Mille, E. M. (2019). Perceptions of military personnel regarding workplace disruptions in the fourth industrial revolution (Doctoral dissertation, University of Johannesburg) https://ujcontent.uj.ac.za/esploro/outputs/graduate/Perceptions-of-military-personnel-regarding-workplace/9910969607691 .

Millington, K. A. (2017). *How changes in technology and automation will affect the labour market in Africa. Helpdesk report on knowledge, evidence and learning for development*. https://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/13054/K4D_HDR_Impact%20of%20automation%20on%20jobs%20in%20Africa.pdf?sequence=166&is Allowed=y.

Mindell, D. A., & Reynolds, E. (2022). *The work of the future: Building better jobs in an age of intelligent machines*. MIT Press.

Misbah, Z., Gulikers, J., Maulana, R., & Mulder, M. (2015). Teacher interpersonal behaviour and student motivation in competence-based vocational education: Evidence from Indonesia. *Teaching and Teacher Education, 50*, 79-89.

Mishel, L. (2022). Policy decisions' role in wage suppression and inequality. In Arnim, R. & Stiglitz, J (Eds)*The great polarization* (pp. 191-224). Columbia University Press.

Mishra, P., Pandey, C. M., Singh, U., Gupta, A., Sahu, C., & Keshri, A. (2019). Descriptive statistics and normality tests for statistical data. *Annals of Cardiac Anaesthesia, 22*(1), 67-72.

Mitcham, C. (1994). *Thinking through technology*. University of Chicago Press.

Mittelstadt, B. (2019). Principles alone cannot guarantee ethical AI. *Nature Machine Intelligence, 1*(11), 501-507.

Mngxati, V., & De Haas, J. (2019). *Unlocking digital value for business and society in South Africa*. Accenture.

Mohajan, H. (2019). The first industrial revolution: Creation of a new global human era. *American Institute of Science Journal of Social Sciences and Humanities, 5*(4), 377-387.

Moll, I. (2020, 20 August . The first three industrial revolutions stripped Africa Bare–It's hard to see why the fourth would be any different'. *Daily Maverick*, 20. https://www.researchgate.net/profile/IanMoll/publication/352748433_The_first_three_industrial_revolutions_stripped_Africa_bare_it's_hard_to_see_why_the_fourth_would_be_any_different/links/60d61a6fa6fdccb745e411cc/The-first-three-industrial-revolutions-stripped-Africa-bare-its-hard-to-see-why-the-fourth-would-be-any-different.pdf

Monga, C., Shimeles, A., & Woldemichael, A. (2019). *Creating decent jobs-strategies, policies and instruments.* Africa Development Bank.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research, 2*, 192-222.

Morathi, L.P. (2020). *Millennial perceptions of the 4th industrial revolution in an information technology company*. (MA Dissertation North-West University). https://repository.nwu.ac.za/handle/10394/34660

Morgan, L. O., & Daniels, R. L. (2001). Integrating product mix and technology adoption decisions: A portfolio approach for evaluating advanced technologies in the automobile industry. *Journal of Operations management, 19*(2), 219-238.

Morozov E. (2013). *To save everything, click here: Technology, solutionism, and the urge to fix problems that don't exist*. Public Affairs.

Morozov, E. (2014). *To save everything, click here: The folly of technological solutionism*. Public Affairs.

Mtapuri, O., & Tinarwo, P. (2021). From apartheid to democracy. *Southern African Journal of Demography, 21*(1), 104-133.

Mtapuri, O. (2023). Poverty, inequality, development, and innovation: An introduction. In Mtapuri, O (ed) *Poverty, inequality, and innovation in the global south* (pp. 1-11). Springer International Publishing.

Mtapuri, O., & Okem, A. E. (2023). Perceptions of inequality in an informal settlement in Durban, South Africa. In Mtapuri, O (ed) *Poverty, inequality, and innovation in the global south* (pp. 13-34). Springer International Publishing.

Mumford, L. (1966). *The myth of the machine. Volume 1: Technics and human development*. Harvest/HBJ.

Muñoz, A., Moreno, C., & Luján J. L. (2012). Who is willing to pay for science? On the relationship between public perception of science and the attitude to public funding of science. *Public Understanding of Science, 21*(2), 242-253. https://doi.org/10.1177/0963662510373813

Murtin, F., Fleischer, L., Siegerink, V., Aassve, A., Algan, Y., Boarini, R., González, S. … Smith, C. (2018). *Trust and its determinants: Evidence from the Trustlab experiment*. (OECD Statistics Working Papers 2018/02). OECD Publishing.

Musa, P. F., Meso, P., & Mbarika, V. W. (2005). Toward sustainable adoption of technologies for human development in Sub-Saharan Africa: Precursors, diagnostics and prescriptions. *Communications of Associations for Information Systems, 15*, 33.

Nam, T. (2019). Citizen attitudes about job replacement by robotic automation. *Futures, 109*, 39-49.

Naudé, W. (2017). *Entrepreneurship, education and the fourth industrial revolution in Africa*. (IZA Discussion Papers, No. 10855), RWTH Aachen University; IZA Institute of Labor Economics; ASC University of Leiden; University of Johannesburg. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2998964.

Ndung'u, N., & Signé, L. (2020). *The fourth industrial revolution and digitization will transform Africa into a global powerhouse*. Foresight Africa Report. https://fully-human.org/wp-content/uploads/2020/01/NdunguSigne_The-Fourth-Industrial-Revolution-And-Digitization-Will-Transform-Africa-Into-A-Global-Powerhouse.pdf.

Neufeind, M., Ranft, F., & O'Reilly, J. (2018). *Political realities and a reform agenda for the digital age. Praise for work in the digital age*. Policy Network. https://policynetwork.progressivebritain.org/opinions/essays/political-realities-reform-agenda-digital-age/

Newton, K. (2001). Social capital and democracy. In B. Edwards, M. J. Foley, & M. Diani (Eds.), *Beyond Tocqueville: Civil society and the social capital debate in comparative perspective* (pp. 225-234). Tufts University Press.

Newton, K., Stolle, D., & Zmerli, S. (2017). Social and political trust. In E. M. Uslaner (Ed.), *The Oxford handbook of social and political trust*. (Part I). Oxford University Press.

Nilsson, S. (2016). Coloured by race: A study about the making of coloured identities in South Africa. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=definition+of+couloured+person+in+south+africa&btnG=

Njenga, J. K. (2018). Sociocultural paradoxes and issues in e-learning use in higher education Africa. *Globalisation, Societies and Education, 16*(1), 120-133.

Nomura, T., Kanda, T., Suzuki, T., & Kato, K. (2009). Age differences and images of robots: Social survey in Japan. *Interaction Studies, 10*(3), 374-391.

Nordhaus, W. (2017). *Are we approaching an economic singularity? Information technology and the future of economic growth*. National Bureau of Economic Research. https://doi.org/10.3386/w21547

Norman, J., Madurawe, R., Moore, C. M. V., Khan, M. A., & Khairuzzaman, A. (2017). A new chapter in pharmaceutical manufacturing: 3D-printed drug products. *Advanced Drug Delivery Reviews, 108*, 39-50.

Norris, P. (2001). *The digital divide: Civic engagement, information poverty and the internet worldwide*. Cambridge University Press.

Norris, P., & Inglehart, R. (2018). *Cultural backlash: Trump, Brexit, and authoritarian populism*. Cambridge University Press.

Nübler, I., Hofmann, C., & Greiner, C. (2010). *Understanding informal apprenticeship: Findings from empirical research in Tanzania*. ILO.

Nwoye, A. (2015). What is African psychology the psychology of? *Theory & Psychology, 25*(1), 96–116. https://doi.org/10.1177/0959354314565116

Nyadera, I. N. (2018). South Sudan conflict from 2013 to 2018: Rethinking the causes, situation and solutions. *African Journal on Conflict Resolution, 18*(2), 59-86.

Nzau, M. (2010). Africa's industrialization debate: A critical analysis. *Journal of Language, Technology & Entrepreneurship in Africa, 2*(1), 146-165.

O'Brien, P. (2006). *Provincializing the first industrial revolution*. (Working Papers of the Global Economic History Network (GEHN), No. 17/06). GEHN.

O'Brien, P. (2017). *Was the first industrial revolution a conjuncture in the history of the world economy?*. (London School of Economics, Working Papers No. 259 – March 2017). http://eprints.lse.ac.uk/84126/1/WP259%20was%20the%20first%20industrial%20revolution%20a%20conjucture.pdf.

Ocampo, J.A., Rada C., & Taylor L. (2009). *Growth and policy in developing countries: A structuralist approach*. Columbia University Press.

Odekunle, F. F., Odekunle, R. O., & Shankar, S. (2017). Why sub-Saharan Africa lags in electronic health record adoption and possible strategies to increase its adoption in this region. *International Journal of Health Sciences, 11*(4), 59-64.

Odendaal, N. (2019, June 21) SA mining adopting, driving 4ir as its transformation journey continues. *Engineering News*. www.engineeringnews.co.za/article/sa-mining- adopting-driving-4ir-as-its-transformation-journey-continues-2019-06-21.

Organisation for Economic Cooperation and Development. (2017). *Economic survey of South Africa 2017*. Organisation for Economic Cooperation and Development.

Organisation for Economic Cooperation and Development. (2019). *Artificial intelligence in society*. Organisation for Economic Cooperation and Development.

Ogundari, K., & T. Awokuse. (2018). Human capital contribution to economic growth in sub-Saharan Africa: Does health status matter more than education? *Economic Analysis and Policy, 58*, 131-140.

Ogwo, B. A. (2018). Re-visioning technical vocational education and training (TVET) for the youth in sub-Saharan Africa (SSA) and the sustainable development goals (SDGs): Prospects and promises within the framework of the Ubuntu paradigm. In E. Takyi-Amoako, & N. Assié-Lumumba (Eds.), *Re-visioning education in Africa* (pp. 155-173). Palgrave Macmillan.

Oke, A., Walumbwa, F., Yan, T., Idiagbon-Oke, M., & Ojode, L. A. (2014). Linking economic status with technology adoption in three emerging economies of Sub-Saharan Africa. *Journal of Manufacturing Technology Management*, 25 (1), 49-68

Oke, A., & Fernandes, F. A. P. (2020). Innovations in teaching and learning: Exploring the perceptions of the education sector on the 4th industrial revolution (4IR). *Journal of Open Innovation: Technology, Market, and Complexity, 6*(2), 31.

Oketch, M. (2014). *Education policy, vocational training, and the youth in sub-Saharan Africa*. (Working Paper 2014/069). World Institute for Development Economics Research (WIDER).

Olaitan, O. O., Issah, M., & Wayi, N. (2021). A framework to test South Africa's readiness for the fourth industrial revolution. *South African Journal of Information Management, 23*(1), 1-10.

Olawuyi, D. S. (2018). From technology transfer to technology absorption: Addressing climate technology gaps in Africa. *Journal of Energy & Natural Resources Law, 36*(1), 61-84.

Oliver, R. L. (1977). Effect of expectation and disconfirmation on postexposure product evaluations – an alternative interpretation. *Journal of Applied Psychology, 62*, 480-486.

Olofsson, A., Öhman, S., & Rashid, S. (2006). Attitudes to gene technology: the significance of trust in institutions. *European Societies, 8*(4), 601-624.

Olson, J. R., & Boyer, K. K. (2003). Factors influencing the utilization of internet purchasing in small organizations. *Journal of Operations Management, 21*(2), 225-245.

Oluwatayo, I. B., & Ojo, A. O. (2018). Walking through a tightrope: The challenge of economic growth and poverty in Africa. *Journal of Developing Areas, 52*(1), 59-69.

Opesade, A. O., & Tiamiyu, M. A. (2022). Scientific information literacy, attitude and persuasiveness in decision making among Nigerian university students. *Information Development, 38*(3), 363-379.

Opoku, E. E. O., & Yan, I. K. M. (2019). Industrialization as driver of sustainable economic growth in Africa. *Journal of International Trade & Economic Development, 28*(1), 30-56.

Orlikowski, W., & Iacono, S. (2001). Reseach commentary: Desperately seeking the IT in IT research – a call to action theorizing the IT artefact. *Information Systems Research, 12*, 121-134.

Orthofer, A. (2016). Wealth inequality in South Africa: Evidence from survey and tax data. Research project on employment, income distribution & inclusive growth, 15. https://thedocs.worldbank.org/en/doc/731511476914370714005002 2016/original/WeathinequalityinSouthAfrica.pdf

Osabutey, E. L. C., Williams, K., & Debrah, Y. A. (2014). The potential for technology and knowledge transfers between foreign and local firms: A study of the construction industry in Ghana. *Journal of World Business, 49*, 560-571.

Osborne, M., & Frey, C. B. (2018). *Automation and the future of work – Understanding the numbers*. https://www.oxfordmartin.ox.ac.uk/blog/automation-and-the-future-of-work-understanding-the-numbers/.

Osborne, T. & Rose, N. (1999). Do the social sciences create phenomena?: The example of public opinion research. *British Journal of Sociology, 50*(3), 367-396. https://doi.org/10.1111/j.1468-4446.1999.00367.x

Osei-Boateng, C., & Ampratwum, E. (2011). *The informal sector in Ghana*. Friedrick Ebert Stiftung-Ghana office. http://library.fes.de/pdffiles/ bueros/ghana/10496.pdf.

Osembe, L. (2021). A comparative study on South African users' perception to use, choose, and purchase a smartphone device through the lens of the social shaping of technology (SST) theory. *International Journal of Computer and Information Technology 10*(2).

Ovadia, J. S., & Wolf, C. (2018). Studying the developmental state: Theory and method in research on industrial policy and state-led development in Africa. *Third World Quarterly, 39*(6), 1056-1076.

Oyedemi, T. D. (2012). Digital inequalities and implications for social inequalities: A study of internet penetration amongst university students in South Africa. *Telematics and Informatics, 29*(3), 302-313.

Page, B. I., & Shapiro, R. Y. (1983). Effects of public opinion on policy. *American Political Science Review, 77*(1), 175-190.

Park, H. M., & Perry, J. L. (2008). Do campaign web sites really matter in electoral civic engagement? Empirical evidence from the 2004 post-election internet tracking survey. *Social Science Computer Review, 26*(2), 190-212.

Park, Y. S., Konge, L., & Artino, A. R. (2020). The positivism paradigm of research. *Academic Medicine, 95*(5), 690-694.

Parker, K., Morin, R., & Horowitz, J. M. (2019). *Looking to the future, public sees an America in decline on many fronts*. Pew Research Center, 21.

Parliamentary Monitoring Group. (2018). *Cybercrimes and Cybersecurity Bill (B6-2017)*. https://pmg.org. za/bill/684/.

Perlusz, S. (2004). Emotions and technology acceptance: Development and validation of a technology affect scale. In Proceedings of the IEEE International Engineering Management Conference, Singapore (pp. 845-847).

Pernegger, L., & Godehart, S. (2006). *Townships in the South African geographic landscape – Physical and social legacies and challenges, training for township renewal*. http://www.treasury.gov.za/divisions/bo/ndp/TTRI/TTRI%20Oct%202007/Day%201%20-%2029%20Oct%202007/1a%20Keynote%20Address%20Li%20Pernegger%20Paper.pdf.

Peters, M. A. (2017). Technological unemployment: Educating for the fourth industrial revolution. *Educational Philosophy and Theory, 49*(1), 1-6.

Peter, C., Friedenstein, H., Bhorat, H., Chipkin, I., Mondi, L., Swilling, M., & Duma, S. (2018). *Shadow state: The politics of state capture*. NYU Press.

Petrillo, A., Felice, F., Cioffi, R., & Zomparelli, F. (2018). *4IR: Current practices, challenges, and opportunities. in digital transformation in smart manufacturing*. https://doi.org/10.5772/intechopen.72304

Petty, R. E., Wegener, D. T., & Fabrigar, L. R. (1997). Attitudes and attitude change. *Annual Review of Psychology, 48*(1), 609-647. https://doi.org/10.1146/annurev.psych.48.1.609

Phillips, E., Ullman, D., de Graaf, M. M., & Malle, B. F. (2017). What does a robot look like?: A multi-site examination of user expectations about robot appearance. In Proceedings of the Human Factors and Ergonomics Society annual meeting (Vol. 61, No. 1, pp. 1215-1219). SAGE Publications.

Pinch, T., & Bijker, W. (1984). The social construction of facts and artefacts: Or how the sociology of science and the sociology of technology might benefit each other. *Social Studies of Science, 14*(3), 399-441.

Pinder, C. C. (2008). *Work motivation in organizational behaviour*. Psychology Press.

Pistono, F. (2014). *Robots will steal your job but that's ok. How to survive the economic collapse and be happy*. Federico Pistono.

Pitlik, H., & Kouba, L. (2015). Does social distrust always lead to a stronger support for government intervention? *Public Choice, 163*(3-4), 355-377.

Pitt, L., Watson, R., & Kavan, B. (1995). Service quality: A measure of information systems effectiveness. *MIS Quarterly, 19*, 173-187.

Piva, M., Santarelli, E., & Vivarelli, M. (2006). Technological and organizational changes as determinants of the skill bias: Evidence from the Italian machinery industry. *Managerial and Decision Economics, 27*, 63-73.

Poni, M. (2014). Research paradigms in education. *Journal of Educational and Social Research, 4*(1), 407-414. https://doi.org/10.5901/jesr.2014.v4n1p407

Potts, D. (2008). The urban informal sector in sub-Saharan Africa: From bad to good (and back again?). *Development Southern Africa, 25*(2), 151-167.

Pretorius, T. (2016). *Fourth industrial revolution: Promise or peril?* http://www.leader.co.za/article.aspx?s=6&f=1&a=6256,

Puddifoot, J. (1997) The processual origins of social representations. *Journal for the Theory of Social Behaviour, 27*(1), 41-63.

Pulkka, V. V. (2017). A free lunch with robots–Can a basic income stabilize the digital economy? *Transfer: European Review of Labor and Research, 23*(3), 295-311.

Purkhardt, S. C. (1993). *Transforming social representations: A social psychology of common sense and science*. Routledge.

Ramaphosa, C. (2019). *State of the Nation Address*. https://www.gov.za/sona2019.

Rana, N. P., & Dwivedi, Y. K. (2015). Citizen's adoption of an e-government system: Validating extended social cognitive theory (SCT). *Government Information Quarterly. 32*(2), 172-181.

Rankin, K. (2016). *Basic income as public equity: The New Zealand case. Basic income in Australia and New Zealand*. Palgrave Macmillan.

Ratele, K. (2018). Engaging young male university students: Towards a situated, social-psychological profeminist praxis. In T. Shefer, J. Hearn, K. Ratele, & F. Boonzaier (Eds.), *Engaging youth in*

activism, research and pedagogical praxis: Transnational and intersectional perspectives on gender, sex, and race (pp. 93–109). Routledge.

Ratele, K. (2017). Frequently asked questions about African psychology. *South African Journal of Psychology, 47*, 273-279.

Ratele, K., Cornell, J., Dlamini, S., Helman, R., Malherbe, N., & Titi, N. (2018). Some basic questions about (a) decolonizing Africa (n)-centred psychology considered. *South African Journal of Psychology, 48*(3), 331-342.

Raza, G., Singh, S., & Shukla, R. (2009). Relative cultural distance, and public understanding of science. *Science, Technology & Society. 14*(2), 269-287. https://doi.org/10.1177/097172180901400204

Reddy, V., Gastrow, M., Juan, A., & Roberts, B. (2013). Public attitudes to science in South Africa. *South African Journal of Science, 109*(1/2): 1-8. https://doi.org/10.1590/ sajs.2013/1200

Reddy, V., Bhorat, H., Powell, M., Visser, M., & Arends, A. (2016). *Skills supply and demand in South Africa*. LMIP Publication, Human Sciences Research Council. http://lmip.org.za/sites/default/files/documentfiles/LMIP_SkillsSupplyandDemand_Sept2016_Author_0.pdf.

Reece, J. (2021). Confronting the legacy of "separate but equal": Can the history of race, real estate, and discrimination engage and inform contemporary policy?. *RSF: The Russell Sage Foundation Journal of the Social Sciences, 7*(1), 110-133.

Reed, H., & Lansley, S. (2016). *Universal basic income: An idea whose time has come?* Compass.

Rheingold, H. (1993). *The virtual community*. Addison-Wesley.

Ricci, M., & Gulick, J. (2016). Cybersecurity games: Building tomorrow's workforce. *JL & Cyber Warfare, 5*, 183.

Riebl, S. K., Estabrooks, P. A., Dunsmore, J. C., Savla, J., Frisard, M. I., Dietrich, A. M.Davy, B. M. (2015). A systematic literature review and meta-analysis: The theory of planned behaviour's application to understand and predict nutrition-related behaviours in youth. *Eating Behaviours, 18*, 160-178.

Rip, A., Misa, T. J., & Schot, J. (Eds.). (1995). *Managing technology in society*. Pinter Publishers.

Roberts, B. H. (2015). *The third industrial revolution: Implications for planning cities and regions*. (Urban Frontiers Working Paper). Urban Frontiers.

Roberts, B. J. (2013). Your place or mine? Beliefs about inequality and redress preferences in South Africa. *Social Indicators Research, 118*(3), 1167-1190.

Roberts, B. J., Struwig, J., Gordon, S. L., Zondi, T., Hannan, S., & Gastrow, M. (2022). Generation of change? South African attitudes towards climate change in comparative perspective. *Development Southern Africa*, 40 (2), 1-25.

Roberts, B. (2019) Economic Freedom Fighters: authoritarian or democratic contestant?. In: Schulz-Herzenberg, C. & Southall, R. (eds).Election 2019: change and stability in South Africa's

democracy. Johannesburg: Konrad-Adenauer Stiftung. 97-113. http://hdl.handle.net/20.500.11910/14742.

Roberts, B. (2010). *Fear factor perceptions of safety in South Africa. South African social attitudes second report: Reflections on the age of hope*. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Roberts%2C+B.+%282010%29.+Fear+factor+perceptions+of+safety+in+South+Africa.+South+African+social+attitudes+second+report%3A+rReflections+on+the+age+of+hope.%2C+250-275&btnG=.

Roberts, B. J., Gordon, S. L., Struwig, J., Bohler-Muller, N., & Gastrow, M. (2021). Promise or precarity? South African attitudes towards the automation revolution. *Development Southern Africa, 39*(4), 1-18.

Robinson, J. (2009). *Triandis theory of interpersonal behaviour in understanding software privace behaviour in the South African context*. University of the Witwatersrand.

Rocha, E. (2018). Sophia: Exploring the ways AI may change intellectual property protections. *Journal of Art Technology and Intellectual Property Law, 28*(126), 126-146. https://doi.org/10.3868/s050-004-015-0003-8

Rodney, W. (1973). *How Europe underdeveloped Afric*a. Bogle- L'Ouverture Publications and Tanzanian Publishing House. https://doi.org/10.2307/ 217137

Rodney, W. (2010). *How Europe underdeveloped Africa. Perspectives on Africa*. Blackwell.

Rogan, M. (2018). The post-school education and training landscape in South Africa: 'Massification' amidst inequality. In M. Rogan (Ed.), *Post-school education and the labour market in South Africa* (pp. 1–16). HSRC Press.

Rogers, E. (1983). *Diffusion of innovations* (3rd ed.). The Free Press.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed). Free Press.

Rohracher, H. (2001). Managing the technological transition to sustainable construction of buildings: A socio-technical perspective. *Technology Analysis & Strategic Management, 13*(1), 137-150.

Rolandsen, Ø. H. (2015) Another civil war in South Sudan: The failure of guerrilla government? *Journal of Eastern African Studies, 9*(1), 163-174. https://doi.org/10.1080/17531055.2014.993210

Rotberg, R. (2010). *Failed states, collapsed states, weak states: Causes and indicators*. Princeton University Press.

Runde, D. (2016). *Is America ready for the 'fourth industrial revolution'?* Foreign Policy. https://foreignpolicy.com/2016/04/04/is-america-ready-for-the-fourth-industrial-revolution/.

Sachs, J. D. (2005). *The end of poverty: How we can make it happen in our lifetime*. Penguin.

Sackmann, R., & Winkler, O. (2013). Technology generations revisited: The internet generation. *Gerontechnology, 11*(4), 493-503.

Salahuddin, M., & Gow, J. (2016). The effects of internet usage, financial development and trade openness on economic growth in South Africa: A time series analysis. *Telematics and Informatics, 33*(4), 1141-1154.

Santarius, T., & Soland, M. (2018). How technological efficiency improvements change consumer preferences: Towards a psychological theory of rebound effects. *Ecological Economics, 146*, 414-424.

Satterfield, T., Kandlikar, M., Beaudrie, C. E., Conti, J., & Harthorn, B. H. (2009). Anticipating the perceived risk of nanotechnologies. *Nature Nanotechnology, 4*(11), 752-758.

Say, J. B. (2009. *A treatise on political economy or the production, distribution and consumption of wealth*. BiblioBazaar. ISBN 9781110312887.

Schatzberg, E. (2018). *Technology: Critical history of a concept*. University of Chicago Press.

Schiuma, G. (2017). Arts catalyst of creative organisations for the fourth industrial revolution. *Journal of Open Innovation: Technology, Market, and Complexity, 3*(20), 1-12.

Schneider, F. (2008). *Macroscopic rebound effect as argument for Economic Degrowth. Economic degrowth for ecological sustainability*. Research & Degrowth, INT.

Schneider, T., Hong, G. H., & Van Le, A. (2018). *Robots.* Finance & Development. https://www.sipotra.it/old/wp-content/uploads/2018/05/Land-of-the-Rising-ROBOTS.pdf.

Schofield, A., & Dwolatzky, B. (2019). *2019 JCSE-IITPSA ICT skills survey: The tenth edition*. Joburg Centre for Software Engineering (JCSE) and Institute of Information Technology Professionals South Africa (IITPSA).

Schot, J. (1992). Constructive technology assessment and technology dynamics: The case of clean technologies. *Science, Technology, & Human Values, 17*(1), 36-56.

Schumpeter, J. A. (2013). *Capitalism, socialism and democracy*. Routledge.

Schumpeter, J. A. (2017). *The theory of economic development*. Routledge. ISBN 978-0-06-156161-0.

Schumpeter, J. A. (1952). *Theorie der wirtschaftlichen entwicklung: Eine untersuchung über unternehmergewinn, kapital, kredit, zins und den konjunkturzyklus*. Duncker & Humblot.

Schwab, K. (2017). *The fourth industrial revolution*. Penguin.

Schwartz, B., & Schuman, H. (2005). History, commemoration, and belief: Abraham Lincoln in American memory, 1945-2001. *American Sociological Review, 70*(2), 183-203.

Sears, D. O. (1993). Symbolic politics: A socio-psychological theory. In I. Shanto, & W. J. McGuire (Eds.), *Explorations in political psychology* (pp. 113-150). Duke University Press.

Seddon, P., & Scheepers, R. (2006). Other-settings generalizability in IS research. Paper presented at the *International Conference on Information Systems (ICIS*), Millwaukee, Wisconsin, https://core.ac.uk/download/pdf/301354805.pdf

Seekings, J. (2001). The uneven development of quantitative social science in South Africa. *Social Dynamics, 2*(1), 1-36. https://doi.org/10.1080/02533950108458702

Serdyukov, P. (2017). Innovation in education: What works, what doesn't, and what to do about it? *Journal of Research in Innovative Teaching & Learning,10* (1), 4-3.

Serumaga-Zake, J. M., & van der Poll, J. A. (2021). Addressing the impact of fourth industrial revolution on South African manufacturing small and medium enterprises (SMEs). *Sustainability, 13*(21), 11703.

Sethuraman, S. V. (1977). The urban informal sector in Africa. *International Labour Review, 116*(3), 343-352.

Shan, Y., & King, K. W. (2015). The effects of interpersonal tie strength and subjective norms on consumers' brand-related eWOM referral intentions. *Journal of Interactive Advertising, 15*(1), 16-27.

Shannon, G., Morgan, R., Zeinali, Z., Brady, L., Couto, M. T., Devakumar, D & Muraya, K. (2022). Intersectional insights into racism and health: Not just a question of identity. *The Lancet, 400*(10368), 2125-2136.

Shareef, M. A., Baabdullah, A., Dutta, S., Kumar, V., & Dwivedi, Y. K. (2018). Consumer adoption of mobile banking services: An empirical examination of factors according to adoption stages. *Journal of Retailing and Consumer Services, 43*, 54-67.

Shaturaev, J. (2022). Economies and management as a result of the fourth industrial revolution: An education perspective. *Indonesian Journal of Educational Research and Technology, 3*(1), 51-58.

Sheppard, B. H., Hartwick, J., & Warshaw, P. R. (1988). The theory of reasoned action: A meta-analysis of past research with recommendations for modifications and future research. *Journal of Consumer Research, 15*(3), 325-343.

Shi, S., Li, H., Ding, X., & Gao, X. (2020). Effects of household features on residential window opening behaviors: A multilevel logistic regression study. *Building and Environment, 170*, 106610.

Shivdasani, A. (2019, July 24). South Africa's foray into the fourth industrial revolution: Let's learn to walk before we try to fly. *Daily Maverick*. https://www.dailymaverick. co.za/opinionista/2019-07-24-south-africas-foray-into-the-fourth-industrial-revolution-lets-learn-to-walk-before-we-try-to-fly/.

Shonfeld, M., Cotnam-Kappel, M., Judge, M., Ng, C. Y., Ntebutse, J. G., Williamson-Leadley, S., & Yildiz, M. N. (2021). Learning in digital environments: A model for cross-cultural alignment. *Educational Technology Research and Development*, 69, 1-20.

Siebenhüner, B., Arnold, M., Eisenack, K., & Jacob, K. H. (Eds.). (2013). *Long-term governance for social-ecological change*. Routledge.

Siegrist, M. (1999). A causal model explaining the perception and acceptance of gene technology 1. *Journal of Applied Social Psychology, 29*(10), 2093-2106.

Siegrist, M. (2000). The influence of trust and perceptions of risks and benefits on the acceptance of gene technology. *Risk Analysis, 20*(2), 195-204.

Siegrist, M., Gutscher, H., & Earle, T. C. (2005). Perception of risk: The influence of general trust, and general confidence. *Journal of Risk Research, 8*(2), 145-156.

Siegrist, M., Keller, C., Kastenholz, H., Frey, S., & Wiek, A. (2007). Laypeople's and experts' perception of nanotechnology hazards. *Risk Analysis: An International Journal, 27*(1), 59-69.

Signé, L. (2023). *Africa's fourth industrial revolution*. Cambridge University Press.

Sila, I. (2015). The state of empirical research on the adoption and diffusion of business-to-business e-commerce. *International Journal of Electronic Business, 12*(3), 258-301.

Silva, J. (2018). A Cinderella story gone wrong: The Central African Republic's state failure. *Humania del Sur, 24*, 105-117.

Sinclair, A. (1907). *Development of the locomotive engine*. Angus Sinclair Publishing Company.

Singh, V. (2015). The technologies & machines that powered the industrial revolution. *Journal of Research in Humanities and Social Science, 3*(4), 27-29.

Sinha, P. (2013). *Combating youth unemployment in India*. Friedrich-Ebert-Stiftung. https://s3.amazonaws.com/academia.edu.documents/46352546/Combating_Youth_Unemployment_in_India.pdf?responsecontent.

Sithole, M. (1993). Is Zimbabwe poised on a liberal path? The state and prospects of the parties. *African Studies Association, 21*(1-2), 35-43.

Sjoberg, L. (1998). Worry and risk perception. *Risk Analysis, 18*(1), 85-93.

Skocpol, T. (1994). *Social revolutions in the modern world*. Cambridge University Press.

Skocpol, T., & Trimberger, E. K. (1977). Revolutions and the World-historical developments of capitalism. *Berkeley Journal of Sociology, 22*, 101-113.

Slack J. D., & Fejes, F. (1987). *The ideology of the information age*. Ablex.

Smith, A., & Anderson, M. (2017). *Automation in everyday life*. Pew Research Center.

Smith, A. (1776). *An Inquiry into the nature and causes of the wealth of nations*. Random House.

Smith, A. (2019). *More than half of us adults trust law enforcement to use facial recognition responsibly*. Pew Research Center.

Sniderman, P. M., Brody, R. A., & Tetlock, P. E. (1993). *Reasoning and choice: Explorations in political psychology*. Cambridge University Press.

Soeteman-Hernández, L. G., Sutcliffe, H. R., Sluijters, T., van Geuns, J., Noorlander, C. W., & Sips, A. J. (2021). Modernizing innovation governance to meet policy ambitions through trusted environments. *NanoImpact, 21*, 100301.

Solomon, H. (2013). Discarding the failed state Thesis: Neo-Weberian institutionalism as an alternative approach to policy formulation. *Yönetim Bilimleri Dergisi, 11*(22), 221-251.

Solomon, E. M., & van Klyton, A. (2020). The impact of digital technology usage on economic growth in Africa. *Utilities Policy, 67*, 101104.

Somrit, N., & Leurcharusmee, S. (2019). Effects of digital banking on employees' perception of their job security in commercial banking industry. *Chiang Mai University Journal of Economics, 23*(1), 23-31.

Soroka, S. N., & Wlezein, C. (2010). *Degrees of democracy: Politics, public opinion and policy*. Cambridge University Press.

South African Government. (2018). *President Cyril Ramaphosa: 2018 State of the Nation Address, 16 February 2018*. https://www.gov.za/speeches/president-cyril-ramaphosa-2018-state-nation-address-16-feb-2018-0000.

SovTech. (2019, November, 20). Digital transformation in South Africa's banking industry. *SovTech News*. https://www.sovtech.co.za/digitaltransformation-in-south-africas-banking-industry/.

Sparks, C. (2001). The internet and the global public sphere. In W. L. Bennett, & R. M. Entman (Eds.), *Mediated politics: Communication in the future of democracy* (pp. 75-95). Cambridge University Press.

Spencer, A. (2020). *Technology adoption in the Caribbean tourism industry: Analyzing service delivery in the digital age*. Springer Nature.

Srivastava, S., & Rojhe, K. C. (2021). Attitude formation and attitude change: a social psychological perspective. In B Christiansen,& H C. Chandan (eds) *Handbook of research on applied social psychology in multiculturalism* (pp. 1-28). IGI Global.

Standing, G. (1984). The notion of technological unemployment. *International Labor Review, 123*(2), 127-148.

Standing, G. (2017). *Basic income: And how we can make it happen*. Penguin.

Statistics South Africa (StatsSA). (2021). *Quarterly labour force survey (QLFS) – Q2:2021*. http://www.statssa.gov.za/publications/P0211/Media%20release%20QLFS%20Q2%202021.pdf.

Statistics South Africa (StatsSA). (2018). *General Household Survey.* *https://www.statssa.gov.za/?p=12180#:~:text=The%20survey%20shows%20that%2081,still%20living%20in%20informal%20dwellings*.

Statistics South Africa (StatsSA). (2022). *Quarterly labour force survey*. https://www.statssa.gov.za/?p=15685.

Stilgoe, J., Owen, R., & Macnaghten, P. (2013). Developing a framework for responsible innovation. *Research Policy, 42*(9), 1568-1580.

Stirling, A. (2007). Deliberate futures: Precaution and progress in social choice of sustainable technology. *Sustainable Development, 15*(5), 286-295.

Stone, Z. (2017, November 7). Everything you need to know about Sophia, the world's first robot citizen. *Forbes*. www.forbes.com/ sites/ zarastone/ 2017/ 11/ 07/ everything-you-need-to-know-about-sophia-the-worlds-first-robot-citizen/#e46a59d46fa1.

Straub, E. T. (2009). Understanding technology adoption: Theory and future directions for informal learning. *Review of Educational Research, 79*(2), 625-649.

Straubhaar, T. (2017). On the economics of a universal basic income. *Intereconomics, 52*(2), 74-80.

Struwig, J. & Roberts, B. (2012). Heart of the matter: Nuclear attitudes in South Africa. *HSRC Review, 10*(2), 7-9.

Sturgis, P., & Allum, N. (2004). Science in society: Re-evaluating the deficit model of public attitudes. *Public Understanding of Science, 13*(1), 55-74.

Sudman, S., Bradburn, N. M., & Schwarz, N. (2010). *Thinking about answers: The application of cognitive processes to survey methodology*. Jossey-Bass

Sushil, S., & Verma, N. (2010). Questionnaire validation made easy. *European Journal of Science Research, 46*(2), 172-178.

Sutherland, E. (2017). Governance of cybersecurity – The case of South Africa. *The African Journal of Information and Communication, 20*, 83-112.

Sutherland, E. (2020). The fourth industrial revolution – The case of South Africa. *Politikon, 47*(2), 233-252. https://doi.org/10.1080/02589346.2019.1696003

Suttner, R. (2006). Party dominance 'theory': Of what value? *Politikon, 33*(3), 277-297. https://doi.org/10.1080/02589340601122901

Swierstra, T. (2015). Introduction to the ethics of new and emerging science and technology. In R Nakatsu, M Rauterberg & P Ciancarini (eds) *Handbook of digital games and entertainment technologies* (pp. 1-25). Springer.

Szirmai, A. (2012). Industrialisation as an engine of growth in developing countries, 1950-2005. *Structural Change and Economic Dynamics, 23*(4), 406.

Szirmai, A., & Verspagen, B. (2015). Manufacturing and economic growth in developing countries, 1950–2005. *Structural Change and Economic Dynamics, 34*, 46-59. https://doi.org/10.1016/j.strueco.2015.06.002.

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics* (6th ed.). Pearson.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education, 48*(6), 1273-1296.

Taherdoost, H., Namayandeh, M., & Jalaliyoon, N. (2011). Information security and ethics in educational context: Propose a conceptual framework to examine their impact. *International Journal of Computer Science and Information Security, 9*(1), 2011)134-138.

Taherdoost, H., & Masrom, M. (2009). An examination of smart card technology acceptance using adoption model. In ITI 2009 31st International Conference on Information Technology

Interfaces, Cavtat, Croatia. Town: IEEE, https://ieeexplore.ieee.org/abstract/document/5196103/.

Taherdoost, H.(2018). A review of technology acceptance and adoption models and theories. *Procedia Manufacturing, 22*, 960-967.

Taherdoost, H., Sahibuddin, S., & Jalaliyoon, N. (2011). Smart card security: Technology and adoption. *International Journal of Security, 5*(2), 74-84.

Taherdoost, H., Sahibuddin, S., & Jalaliyoon, N. (2012). Smart card technology: Awareness and satisfaction. *Journal of Computing, 4*(6), 128-132.

Taipale, S., de Luca, F., Sarrica, M., & Fortunati, L. (2015). Robot shift from industrial production to social reproduction. In J. Vincent, S. Taipale, B. Sapio, G. Lugano, & L. Fortunati (Eds.), *Social robots from a human perspective*. Springer International Publishing.

Taiwo, S. O., & Vezi-Magigaba, M. F. (2021). Human capital perspective of previous industrial revolutions: Review in support of 4IR and its possible impacts. *Multicultural Education, 7*(8).

Takahashi, K., Muraoka, R., & Otsuka, K. (2020). Technology adoption, impact, and extension in developing countries' agriculture: A review of the recent literature. *Agricultural Economics, 51*(1), 31-45.

Tartaruga, I. G. P., Cazarotto, R. T., Martins, C. H. B., & Fukui, A. (2016). *Innovation and public understanding of science: Possibility of new indicators for the analysis of public attitudes to science, technology and innovation*. (MPRA Working Paper No. 76288). https://mpra.ub.uni-muenchen.de/76288/.

Taylor, S., & Todd, P. (1995). Assessing IT usage: The role of prior experience. *MIS Quarterly, 19*(4), 561.

Thiong, D. A. (2018). How the politics of fear generated chaos in South Sudan. *African Affairs, 117*(469), 613- 635. https://doi.org/10.1093/ afraf/ ady031

Thomas, W. I., & Znaniecki, F. (1918). *The Polish peasant in Europe and America*. Pergamon Press.

Thompson, R. L., Higgins, C. A., & Howell, J. M. (1991). Personal computing: Toward a conceptual model of utilization. *MIS Quarterly, 15*(1), 124-143.

Thurstone, L. (1928). Attitudes can be measured. *American Journal of Sociology, 38*, 529-54.

Thurstone, L. L. (1929). Theory of attitude measurement. *Psychological Review, 36*(3), 222-241.

Țicău, I. R., & Hadad, S. (2021). Technological determinism vs. social shaping of technology: The influence of activity trackers on user's attitudes. *Management Dynamics in the Knowledge Economy, 9*(2), 147-163. https://doi.org/10.2478/mdke-2021-0011

Tieszen, C. L. (2009) "Agonizing for You": Christian responses to religious persecution. *International Journal for Religious Freedom, 2*(2), 87- 97.

Tornatzky, L. G., & Klein, K. J. (1982). Innovation characteristics and innovation adoption implementation: A meta-analysis of findings. *IEEE Transactions of Engineering and Management, EM-29*, 28-45.

Treiman, D. J. (1970). Industrialization and social stratification. *Sociological Inquiry, 40*(2), 207-234.

Tripathi, V. R., Popli, M., Ghulyani, S., Desai, S., & Gaur, A. (2021). Knowledge creation practices at organizational boundaries: The role of ICT in sickle-cell care for tribal communities. *Journal of Knowledge Management, 25*(3), 595-617.

Tsotsotso, K., Montshiwa, E., Tirivanhu, P., Fish, T., Sibiya, S., Mlangeni, T.& Mahlangu, N. (2017). Determinants of skills demand in a state-intervening labour market: The case of South African transport sector. Higher Education, Skills and Work-Based Learning.

Turner, J. H. (1993). *Classical sociological theory: A positivist's perspective*. Nelson-Hall.

Uhunamure, S. E., Nethengwe, N. S., & Tinarwo, D. (2021). Development of a comprehensive conceptual framework for biogas technology adoption in South Africa. *Resources, 10*(8), 76.

UK Commission for Employment and Skills (UKCES). (2014). *The future of work: Jobs and skills in 2030*. UKCES.

Ullah, A. A., Lee, S. C. W., Hassan, N. H., & Nawaz, F. (2020). Xenophobia in the GCC countries: Migrants' desire and distress. *Global Affairs, 6*(2), 203-223.

United Nations. (1995). *World economic and social survey 1995: current trends and policies in the world economy (E/1995/50)*. United Nations.

United Nations. (2020). *The technological revolution: Winners and losers, inequality in a rapidly changing world*. https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/02/World-Social-Report-2020-Chapter-2.pdf.

United Nations Industrial Development Organization. (1969). Small scale industry. Industrialization in developing countries: Problems and prospects. (UNIDO Monographs on Industrial Development, No. 11). UN.

Usher, A. P. (1920). *An introduction to the industrial history of England*. University of Michigan Press.

Uslaner, E. M. (2004). Trust, civic engagement, and the internet. *Political Communication, 21*(2), 223-242.

Uslaner, E. M. (2017). The study of trust. In E. M. Uslaner (Ed.), *The Oxford handbook of social and political trust* (Part I). Oxford University Press.

van der Meer, T. W. G. (2010). In what we trust? A study into trust in parliament as an evaluation of state characteristics. *International Review of Administrative Sciences, 76*(3), 517-536.

van der Meer, T. W. G., & Zmerli, S. (2017). The deeply rooted concern with political trust. In S. Zmerli, & T. W. G. van der Meer (Eds.), *Handbook on political trust* (pp. 1-16). Edward Elgar Publishing.

van Ingen, E., & Bekkers, R. (2015). Generalized trust through civic engagement? Evidence from five national panel studies. *Political Psychology. 36*, 277-294.

Van Rensburg, N. J., Telukdarie, A., & Dhamija, P. (2019). Society 4.0 applied in Africa: Advancing the social impact of technology. *Technology in Society, 59*, 101125.

Van Rensburg, S., Ankiewicz, P., & Myburgh, C., (1999). Assessing South Africa learners' attitudes towards technology by using the PATT (Pupils' attitudes towards technology) questionnaire. *International Journal of Technology and Design Education, 9*(2), 137-151.

Van Rooyen, A. F., Ramshaw, P., Moyo, M., Stirzaker, R., & Bjornlund, H. (2017). Theory and application of agricultural innovation platforms for improved irrigation scheme management in Southern Africa. *International Journal of Water Resources Development, 33*(5), 804-823.

van Vuuren, J. J., & van Vuuren, A. J. (2022). Preparing for the fourth industrial revolution: Recommendations to adapt cyber security governance and skills in South Africa. *Journal of Information Warfare, 21*(1), 71-90.

Van Vuuren, J. C. J. (2016). Methodology and model to establish cybersecurity for national security in Africa using South Africa as a case study (Doctoral dissertation, University of Venda https://univendspace.univen.ac.za/bitstream/handle/11602/744/Thesis%20-%20Van%20Vuuren%2C%20j.%20c.j.-.pdf?sequence=1&isAllowed=y.

Varpio, L., & MacLeod, A. (2020). Introduction to the philosophy of science series: Harnessing the multidisciplinary edge effect by exploring paradigms, ontologies, epistemologies, axiologies, and methodologies. *Academic Medicine, 95*, 686-689.

Velín-Fárez, M. (2021). Population and labor dynamics in large informal markets: Implications for pension systems with evidence from Ecuador. *Contemporary Economics, 15*(2), 164-187.

Venkatesh, V. (1999). Creation of favorable user perceptions: Exploring the role of intrinsic motivation. *MIS Quarterly,* 23 (2), 239-260.

Venkatesh, V. (2000). Determinants of perceived ease of use: Integrating perceived behavioural control, computer anxiety and enjoyment into the technology acceptance model. *Information Systems Research, 11*(4), 342-365.

Venkatesh, V., Morris, M. G., Gordon, B. D., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425-478.

Ventura, J., & Voth, H.-J. (2015). *Debt into growth: How sovereign debt accelerated the first industrial revolution*. (Working Paper No. 194). Department of Economics, University of Zurich.

Vicente, P. N., & Dias-Trindade, S. (2021). Reframing sociotechnical imaginaries: The case of the fourth industrial revolution. *Public Understanding of Science, 30*(6), 708-723.

Vincent, N. A. Nadelhoffer T., & McCay A. (Eds.) (2020). *Neuro-interventions and the law: Regulating human mental capacity*. Oxford University Press.

Von Schomberg, R. (2013). A vision of responsible research and innovation. In R. Owen, J. Bessant, & M. Heintz (Eds.), *Responsible innovation: Managing the responsible emergence of science and innovation in society* (pp. 51-74). Wiley.

Voth, H. J. (2003). Living standards during the industrial revolution: an economist's guide. *American Economic Review, 93*(2), 221-226.

Wade, R. H. (2016). Industrial policy in response to the middle-income trap and the third wave of the digital revolution. *Global Policy, 7*(4), 469-480.

Wajcman, J. (1986). Technological choice and the politics of production. *Social Studies of Science, 16*(4), 746-753.

Weber, R. (2003). Editor's comments: Still desperately seeking the IT artefact. *MIS Quarterly, 27 (2)*, iii–xi.

Webster, M. D. (2017). Philosophy of technology assumptions in educational technology leadership. *Journal of Educational Technology & Society, 20*(1), 25-36.

Weeden, N. (2016). *Drone use for precision agriculture in South Africa*. https://ccainsurance.co.za/drone-use-for-precision-agriculture-in-south-africa/.

White, K. M., Jimmieson, N. L., Obst, P. L., Graves, N., Barnett, A., Cockshaw, W., ... & Paterson, D. (2015). Using a theory of planned behaviour framework to explore hand hygiene beliefs at the '5 critical moments' among Australian hospital-based nurses. BMC health services research, 15, 1-9.

Whittlestone, J., Nyrup, R., Alexandrova, A., & Cave, S. (2019, January). The role and limits of principles in AI ethics: Towards a focus on tensions. In Proceedings of the 2019 AAAI/ACM Conference on AI, Ethics, and Society (pp. 195-200), https://dl.acm.org/doi/pdf/10.1145/3306618.3314289 .

Wilkinson, S. (1988). The role of reflexivity in feminist psychology. *Women's Studies International Forum, 11*(5), 493–502. https://doi.org/10.1016/0277-5395(88)90024-6

William, R. (2012). *The most powerful idea in the world: A story of steam, industry and invention*. University of Chicago Press.

William, T. (2004). *Government and politics in Africa*. Macmillan.

Williams, R., & Edge, D. (1996). The social shaping of technology. *Research Policy, 25*(6), 865- 899.

Willig, C. (2013). *Introducing qualitative research in psychology*. McGraw-Hill Education.

Wilson, F. G. (2013). *A theory of public opinion*. Regnery.

Winfield, A. F., & Jirotka, M. (2018). Ethical governance is essential to building trust in robotics and artificial intelligence systems. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 376*(2133), 20180085.

Wintermann, O., & Daheim, C. (2017). *2050: Die zukunft der arbeit.(The future of work.) Results of an international Delphi study in the Millennium Project*. Bertelsmann-Stiftung.

Winner, L. (1980). Do artefacts have politics? *Daedalus, 109*, 121-136.

Wisskirchen, G., Biacabe, B. T., Bormann, U., Muntz, A., Niehaus, G., & Soler, G. J. (2017). *Artificial intelligence and robotics and their impact on the workplace*. Global Employment Institute of International Bar Association.

Woirol, G. R. (1996). *The technological unemployment and structural unemployment debates* (vol. 173). Greenwood Publishing Group.

Woon, I. M. Y., & Pee, L. G. (2004). Behavioural factors affecting internet abuse in the workplace: An empirical investigation. In Proceedings of the Third Annual Workshop on HCI Research in MIS, Washington, DC.

World Bank. (2016). *World development report 2016: Digital dividends*. The World Bank. https://www.worldbank.org/en/publication/wdr2016

World Bank. (2017). *World development indicators*. International Bank for Reconstruction and Development/The World Bank. https://datatopics.worldbank.org/world-development-indicators/

World Bank. (2022). *Finance for an equitable recovery. https://www.worldbank.org/en/publication/wdr2022*

World Bank. (2018). *South African economic update*. http://pubdocs.worldbank.org/en/798731523331698204/South-Africa-Economic-Update-April2018.pdf.

World Economic Forum. (2015). *Deep shift technology tipping points and societal impact, world economic forum. Survey report.* http://www3.weforum.org/docs/WEF_GAC15_Technological_Tipping_Points_report_2.

World Economic Forum. (2016). *The future of jobs employment, skills and workforce strategy for the fourth industrial revolution. Global challenge insight report.* http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf.

World Economic Forum. (2017a). *White paper on agile governance: Reimagining policy-making in the fourth industrial revolution*. World Economic Forum.

World Economic Forum. (2017b). *The future of jobs and skills in Africa Preparing the region for the fourth industrial revolution*. World Economic Forum. www3.weforum.org/doc/WEF_EGW_FOJ_Africa.pdf.

World Robotics. (2017). Industrial robots. https://ifr.org/downloads/press/Executive_Summary_WR_2017_Industrial_Robots.pdf.

Wu, J. H., & Wang, S. C. (2005). What drives mobile commerce? An empirical evaluation of the revised technology acceptance model. *Information & Management, 42*(5), 719-729.

Wysmułek, I. (2019). Using public opinion surveys to evaluate corruption in Europe: Trends in the corruption items of 21 international survey projects, 1989–2017. *Quality & Quantity, 53*(5), 2589-2610.

Xing, B., Marwala, L., & Marwala, T. (2018). Adopt fast, adapt quick: Adaptive approaches in the South African context. In NW Gleason (ed) *Higher education in the era of the fourth industrial revolution* (pp. 171-206). Palgrave Macmillan.

Xing, B., & Marwala, T. (2017). Implications of the fourth industrial age on higher education. arXiv Preprint. https://doi.org/10.25073/0866-773x/87

Xu, M., David, J. M., & Kim, S. H. (2018). The fourth industrial revolution: Opportunities and challenges. *International Journal of Financial Research, 9*(2), 90-95.

Xu, M., Williams, P. J., Gu, J., Liu, M., & Hong, J. C. (2022). Technology teachers' professional attitudes towards technology: An investigation of Chinese high school general technology teachers. *International Journal of Technology and Design Education, 32*(4), 2111-2127.

Yang, A. (2018). *The war on normal people: The truth about America's disappearing jobs and why universal basic income is our future*. Hachette.

Yar, M. (2014). *The cultural imaginary of the internet: Virtual utopias and dystopias*. Springer.

Zahid, M.J.A., Ashraf, M.M., Malik, B.T., Hoque, M.R. (2013). Information Communication Technology (ICT) for Disabled Persons in Bangladesh: Preliminary Study of Impact/Outcome. In: Dwivedi, Y.K., Henriksen, H.Z., Wastell, D., De', R. (eds) Grand Successes and Failures in IT. Public and Private Sectors. TDIT 2013. IFIP Advances in Information and Communication Technology, vol 402. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-38862-0_48.

Zaller, J. R. (1992). *The nature and origins of mass opinion*. Cambridge University Press.

Zanna, M. P., & Rempel, J. K. (1988). Attitudes: A new look at an old concept. In D. Bar-Tal, & A. W. Kruglanski (Eds.), *The social psychology of knowledge* (pp.315-334). Cambridge University Press.

Zhang, B. (2019). *Public opinion lessons for AI regulation. Technical Report*. Brookings Institution. https://perma. cc/B3FY-K6JH.

Zhang, B., & Dafoe, A. (2020, February). US public opinion on the governance of artificial intelligence. In Proceedings of the AAAI/ACM *Conference on AI, Ethics, and Society* , arXiv (pp. 187-193), https://arxiv.org/abs/1912.12835.

Zhang, X., & Kanbur, R. (2005). Spatial inequality in education and health care in China. *China Economic Review, 16*(2), 189-204. https://doi.org/10.1016/j.chieco.2005.02.002

Zmerli, S., & K. Newton. (2017). Objects of political and social trust: Scales and hierarchies. In S. Zmerli, & T. W.G. van der Meer (Eds.), *Handbook on political trust* (pp. 104-124). Edward Elgar Publishing.

APPENDICES

APPENDIX A: ETHICAL CLEARANCE LETTER UKZN

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

30 August 2022

Zama Mabel Mthombeni (210533654)
School Of Built Env & Dev Stud
Howard College

Dear ZM Mthombeni,

Protocol reference number: HSSREC/00002210/2020
Project title: An Analysis of societal attitudes towards the fourth industrial revolution in South Africa: Application of the Technology Acceptance Model
Amended title: A quantitative analysis of public attitudes towards the fourth industrial revolution: an integrated technology adoption model in South Africa

Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 29 August 2022 has now been approved as follows:

- Change in title

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

Best wishes for the successful completion of your research protocol.

Yours faithfully

.....
Professor Dipane Hlalele (Chair)

/dd

APPENDIX B: LETTER OF SUPPORT FROM HSRC

HSRC
Human Sciences Research Council

Human Sciences Research Council
Lekgotla la Dinyakišišo tša Semahlale tša Setho
Raad vir Geesteswetenskaplike Navorsing
Umkhandlu Wezokucwaninga Ngezeyensi Yezintu
Ithunga Lophando Ngenzulu-Lwezi Kantu

Democracy, Governance and Service Delivery

4th March, 2019

Prof. Oliver Mtapuri
School of the Built Environment and Development Studies
University of KwaZulu-Natal (UKZN)
Durban

Dear Professor Mtapuri,

Re: Use of HSRC South African Social Attitudes Survey (SASAS) data on attitudes towards the Fourth Industrial Revolution (4IR) for dissertation purposes

I have been approached by one of your doctoral candidates, Ms. Zama Mabel Mthombeni (student number: 210533654), about using secondary data collected in the 2018/19 round of the HSRC South African Social Attitudes Survey (SASAS) on the topic of attitudes towards the Fourth Industrial Revolution (4IR). This was an experimental module that was designed and fielded in order to provide initial nationally representative insight into the views of the South African public on different aspects of 4IR.

The working title of Zama's doctoral thesis is "The Fourth industrial revolution in the socio-economic context of South Africa: A quantitative study on citizen's attitudes". The SASAS 4IR data are being considered as the principle source for the analytical chapters of the thesis, and would be well-suited for the aims and objectives of the planned research.

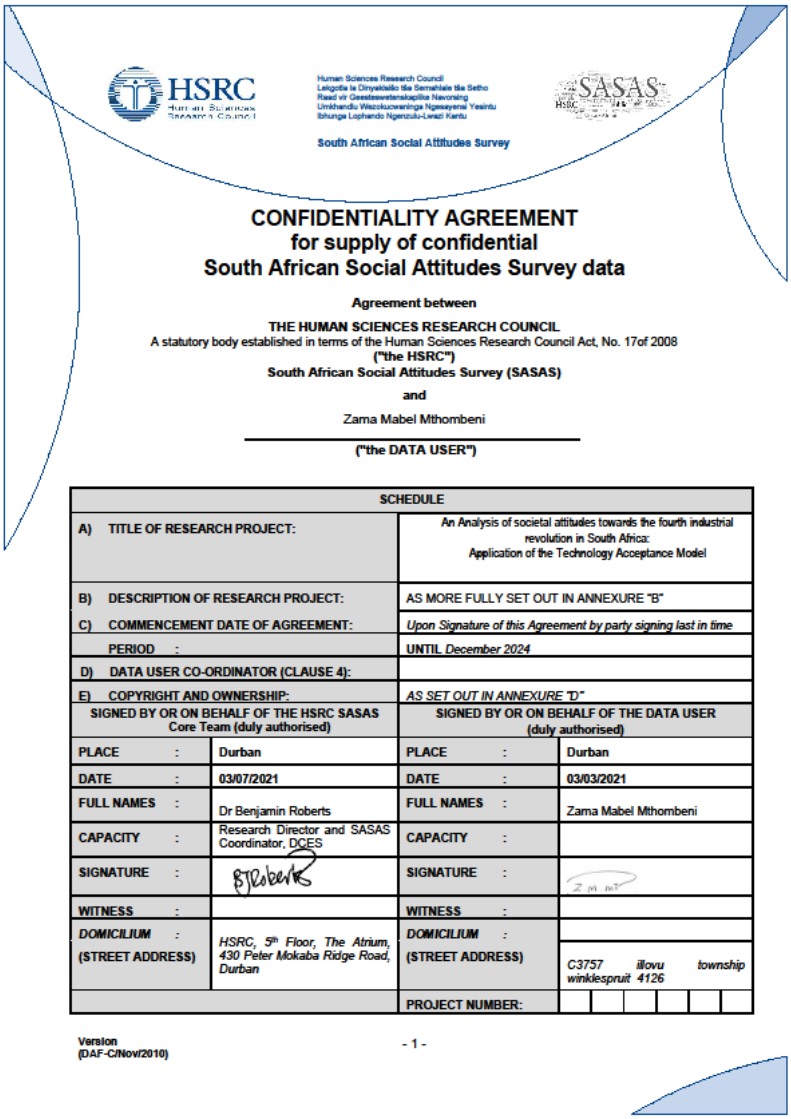
Although the data still remain embargoed at present, Ms. Mthombeni request has been considered and permission to use the data for her doctoral thesis has been granted, subject to the standard ethical guidelines governing secondary data usage.

I wish Zama, and you as her supervisor, everything of the best for the doctoral process.

Best regards,

Dr. Benjamin Roberts
Chief Research Specialist: Democracy, Governance & Service Delivery (DGSD), and
Coordinator: South African Social Attitudes Survey (SASAS)
Human Sciences Research Council (HSRC)
Tel: 031-242 5606; Cell: 0845230374
email: broberts@hsrc.ac.za

APPENDIX C: CONFIDENTIALITY AGREEMENT: HSRC & RESEARCHER



Human Sciences Research Council
Lekgotla la Dinyakisiso tša Semahlale tša Setho
Raad vir Geesteswetenskaplike Navorsing
Umkhandlu Wezokucwaninga Ngesayensi Yesintu
Ibhunga Lophando Ngenzulu-Lwazi Kantu

South African Social Attitudes Survey

CONFIDENTIALITY AGREEMENT
for supply of confidential
South African Social Attitudes Survey data

Agreement between

THE HUMAN SCIENCES RESEARCH COUNCIL
A statutory body established in terms of the Human Sciences Research Council Act, No. 17of 2008
("the HSRC")
South African Social Attitudes Survey (SASAS)

and

Zama Mabel Mthombeni

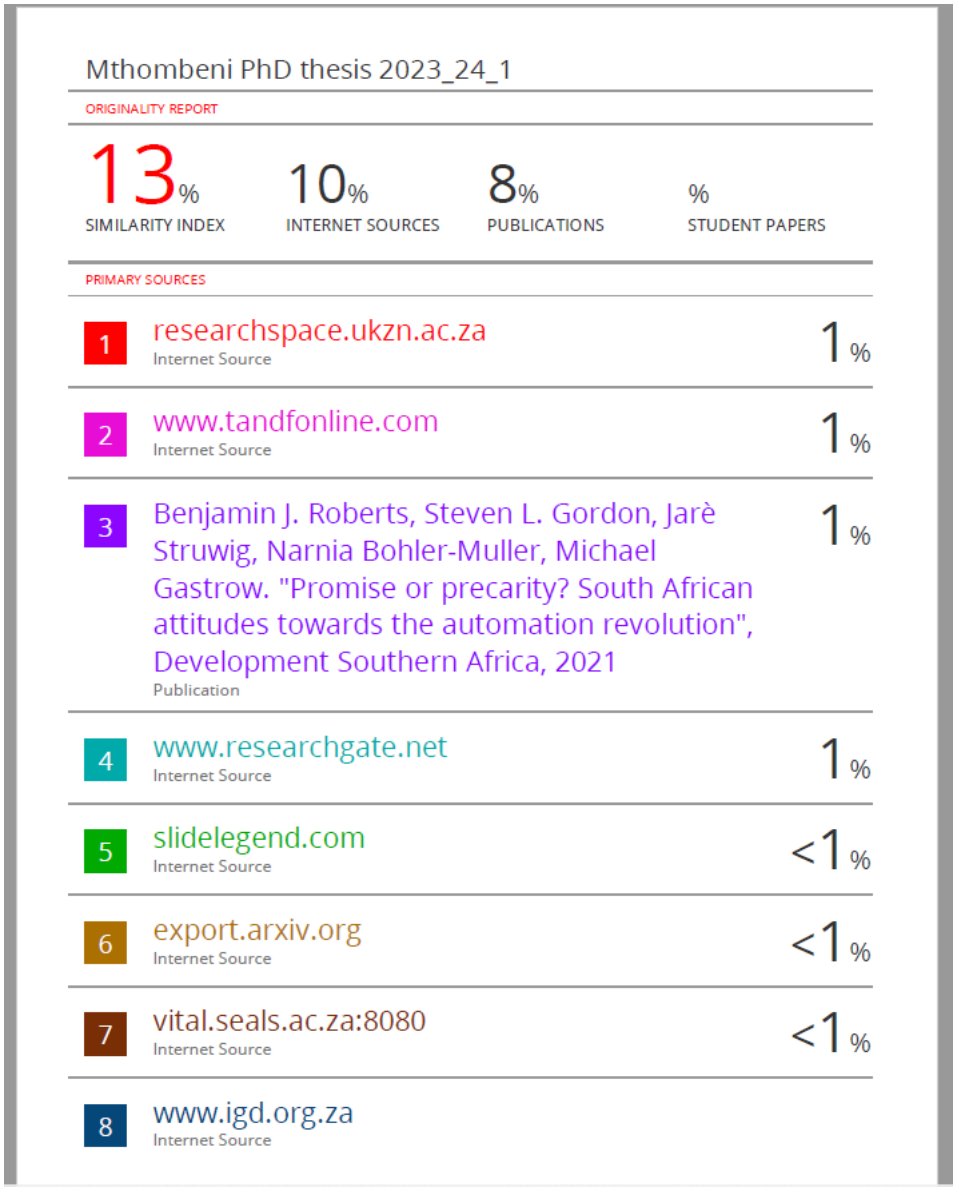
("the DATA USER")

SCHEDULE			
A) TITLE OF RESEARCH PROJECT:		An Analysis of societal attitudes towards the fourth industrial revolution in South Africa: Application of the Technology Acceptance Model	
B) DESCRIPTION OF RESEARCH PROJECT:		AS MORE FULLY SET OUT IN ANNEXURE "B"	
C) COMMENCEMENT DATE OF AGREEMENT:		*Upon Signature of this Agreement by party signing last in time*	
PERIOD :		UNTIL *December 2024*	
D) DATA USER CO-ORDINATOR (CLAUSE 4):			
E) COPYRIGHT AND OWNERSHIP:		*AS SET OUT IN ANNEXURE "D"*	
SIGNED BY OR ON BEHALF OF THE HSRC SASAS Core Team (duly authorised)		SIGNED BY OR ON BEHALF OF THE DATA USER (duly authorised)	
PLACE :	Durban	PLACE :	Durban
DATE :	03/07/2021	DATE :	03/03/2021
FULL NAMES :	Dr Benjamin Roberts	FULL NAMES :	Zama Mabel Mthombeni
CAPACITY :	Research Director and SASAS Coordinator, DCES	CAPACITY :	
SIGNATURE :	BRoberts	SIGNATURE :	ZMM
WITNESS :		WITNESS :	
DOMICILIUM : (STREET ADDRESS)	*HSRC, 5th Floor, The Atrium, 430 Peter Mokaba Ridge Road, Durban*	*DOMICILIUM* : (STREET ADDRESS)	*C3757 illovu township winklespruit 4126*
		PROJECT NUMBER:	

Version
(DAF-C/Nov/2010)

- 1 -

APPENDIX D: TURNITIN REPORT



Mthombeni PhD thesis 2023_24_1

ORIGINALITY REPORT

13%	10%	8%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	researchspace.ukzn.ac.za Internet Source	1%
2	www.tandfonline.com Internet Source	1%
3	Benjamin J. Roberts, Steven L. Gordon, Jarè Struwig, Narnia Bohler-Muller, Michael Gastrow. "Promise or precarity? South African attitudes towards the automation revolution", Development Southern Africa, 2021 Publication	1%
4	www.researchgate.net Internet Source	1%
5	slidelegend.com Internet Source	<1%
6	export.arxiv.org Internet Source	<1%
7	vital.seals.ac.za:8080 Internet Source	<1%
8	www.igd.org.za Internet Source	

APPENDIX E: SUBMITTED JOURNAL ARTICLE 1 IN PRESS

Gmail Zama Mthombeni <mthombeni.z@gmail.com>

Submission received for African Journal of Science, Technology, Innovation and Development (Submission ID: 236450010)

1 message

rpsupport@tandf.co.uk <rpsupport@tandf.co.uk> Thu, Jan 26, 2023 at 7:46 PM
To: mthombeni.z@gmail.com

Routledge
Taylor & Francis Group

Dear Zama Mthombeni,

Thank you for your submission.

Submission ID	**236450010**
Manuscript Title	**CITIZEN'S ATTITUDES ON THE FOURTH INDUSTRIAL REVOLUTION IN SOUTH AFRICA**
Journal	**African Journal of Science, Technology, Innovation and Development**

You can check the progress of your submission, and make any requested revisions, on the Author Portal.

Thank you for submitting your work to our journal.
If you have any queries, please get in touch with RAJS-peerreview@journals.tandf.co.uk.

Kind Regards,
African Journal of Science, Technology, Innovation and Development Editorial Office

APPENDIX F: SUBMITTED JOURNAL 2 IN PRESS

Gmail Zama Mthombeni <mthombeni.z@gmail.com>

Submission received for Behaviour & Information Technology (Submission ID: 237572823)
1 message

TBIT-peerreview@journals.tandf.co.uk <TBIT-peerreview@journals.tandf.co.uk> Sat, May 6, 2023 at 6:36 PM
To: mthombeni.z@gmail.com

Taylor & Francis
Taylor & Francis Group

Dear Zama Mthombeni,

Thank you for your submission.

Submission ID	**237572823**
Manuscript Title	**Exploring the Intersection of Social Class and Technological Change: A Study of South African Perceptions of Industry 4.0**
Journal	**Behaviour & Information Technology**

You can check the progress of your submission, and make any requested revisions, on the Author Portal.

Thank you for submitting your work to our journal.
If you have any queries, please get in touch with TBIT-peerreview@journals.tandf.co.uk.

Kind Regards,
Behaviour & Information Technology Editorial Office