



**A critical analysis of the implications of Industry 4.0
digital technologies on organisational adaptation in
a technology company.**

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15105

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2025

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ABSTRACT

Digital transformation and Industry 4.0 technologies are driving significant changes in how employees work and how organisations operate. These advancements bring opportunities for innovation, improved productivity, and workforce development, but they also pose challenges, such as job insecurity and the need for new skills. This study critically analysed the impact of Industry 4.0 technologies on workforce skills and organisational change, focusing on a South African technology company. Using the Technology Readiness and Acceptance Model (TRAM) as a guiding framework, the research explored employee readiness and acceptance of the 4.0 technologies, examining their perceptions, experiences, and adaptation strategies.

The study employs a qualitative approach using semi-structured interviews with employees across various organisational levels. Participants included frontline staff engaging with new technologies and senior management overseeing digital transformation strategies. This broad participant base ensured a comprehensive understanding of Industry 4.0's impact. The study also captured insights from employees with 17 to 30 years of industry experience, reflecting extensive sector-specific knowledge and leadership expertise. Findings reveal a dual impact of Industry 4.0 technologies: while employees recognise the benefits of automation and artificial intelligence in streamlining tasks and enabling innovation, they also express concerns about job displacement and the steep learning curve associated with these technologies. The TRAM framework provides a useful lens for interpreting these findings, particularly through dimensions such as Perceived Usefulness, Perceived Ease of Use, Optimism, and Insecurity. These dimensions highlight both the drivers and barriers to successful technology adoption.

The study offers practical recommendations for organisations to support employees during digital transformation. These include providing tailored training programs to address skill gaps, fostering transparent communication to build trust and reduce insecurity, and creating incentives to encourage innovation and engagement with new technologies. The research also emphasises the importance of collaborative work environments to simplify the adaptation process.

Beyond its immediate context, the study contributes to the broader understanding of Industry 4.0 by exploring how its strategies can be applied in other sectors and developing countries. It offers actionable insights for business leaders, policymakers, and educators, providing a roadmap for fostering workforce readiness and organisational success in an increasingly digital world.

Keywords: Industry 4.0, Digitalisation, Digital Transformation, Telecommunications, Technology Company

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LIST OF ACRONYMS

| | |
|---------------------|--|
| 5G | Fifth Generation |
| AI | Artificial Intelligence |
| CPS | Cyber-Physical Systems |
| CRM | Customer Management Relationship |
| GPS | Global positioning system |
| GSM | Global System for Mobile communication |
| IaaS | Infrastructure as a Service |
| ICASA | Independent Communications Authority of South Africa |
| ICT | Information and Communication Technologies |
| Industry 4.0 | Fourth Industrial Revolution |
| IoT | Internet of Things |
| IS | Information System |
| PaaS | Platform as a Service |
| PEU | Perceived Ease of Use |
| PU | Perceived Usefulness |
| RPA | Robotic and Process Automation |
| SaaS | Software as a Service |
| SMEs | Small and Medium-sized Enterprises |
| TAM | Technology Acceptance Model |
| TRAM | Technology Readiness and Acceptance Model |
| TRI | Technology Readiness Index |

CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1 Introduction and background

The digital transformation and adoption of Industry 4.0 technologies in technology companies have significant implications for organisational change, job profiles, and competencies (Cimini, Boffelli, Lagorio, Kalchschmidt & Pinto, 2020). These changes are underpinned by strategic organisational shifts including but not limited to a move from planning to discovery, scarcity to abundance, and hierarchy to partnership (Tronvoll, Sklyar, Sörhammar & Kowalkowski, 2020). However, successfully implementing these technologies requires a structured approach, such as a conceptual framework that is based on business process management (Butt, 2020). The rise of machine customers is transforming traditional consumer markets, thereby necessitating new Customer Management Relationship (CRM) strategies and business models catering to human and machine customers (Dotzel, Shankar & Berry, 2013). This aligns with the broader themes of Industry 4.0 which emphasise on automation and intelligent systems. Despite the surge in digital technologies, there remains a significant affinity for analogue tools. This balance between digital and analogue technologies can influence digital transformation strategies, thus offering a more nuanced approach to technology adoption (Hassan, Qamar, Hasan, Aman & Ahmed, 2020).

According to Kohnová and Salajová (2023), the impact of Industry 4.0 on companies is evident in the value chain model, which focuses on robotisation, automation, and technological development. Lee (2021) states that the evolutionary and disruptive potential of Industry 4.0 calls for further research on the reference models and workforce readiness. Renanita and Hidayat (2020) discuss the changing elements of work and the organisational life in the era of Industry 4.0, by emphasising the need for a deeper understanding of these changes. The Information and Communication Technologies (ICT) sector in South Africa has seen significant growth and transformation, where the use of ICT has been widely embraced, albeit with challenges such as technological expertise and funding (Shava, 2022).

A growing trend in the ICT industry is transforming telecommunications companies into technology companies. For the company to successfully transform, it must expand beyond the traditional telecom services such as the voice and data communications to offer a broad range of technology-based services (Tronvoll et al., 2020). The industry is undergoing a significant transformation driven by digitalisation and the adoption of new technologies. This shift is characterised by a move towards digital servitization which requires a strategic shift from planning to discovery, scarcity to abundance, and hierarchy to partnership (Tronvoll et al., 2020). The industry is also experiencing a move towards a more interactive, intelligent, self-organising, and interconnected planning paradigm (Potts, 2020). This transformation is further underscored by the emergence of new business models, essential digital economy features (Swamy, 2020), and the need for infrastructure sharing as well as colocation in the mobile telecoms industry (Amadasun, Short, Shankar-Priya & Crosbie, 2021). The sector is also witnessing the reconfiguration of traditional industries and the emergence of new organisational forms and business models (Acciarini, Borelli, Capo, Cappa & Sarrocco, 2021).

In response to the economic challenges posed by the COVID-19 pandemic, the Independent Communications Authority of South Africa (ICASA) adapted by issuing temporary High-demand Spectrum (HDS) and International Mobile Telecommunications (IMT) licenses. These measures aimed to improve network efficiency and make services more affordable, by showcasing ICASA's commitment to maintaining resilient and accessible telecommunications services (ICASA, 2022).

The global shift towards Industry 4.0 technologies, including Artificial Intelligence (AI), Internet of Things (IoT), cloud computing, and big data analytics, disrupt traditional business models and operational workflows. In South Africa, this transformation is particularly significant for the telecommunications and broader ICT sectors, which are increasingly expected to lead the digital economy. According to the Independent Communications Authority of South Africa (ICASA, 2022), the mobile telecommunications market grew from R78 billion in 2015 to R114 billion in 2021, reflecting an increased reliance on digital connectivity and digital services. However, this rapid growth has not been matched by workforce readiness or organisational change strategies, leaving a widening gap between technological capability and

human capacity. This mismatch underscores a critical need for technology companies to adopt emerging technologies and simultaneously adapt organisational systems and workforce competencies to remain competitive.

The World Economic Forum (2020) estimates that by 2025, 50% of all employees globally will need reskilling, and this trend is already evident in technology-intensive industries. In South Africa, the urgency is further compounded by structural unemployment, technological inequality, and skills mismatches in the labour market. Therefore, a deeper understanding of how technology organisations adapt internally — in terms of operations, culture, and skills — is not only timely but necessary for long-term sustainability and inclusion in the fourth industrial revolution.

This study provides a practical and theoretical contribution by highlighting how a South African technology company can navigate digital transformation in a way that balances technological investment with workforce development and organisational readiness. The findings can inform both internal strategy and national policy in advancing digital capability across sectors.

Table 1-1: Research justification

| Business Case Component | Justification |
|--------------------------------|--|
| Sectoral Relevance | SA ICT sector grew 46% between 2015–2021 (ICASA, 2022) |
| Workforce Risk | 50% of jobs to change by 2025 (WEF, 2020) |
| National Relevance | High digital inequality and skills mismatch in SA |
| Research Gap | Limited qualitative studies on <i>internal</i> adaptation strategies in African tech companies |

Source: own elaboration

The telecom companies are uniquely positioned to become technology companies with their existing infrastructure and network management expertise. A telecom company can leverage its existing assets and capabilities to expand into new areas such as the Internet of Things (IoT), cloud computing, and cybersecurity. The telecom companies must invest in new technologies and talent, develop partnerships with related technology companies, and adopt new business models to achieve this

transformation. As a result, new internal teams may be formed, technology start-ups may be acquired, or existing technology companies may be partnered with (Caylar & Ménard, 2016).

The fourth industrial revolution is reshaping how people live and work. This revolution and the underlying digital transformation are changing the business world. A total of three revolutions precedes the fourth industrial revolution. The first revolution took place at the end of the 18th century with the invention of the steam engine. The second industrial revolution started in the early 20th century and introduced mass production in assembly lines using electrical energy. The third industrial revolution emerged at the end of the 20th century, and it was characterised by the automation of processes through information technology and biotechnology, with the invention of the integrated circuit.

Industry 4.0 was introduced in 2011 in Germany to take a pioneering role in industries by utilising technologies such as Cyber-Physical Systems (CPS), the Internet of Things (IoT) and cloud computing (Sony & Naik, 2020). Cyber-physical systems are automated technology enabling the interconnected systems to communicate by integrating physical reality with computing. The IoT is a global infrastructure that connects physical and virtual things to the internet. Cloud computing delivers the remote computational services that are stored in an external environment through the internet (Li, 2023). A deeper understanding of these industrial shifts can be gained by referring to Table 1-1, which illustrates the progression of industrial revolutions. The table outlines the key transformations that have occurred, starting from mechanical production in the First Industrial Revolution to the integration of artificial intelligence in the Fourth Industrial Revolution. This historical perspective provides a framework for understanding the technological advancements driving digital transformation today.

Table 1-2: Stage of Revolutions

| Revolution | Period | Characteristics | Inventions |
|-----------------------------|---------------------|---------------------------------------|-------------------|
| First Industrial Revolution | End of 18th century | Introduction of mechanical production | Steam engine |

| | | | |
|------------------------------|---------------------|---|-------------------------|
| Second Industrial Revolution | Early 20th century | Mass production in assembly lines using electrical energy | Electricity |
| Third Industrial Revolution | End of 20th century | Automation of processes through information technology and biotechnology | Integrated circuit |
| Fourth Industrial Revolution | Present | Reshaping how people live and work, digital transformation, changing the business world | Artificial intelligence |

Source: own elaboration

Industry 4.0 is helping most organisations to improve their production process by integrating intelligence and automation in their industries (Yüksel, 2020). Yüksel (2020) and Kadir, Broberg and da Conceicao (2019) posit that Industry 4.0 is changing how organisations work and the skills required to perform specific jobs. According to Yüksel (2020), the organisations are digitally transforming their businesses with an adaptation of Industry 4.0 technologies to remain competitive. Yüksel (2020) and Kadir et al. (2019) highlight that Industry 4.0 comprises of nine fundamental technologies, that is, the IoT, cloud computing, big data and analytics, robotics, simulation, vertical and horizontal integration, additive manufacturing, cybersecurity and augmented reality. Yüksel (2020) believes that the success in adopting Industry 4.0 depends on the new technologies and the organisational and managerial practices. Yüksel (2020) as well as Turkyilmaz, Dikhanbayeva, Suleiman, Shaikholla and Shehab (2021) recommend that organisational strategy should determine if the organisation is ready for Industry 4.0. Yüksel (2020) discusses that competent employees are critical to the success of Industry 4.0 transformation and that the employees should perceive that the top management is supporting the transformation. The top management must demonstrate that it is a priority for the organisation.

Yüksel (2020) has indicated that organisations in developed and in developing countries such as Germany, America, the United Kingdom (UK), China and Turkey use various Industry 4.0 technologies at varying degrees. Chauhan, Singh, & Luthra (2021) stress that digital transformation started later in the developing countries compared to the developed countries, and both have varying challenges in adopting Industry 4.0. Turkyilmaz et al. (2021) highlight that the digital transformation challenges in the developed countries focus on marketing while the developing countries need an adequate skilled workforce.

1.2 Preliminary Literature Review

According to Yüksel (2020), Industry 4.0 presents many opportunities to organisations by improving production processes and increasing efficiency and flexibility while reducing costs. It has presented unique challenges in the business environment, which has become unpredictable, and organisations require new approaches to protect their competitive advantage (Yüksel, 2020). The technology readiness and acceptance model guided the study and this research. Industry 4.0 technologies are disruptive, and they challenge the status quo. The technology organisations are adopting new technologies to remain competitive in the market. Technology is enabling the organisations to offer innovative products and services to the customers.

1.2.1 Cloud Computing

The emergence of cloud computing and the digital transformation initiative have impacted how the organisations engage with their customers, as well as how they run their business operations and it has also altered their product and service offerings (Stein, Campitelli & Mezzio, 2020).

Lanz (2021) posits that cloud computing has three service models: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). The SaaS is expected to be the cloud model of choice in the market due to its benefits to the organisations. The IaaS and the PaaS will drive the next cloud computing chapter (Lanz, 2021). Many organisations are moving their technology operations to gain cloud benefits such as scalability, flexibility, and affordability. However, the cloud has shortcomings such as security, privacy, and control (Stein, et al., 2020).

1.2.2 Internet of Things

According to Cong, Li and Zhang (2021), the IoT is interconnected physical devices that are connected through the internet. These items collect and exchange data without being connected physically. Various industries have significantly progressed in transforming their businesses to IoT technology. The emergence of IoT has a central role in transforming the telecommunication industry (Mihardjo, Djoemadi & Rukmana, 2020).

Despite the apparent successes, the individuals tasked with managing the IoT projects in the organisations still face challenges and limiting factors. These include but are not limited to regulatory and legal issues, security challenges, internal expertise, interoperability, and privacy (Prasher & Onu, 2020).

Mihardjo et al. (2020) add that significant employee skills are required to implement the IoT technology successfully. Hence, the employees must possess innovative capabilities that will equip them with organisational internal and external knowledge.

1.2.3 Artificial Intelligence

The AI's rapid advancements have far-reaching implications for various sectors. The AI technologies surpass human capabilities in diagnostics and automation, thus highlighting opportunities and ethical challenges (Kissinger, Schmidt, & Huttenlocher, 2021). According to Puntoni, Reczek, Giesler, & Botti (2021), AI is changing how the consumers work, play, eat and sleep. Given the rising ubiquity of artificial intelligence, the marketing and advertising teams in the telecommunication industry have made inroads in creating valued customer experiences. Liengpunsakul (2021) defines AI as a system or a machine that can make intelligent decisions through sensing, learning, acting and comprehending, utilising machine learning as a core technology.

Liengpunsakul (2021) discusses the challenges and the risks that are associated with implementing AI applications, stating that a simple AI implementation can present difficulties. Implementing even the most straightforward AI task requires employees to acquire suitable skills.

1.2.4 Big Data

According to Costa, Moreira, Pintor, dos Santos, and Lifschitz (2021), big data analytics is regarded as an emerging disruptive technological development in business that transforms large amounts of data collected from various devices such as mobile phones, social networks, sensors, global positioning system (GPS) devices, and IoT devices. Kusi-Sarpong, Orji, Gupta and Kunc (2021) highlight the significance of big data decision-making by organisations to improve performance and increase competitive advantage in this digital "age of data".

1.2.5 Robotic and Process Automation

According to Ribeiro, Lima, Eckhardt and Paiva (2021), the Robotic and Process Automation (RPA) is utilised to automate routine, structured, rules-based, and repetitive jobs to reduce human or manual intervention. The authors further posit that RPA is achieved by employing software bots that function as digital workers to perform tasks that are meant for humans. These bots can perform tasks for approximately 24 hours; and another bot is added if there is an additional workload.

1.2.6 Digital Transformation

Technological revolutions have often led to increased economic inequality and societal disruptions. The lessons from these past events are crucial in understanding the current and the future impacts of Industry 4.0 (Frey, 2019). The potential risks of AI include but are not limited to enabling cyberattacks and automated warfare, thus underscoring the need for balanced strategies that harness technological benefits while mitigating dangers (Suleyman, 2023). Telecommunication industry organisations are expanding their services portfolios by offering new digital services and accessing new markets.

1.2.7 Impact on Jobs

Industry 4.0 is transforming the telecommunications industry into a more competitive environment in various ways, including job complexity and skills requirements. Skillset and workforce digital capability are the core to a successful digital transformation and an adoption of Industry 4.0. According to Maisiri and van Dyk (2021), the changes in the job requirements due to increased workplace complexity threaten manual and repetitive jobs being replaced by automation.

1.3 Research Problem

Several scholarly and research studies focus on organisations adopting advanced digital technologies in preparation for the rise of Industry 4.0. Mukwawaya, Emwanu & Mdakane (2018) highlight that Industry 4.0 has a significant social and economic impact and it will disrupt and challenge the status quo in the South African economy. Industry 4.0 will redefine the workplace and the skills required to handle tasks, thereby resulting in human labour and repetitive jobs being replaced by automation (Mukwawaya, et al., 2018). Navigating the "narrow path" between technological benefits and risks is a critical challenge. The research in line with Suleyman (2023)'s views, explores how organisations can balance innovation with ethical considerations and regulatory frameworks to avoid potential societal disruptions (Suleyman, 2023).

According to Maisiri and van Dyk (2021), skills availability is among the factors influencing organisations to adopt Industry 4.0 successfully. Industry 4.0 is set to increase the requirement of new skills in companies such as technology organisations, and the increase in skills requirement results from a surge in job complexity in the workplace (Maisiri & van Dyk, 2021). A study is required to critically analyse which Industry 4.0 technologies are being implemented in the technology organisations and the implications for employment.

1.4 Purpose and objectives of the study

The purpose of this study is to critically analyse the implications of Industry 4.0 digital technologies on organisational adaptation within a South African technology company. It focuses on how these technologies influence operational processes, organisational culture, and workforce capabilities during digital transformation. The study sought to unearth how digital transformation influences the employees' skill requirements, thus acknowledging that the success of Industry 4.0 hinges not only on technological advancements but significantly on the human elements that navigate these changes.

1.4.1 Research objectives:

- To explore how Industry 4.0 digital technologies have influenced organizational adaptation in a South African technology company.
- To examine how these technologies have transformed operational processes and organizational structures.

- To investigate how organizational culture and workforce capabilities have evolved in response to Industry 4.0 technologies.
- To identify strategies used by the organization to enable effective adaptation and address workforce readiness.

1.5 Research Questions

The study answered the following main research questions:

What are the implications of Industry 4.0 digital technologies on workforce skills and organisational adaptation within a technology company?

The following research questions were used to support the main research question:

- How have Industry 4.0 digital technologies influenced organizational adaptation in a technology company?
- How have these technologies impacted operational processes and workforce roles?
- How is the organizational culture evolving in response to digital technology adoption?
- What strategies are being used to support workforce adaptation and reskilling in Industry 4.0?

1.6 Scope and delimitation of the study

This study was expressly concerned with the implications of Industry 4.0 within a selected technology company in South Africa. It delved into the company's workforce's experiences, perceptions, and reactions as they interface with the transformative elements of these advanced technologies. This research focused on discerning the intricate dynamics of digital transformation, including the shifts in job roles, necessary skill development, and the adaptation of organisational culture as well as structure.

1.6.1 Scope of the Study

The exploration was confined to:

- The qualitative impacts of the Industry 4.0 technologies on human labor within the selected organization.
- Understanding the Industry 4.0's role in altering job profiles, skill requirements, and the nature of work.

- The assessment of employee sentiments towards integrating these technologies into their work environment.
- The adopted strategies and approaches by the organization to facilitate the transition to Industry 4.0.

1.6.2 Delimitation of the Study

In terms of the delimitations, the study:

- Was limited to a single technology company to provide a detailed case study within the South African context.
- Excluded the quantitative assessments of Industry 4.0's impact, such as the productivity metrics or the economic performance indicators.
- Did not cover the external stakeholders' perspectives, such as the customers, suppliers, or the industry competitors.
- Did not extend to comparing the effects of Industry 4.0 across multiple organizations or industries.
- Included only the employees in a technology organization in Gauteng, South Africa.
- Was restricted to the employees who utilize Industry 4.0 technologies.
- Included senior managers, middle and lower managers, as well as the frontline employees.

This study also set temporal and thematic boundaries, concentrating on the current state of Industry 4.0 adoption without speculating on future developments or providing a historical comparative analysis.

By clearly delineating its scope and limitations, the study examined Industry 4.0 within a specific organisational context. This approach ensured depth and specificity in understanding the phenomenon while acknowledging the research's constraints. The findings were intended to offer insights into the organisational and human aspects of the digital transformation journey, thus contributing to both scholarly discourse and practical applications in the field.

1.7 Significance of the Study

This study's significance is multifaceted, offering substantial contributions to both theoretical knowledge and the practical applications within the realm of digital transformation and Industry 4.0. By investigating the nuances of Industry 4.0's impact within a South African technology company, this research holds implications for various stakeholders, from business leaders and policymakers to employees and academic researchers.

Academic Contributions: From an academic perspective, this study enriches the current literature on Industry 4.0 by:

- Providing empirical data on the adoption and integration of Industry 4.0 technologies in the workplace;
- Contributing qualitative insights into the human aspects of digital transformation, an area which is less explored compared to the quantitative impacts;
- Enhancing an understanding of the interplay between technology and organisational culture within the context of a developing country's technology sector.

Organisational Impact: For the organisation under study and similar entities, the research:

- Offers a deep dive into employee perspectives, potentially informing strategies for technology integration and change management.
- Identifies skill gaps and training needs, thus supporting human resource development aligned with technological advancements.
- Illuminates potential pathways for leadership to foster a resilient, adaptive workforce that is ready to embrace Industry 4.0.

Policy Implications: Policymakers can leverage the study's findings to:

- Understand the challenges and opportunities presented by Industry 4.0, particularly in the South African context.
- Develop frameworks that support organisations and employees through the transition to increasingly digitised work environments.

- Shape educational and economic policies to prepare current and future workforces for the demands of Industry 4.0.

Social Relevance: On a broader societal level, the significance of this study lies in its potential to:

- Provide insights into the societal implications of Industry 4.0, particularly concerning employment and the nature of work.
- Inform discussions on the ethical considerations of implementing advanced technologies in the workplace.
- Contribute to the discourse on ensuring equitable and inclusive access to the benefits of Industry 4.0 technologies.

This study is a pivotal inquiry into the tangible and intangible shifts precipitated by Industry 4.0 in the South African technology sector. Its significance extends beyond academic enrichment, thus resonating with the digital era's strategic, policy, and societal dimensions. The research findings aim to offer actionable insights, by fostering a comprehensive understanding of Industry 4.0 that benefits stakeholders across various sectors and communities.

1.8 Theoretical/Conceptual Frameworks

The Technology Readiness and Acceptance Model (TRAM) guided the study and this research. Larasati and Santosa (2017) define the TRAM as a conceptual model that combines the Technology Readiness Index (TRI) that is the common personality elements with the Technology Acceptance Model (TAM) specific element system.

Technology changes are unpredictable, with customers having high expectations of how the latest technology can enhance their experience. The telecommunications industry being customer-driven, must keep pace with Industry 4.0 technologies to meet customer expectations (Ribeiro, et al., 2021). Ribeiro et al. (2021) stipulate that although the Industry 4.0 technologies are adopted to serve customers, they are internally beneficial to the employees in the telecommunication organisation. The employees must perform extensive daily operations utilising new innovative technologies, and quality service is expected (Ribeiro, et al., 2021).

To ensure that the telecommunication industry provides excellent and personalised customer service, it is essential to examine whether its employees are adequately technology-ready and accept Industry 4.0 technologies (Ribeiro, et al., 2021).

1.8.1 Technology Acceptance Model (TAM)

Davis (1989) posits that the technology acceptance model is an Information System (IS) theory that uses two dimensions, Perceived Usefulness (PU) and Perceived Ease of Use (PEU) to determine the employees' attitudes toward using Industry 4.0 technologies. The TAM is widely accepted for examining consumer behaviour, with a few studies focusing on employee perspectives. A study is required to examine how the employees perceive the usefulness and ease of use of the adopted Industry 4.0 technologies (Ribeiro, et al., 2021).

1.8.2 Technology Readiness Index

Walczuch, Lemmink & Streukens (2007) define the technology readiness index as a multifaceted framework that categorises users into four groups that differentiate them by their personality traits: Optimism, innovativeness, discomfort, and insecurity. The four groups are split into two factors: motivators of new technology use and inhibitors.

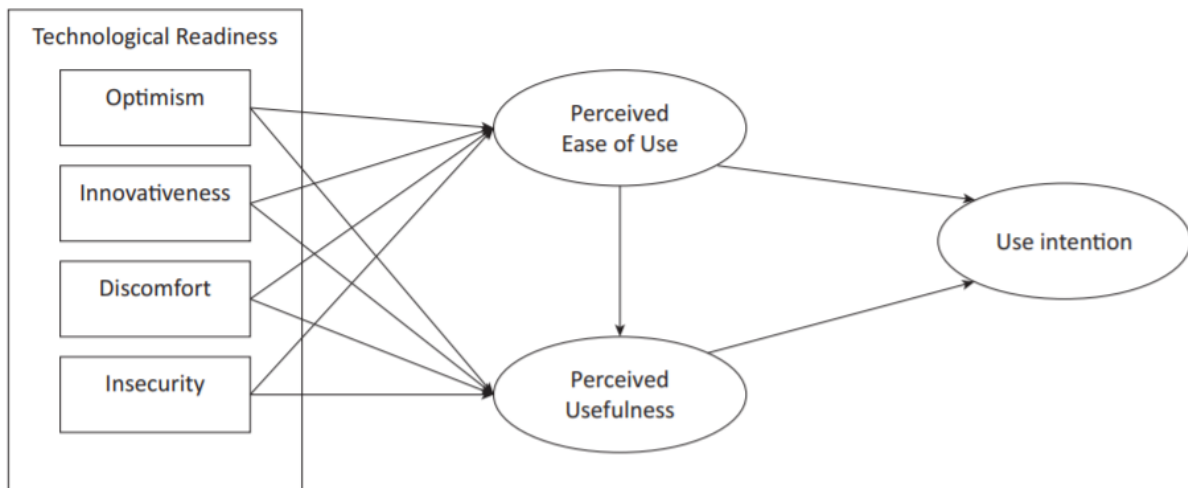
The TRI defines four types of personalities:

- Optimism – Positive view about technology and perception in increased control, efficiency and flexibility;
- Innovativeness – A tendency to be the first in utilizing new technology;
- Discomfort – Being overwhelmed and the need to have control;
- Insecurity – Skepticism about technology for security reasons.

1.8.3 Technology Readiness and Acceptance Model (TRAM)

In this study, the Technology Readiness and Acceptance Model (TRAM) was employed as a theoretical framework to guide the interpretation of findings, rather than as a predictive model to be tested statistically. TRAM offered a structured lens through which employee attitudes, readiness levels, and behavioural responses to Industry 4.0 technologies could be analysed. The framework enabled the researcher to map qualitative themes to four key TRAM dimensions: Perceived Usefulness (PU), Perceived Ease of Use (PEU), Optimism, and Insecurity. The integration of historical perspectives on technology adoption, as seen in "the technology trap," provides a

deeper understanding of how past technological advancements can inform current Industry 4.0 adoption strategies (Frey, 2019). Understanding AI's societal impact is crucial for refining the conceptual framework, particularly in assessing the readiness and acceptance of AI-driven processes (Kissinger, et al., 2021). The TRAM was formulated as a research model based on the technology acceptance model and the technology readiness index theories.



Source: Larasati and Santosa (2017)

Figure 1.1: Theoretical Model Based on Technology Readiness and Acceptable Model

Table 1-3: Summary of Frameworks or Theories

| Framework/Theory | Definition | Dimensions/Groups |
|--|---|--|
| Technology Readiness and Acceptance Model (TRAM) | A conceptual model that combines the Technology Readiness Index (TRI) common personality elements and the Technology Acceptance Model (TAM) specific element system (Larasati & Santosa, 2017). | Technology Readiness Index (TRI) and Technology Acceptance Model (TAM) |
| Technology Acceptance Model (TAM) | An Information System (IS) theory uses two dimensions, Perceived Usefulness (PU) and Perceived Ease of Use (PEU) to determine the employees' attitudes toward | Perceived Usefulness (PU) and Perceived Ease of Use (PEU) |

| | | |
|----------------------------------|--|--|
| | using Industry 4.0 technologies (Davis, 1989). | |
| Technology Readiness Index (TRI) | A multifaceted framework categorises users into four groups that differentiate them by their personality traits: Optimism, innovativeness, discomfort, and insecurity (Walczuch et al., 2007). | Optimism, innovativeness, discomfort, and insecurity |

Source: Own elaboration

1.9 Research Philosophy

A research philosophy refers to a system of beliefs and assumptions about the development of knowledge that guides research. The research process has three significant dimensions: Ontology, epistemology, and axiology.

1.9.1 Research Paradigm

A research paradigm is a research culture that has a set of beliefs, values, and assumptions. It is an approach to thinking that guides the research community (Antwi & Hamza, 2015). Al-Ababneh (2020) outlines the different research paradigms as interpretivism, positivism, realism, or pragmatism. Positivism assumes that reality is objectively given, while realism assumes that reality is independent of the mind (Al-Ababneh, 2020). In this study, an interpretivism paradigm was chosen and applied. Interpretivism believes that the research participants and the researchers construct reality and focus on subjectivity to develop knowledge (Al-Ababneh, 2020; Creswell & Creswell, 2017).

- **Ontology perspective:** According to Antwi and Hamza (2015), ontology is the study of the nature of reality. It reflects an individual's belief. By taking the subjective ontology approach, the researcher aimed to uncover the implications of digitalization and the adoption of Industry 4.0 technologies. The researcher's subjective approach implies that reality is made from the perceptions and the consequent actions of the people (Sławecki, 2018).
- **Epistemology perspective:** Epistemology is the relationship between the researcher and reality. The study seeks to understand how people know what they know, that is the relationship of the researcher and what is known (Antwi

& Hamza, 2015). As an interpretivist, the researcher performed face-to-face interviews with the participants to gain insight into the research problem.

- **Axiology perspective:** Axiology studies the nature of value and ethics within the research and how good researchers are (Aliyu, Singhry, Adamu, & AbuBakar, 2015). The researcher adheres to values, assumptions, and the ethical guidelines that dictate how they approach the study (Raqib, 2019). Thus, axiology also involves analyzing the purpose of the research. Research is conducted to create new knowledge or to provide insight into a particular phenomenon (Raqib, 2019).

The study's interpretivism philosophy shaped a path for understanding the subjective realities of Industry 4.0's impact, by acknowledging the co-creation of knowledge between the researcher and the participants. Ontologically, it views reality as a construct of human perceptions and actions. The epistemological stance facilitates this view through direct engagement with the participants. At the same time, the axiological considerations ensure that the research is conducted with ethical rigour, thereby valuing the insights gained as contributions to knowledge and practice.

1.9.2 Research Methodology

The study adopted a qualitative methodology with an interpretivist epistemology, by focusing on understanding the subjective experiences of the individuals in the technology organisation. This approach was justified by the need to capture the complex and dynamic nature of technological change and the subjective experiences of the employees adapting to the Industry 4.0 technologies (Suleyman, 2023). Creswell and Creswell (2017) mention that research can be done using either qualitative or quantitative methods. The qualitative researchers focus on the socially formed nature based on the truth, while quantitative research emphasises gathering statistics and simplifying them across a collection of individuals. The study was based on the qualitative method that utilises non-numerical methods to interpret and manipulate results. The objective of using qualitative methodology was to employ face-to-face interviews to collect data from the participants. The qualitative research method also allows the researcher to be a data collection instrument (Creswell & Creswell, 2017).

1.10 Conclusion

This introductory chapter exploring the implications of Industry 4.0 adoption within a South African technology company has laid the groundwork for a comprehensive study that delves into the complexities and nuances of digital transformation in the contemporary workplace. The introductory chapter has set the stage, by outlining the study's rationale, objectives, and the significance of understanding the multifaceted impact of Industry 4.0's technologies on organisational structures, cultural dynamics, and workforce skills.

The subsequent chapters of this research are structured to build upon this foundation, thus offering a detailed examination of the theoretical frameworks, methodological approaches, empirical findings, and the broader implications of the research.

Chapter 2: The literature review delves into the existing body of research surrounding Industry 4.0, digital transformation, and its implications for the organisations and employees. This chapter aims to contextualise the study within the broader academic discourse, by identifying the gaps in the literature that this research seeks to address.

Chapter 3: The research methodology articulates the study's methodological framework, by detailing the qualitative research design, the data collection methods, and the employed analytical strategies. Grounded in constructivist and interpretivist paradigms, this chapter explains how the research approach facilitates a deep, nuanced understanding of the adoption and integration of Industry 4.0 technologies.

Chapter 4: Results and analysis. This chapter presents the empirical data that was gathered through semi-structured interviews, document analysis, and observations. This chapter offers rich, descriptive insights into the experiences, perceptions, and challenges that are encountered by individuals and organisations during the transition to Industry 4.0.

Chapter 5: Discussion. This chapter interprets the study's findings, linking them to the theoretical frameworks and the literature reviewed in Chapter 2. It also explores the research implications, by examining how the findings contribute to the

understanding of digital transformation and its impact on organisational practices and employee roles.

Chapter 6: Conclusion and Recommendations. This chapter summarises the critical insights derived from the study, by reflecting on the research objectives and the questions. This chapter also discusses the study's limitations, proposes areas for future research, and offers practical recommendations for the organisations navigating the complexities of Industry 4.0 adoption.

Through this structured exploration, the research aimed to contribute valuable perspectives to the ongoing discourse on technological transformation, by offering implications for theory, practice, and policy in the context of Industry 4.0 and the future of work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Industry 4.0 has brought significant technological advancements that are changing how businesses operate worldwide. Digital transformation, which involves using technologies like artificial intelligence (AI), the Internet of Things (IoT), cloud computing, and big data analytics, is reshaping industries, workforce skills, and customer interactions. This chapter reviews existing research on digitalisation in technology companies, with a focus on the telecommunications sector and its response to Industry 4.0. First, the chapter provides an overview of the telecommunications industry, examining its development, regulatory policies, and technological progress. Then, it explores how digitalisation is changing technology companies, discussing key opportunities, challenges, and the need for workforce readiness. The chapter also explains the Fourth Industrial Revolution (Industry 4.0) and how its technological changes are affecting businesses and economies. Additionally, it examines how Industry 4.0 influences workforce skills, business strategies, and leadership roles. By reviewing existing studies, this chapter helps to understand how companies manage digital transformation and prepare for future challenges. It also sets the foundation for later chapters, which will present research findings, strategic recommendations, and practical applications for the industry.

2.2 Overview of the telecommunications industry/sector

The telecommunications industry serving as the backbone of modern digital societies, has witnessed transformative changes, particularly pronounced in dynamic markets such as South Africa. The evolution of this sector characterised by rapid technological advancements and regulatory changes, reflects broader global trends while addressing unique regional challenges. The proliferation of AI and automation technologies has significantly impacted the telecommunications industry, by driving efficiencies and new service models while presenting challenges such as job displacement and the need for new skill sets (Kissinger et al., 2021; Frey, 2019). This overview delves into the sector's evolution, technological strides, regulatory environment, consumer trends, and prospects, while focusing on South Africa's unique position within this global narrative.

The telecommunications landscape in South Africa has mirrored global trends while presenting unique developmental milestones. South Africa's journey reflects a blend of innovation and adaptation from the early adoption of telegraphy and telephony to the widespread use of mobile communications that bypassed traditional landlines. The post-apartheid era marked a significant shift with liberalisation policies that spurred competition and growth within the sector, thereby setting the stage for rapid technological advancement and increased accessibility (ICASA, 2020).

Technological advancements have been pivotal in shaping the telecommunications sector, with South Africa making notable leaps, especially in mobile technology. The country's early embrace of the Global System for Mobile communication (GSM) technology catalysed a mobile revolution, thus positioning it as a leader in mobile adoption in Africa. The transition to 3G and later to 4G networks facilitated a surge in mobile data usage, a trend that continues to grow with the ongoing rollout of the 5G networks (Miao, 2022). South Africa's approach to harnessing satellite technology for rural connectivity further exemplifies its innovative strategies to bridge the digital divides (Tronvoll, et al., 2020).

South Africa's regulatory landscape has evolved to support the sector's growth while ensuring fair competition and consumer protection. The Independent Communications Authority of South Africa (ICASA) has been instrumental in overseeing policy implementation and spectrum management. Recent regulatory shifts focusing on data costs and consumer rights highlight the government's commitment to making telecommunications services more accessible and affordable to the broader population (ICASA, 2020).

The South African consumers have increasingly demanded high-speed, reliable, and affordable telecommunications services, driven by the global shift towards digital lifestyles. The market has responded with diverse services, from traditional voice and data offerings to innovative digital solutions encompassing streaming, the IoT, and fintech services. The competitive landscape characterised by a few dominant players and several dynamic smaller operators, reflects a vibrant and evolving sector that is responsive to consumer needs and global trends (Cong, et al., 2021).

The future of South Africa's telecommunications sector is intrinsically linked to the broader digital transformation agenda. With the advent of 5G and beyond, the industry plays a crucial role in enabling smart cities, e-government services, and digital economies (Sima, Gheorghe, Subić, & Nancu, 2020). Challenges such as infrastructure development, spectrum allocation, and digital literacy remain, but the commitment to overcoming these hurdles is evident in the national policies and industry initiatives (Frey, 2019).

While influenced by the global trends, the telecommunications industry in South Africa has charted a unique path characterised by rapid technological adoption, strategic regulatory interventions, and a market responsive to evolving consumer demands. As the sector stands on the cusp of the 5G era and deeper digital integration, its role in shaping South Africa's digital future remains pivotal, promising innovation, economic growth, and societal transformation opportunities (Ciarli, Kenney, Massini, & Piscitello, 2021).

2.3 Digitisation in the Technology organisation/company

Most leaders need to prepare for automation and digitisation in operationally intensive sectors. Nearly two-thirds of the executives at large organisations, as surveyed by McKinsey in (2017) cited skills as one of the top ten issues. Most respondents believed that their companies needed to prepare for the expected skills gaps in the next five years. In the survey, the executives cited three main barriers for their organisations needing more time to tackle the skills issue. Most respondents were required to understand how future automation and digitisation would affect skill requirements. Most employers need more data and tools to quantify the value of reskilling their workforce. Nearly one-third of the employers said a new strategy designed to address emerging skill gaps would only be possible using their current Human Resource (HR) infrastructure. These problems persist throughout industries, according to the latest survey data (Kweilin, Rahul & Julian 2020). The shift towards digitisation involves technology and transforming customer relationships, with machines increasingly taking on custom roles. This necessitates re-evaluating organisational strategies to integrate these new dynamics (Dotzel, et al., 2013).

2.4 Fourth Industrial Revolution

In a world where technology increasingly intersects with all aspects of business and society, understanding the distinct roles of digital innovations becomes crucial. This section delves into the core components of digitalisation such as cloud computing, the IoT, AI, big data, Robotics Process Automation (RPA), and the broader theme of digital transformation. Despite the digital advancements of Industry 4.0, there remains a significant place for analogue technologies. The balance between digital and analogue can be crucial in shaping the future of industrial processes and customer interactions (Hassan, et al., 2020). Each plays a pivotal role in driving the modern economy and reshaping the fabric of people's daily lives. As these elements are explored, the aim is to delineate their functions and collective impact, thus setting the stage for comprehensively examining their integration and influence within the organisational and societal context (Ciarli, et al., 2021).

2.4.1 Cloud Computing

Cloud computing has emerged as a foundational technology in digitisation, serving as a catalyst for innovation and efficiency in various industries. It allows organisations to store, manage, and process data on remote servers, thereby offering scalability and flexibility that were previously unattainable. The agility afforded by cloud computing has enabled businesses to pivot rapidly in response to market demands and it has laid the groundwork for other digital technologies to flourish (Ciarli, et al., 2021; Lanz, 2021; Stein, et al., 2020).

Cloud computing stands at the vanguard of digital innovation, as it is particularly transformative for Small and Medium-sized Enterprises (SMEs) since it democratises the access to advanced IT resources. It has revolutionised how businesses approach technology investment, by offering cost-effective, scalable, and agile solutions that were once the province of large corporations with substantial IT budgets (Dincă, Dima & Rozsa 2019). This shift is not merely a matter of economics; it represents a paradigm change in the digital economy, which is particularly noted in markets such as China, where cloud computing's standardisation propels industry advancements (Li, 2023).

Cloud computing's relevance in big data cannot be overstated. Its capacity to manage voluminous and complex datasets with agility makes it an indispensable tool for

organisations grappling with big data's intricacies (Aslam, 2023). The cloud's potential to seamlessly scale up or down provides an adaptable infrastructure that is essential for data-intensive tasks, thus offering a blend of flexibility and power that is critical in the contemporary data-driven landscape.

Integrating cloud computing into business processes marks a burgeoning area of interest within academic and industry research circles. As the adoption rates soar, the researchers examine the cloud technology's trajectory, applications, and impacts on various organisational processes (Gonçalves, Messias, Soares & Peixoto, 2023). This growing scholarly attention is a testament to the cloud's increasing centrality to modern business practices and its potential to further mould the future of commerce and technology.

Despite the optimistic outlook, the concerns around security and privacy pose significant challenges for cloud computing. As enterprises entrust sensitive data to cloud providers, robust security measures become imperative. Best practices are continually evolving, thus addressing the need for both the providers and users to ensure data integrity and privacy in the cloud environment (Reema, 2023).

The forecast for cloud computing is one of continued growth and innovation. Its trajectory is marked by a constant evolution, with new services and models emerging to meet the demands of a dynamic digital economy (Li, 2023). As the technology matures, its role in driving business innovation and efficiency expands, thereby solidifying its status as a cornerstone of the digital transformation journey.

Dincă, et al. (2019) studied the adoption of cloud computing in Romania and alluded that cloud computing has become a cornerstone of the modern digital era, through catalysing significant strides in innovation and operational efficiency across the industries. Its capacity for scalability, flexibility, and cost-effectiveness has been incredibly impactful for the SMEs levelling the technological playing field. As the digital economy continues to evolve, the importance of cloud computing grows, and this is reflected in its extensive application in managing big data and driving research interests (Devi & Maruthuperumal, 2023). While security and privacy concerns remain

top priorities, the ongoing advancements in cloud services are anticipated to propel its adoption further. The continuous evolution and integration of cloud computing into business operations suggests a promising future where it remains a crucial driver in the unfolding narrative of digital transformation.

2.4.2 Internet of Things (IoT)

The IoT is more than a technological advancement; it is a digital revolution that marks a significant step in how people interact with the world. It extends the reach of digital capabilities to the physical world, blurring the lines between the two by creating a network of interconnected devices and systems. This network allows vast amounts of data to be collected, analysed, and used to optimise processes, innovate services, and predict future trends, thereby reshaping sectors as diverse as agriculture and healthcare with intelligent, data-driven solutions (Ciarli, et al., 2021; Cong, et al., 2021; Mihardjo, et al., 2020; Prasher & Onu, 2020). The IoT's rapid advancements highlight the necessity of addressing security, privacy, and regulatory challenges to harness its potential for societal and economic benefits fully (Suleyman, 2023).

The IoT's applications are manifold, stretching various aspects of daily life and industry. In healthcare, the IoT enables remote monitoring and control, thus providing a seamless flow of patient data that can lead to more responsive and personalised care (Hassan, Qamar, Hasan, Aman & Ahmed 2020). In the environmental sector, it offers monitoring systems that can provide critical data for managing resources and responding to ecological changes. Home automation has become increasingly sophisticated with the IoT, by offering homeowners greater convenience and energy efficiency. The transportation sector benefits from the IoT through enhanced logistics and improved safety, while the agriculture sector utilises the IoT to improve crop management and yield through precise monitoring and control (Ramson, Vishnu, & Shanmugam 2020).

In South Africa, the IoT is invaluable in optimising processes within these sectors, particularly in agriculture, where predictive capabilities can mean the difference between a bountiful harvest and a poor one. Similarly, predicting patient trends and health crises can significantly improve the quality and efficiency of provided care (Ciarli, et al., 2021; Cong, et al., 2021).

Despite its transformative potential, the IoT has its challenges. Key among these is the development of low-cost sensors that can be widely deployed to capture the necessary data without prohibitive expenses. Additionally, the requirement for high-speed data communications networks to handle the influx of data from these sensors is paramount (Hassan, et al., 2020). Addressing these challenges is essential for the full realisation of the IoT's potential.

As projected, the future of the IoT will significantly impact human life. As Rghioui and Oumnas (2017) note, the extent to which the IoT will redefine daily living and working is profound. The anticipation is not just for incremental improvements, but it is a fundamental shift in how people interact with technology and derive benefits from it.

The IoT's ascendancy in the digital era promises a brighter, more connected, and data-empowered future. Its applications today are merely the tip of the iceberg, with much more being anticipated as the challenges are overcome and as technology advances. The expectation is that the IoT will continue to break new ground by creating smarter environments and more efficient systems that respond to society's needs and enhance the quality of life (Ciarli, et al., 2021; Mihardjo, et al., 2020).

2.4.3 Artificial Intelligence (AI)

Artificial intelligence, particularly machine learning, has transformed digital computing capabilities, giving rise to "intelligent" machines that are capable of learning and evolving. This technology has revolutionised organisational problem-solving and decision-making, thereby positively impacting skill requirements and job availability. AI's adaptability has made it integral to sectors beyond its initial industrial applications, such as the service industries where AI-powered chatbots enhance customer interaction (Ciarli et al., 2021). The rapid advancements in the AI technologies pose both significant opportunities and risks. The ethical and regulatory challenges associated with AI are critical considerations for its integration into business processes (Kissinger et al., 2021).

Artificial intelligence, mainly through the advancements in machine learning, has catalysed a renaissance in how the organisations approach problem-solving and

decision-making. As Ciarli et al. (2021) noted, this evolution has profound implications for job availability and the skill sets required in the modern workplaces. AI's far-reaching impact can be seen in the rise of intelligent robotics, responsive chatbots, and immersive virtual reality applications, thus reshaping the landscape of multiple industries (Venkatesh, 2018). This innovative technology has become a central force in driving global digital transformation (Sousa, de Barros, and Tavares, 2021). With the capability to automate the tasks that were traditionally performed by humans, AI presents considerable potential to redefine employment and operational processes (Dwivedi, Hughes, Ismagilova, Aarts, Coombs, Crick, Duan, Dwivedi, Edwards, Eirug, Galanos, Ilavarasan, Janssen, Jones, Kar, and Kizgin, (2021). Its prominence is notably evident in customer service where the AI-powered virtual assistants and chatbots have revolutionised customer interactions by providing personalised and efficient service (Dwivedi et al, 2021).

AI's value in the digital economy is further magnified by its ability to expedite and systematise decision-making processes, often outpacing the human capabilities in speed and accuracy (Buxmann, Hess, & Thatcher 2021). Its integral role in the ongoing global transformation processes speaks to the pervasive nature of AI's influence, thus suggesting that its integration into various sectors will continue to accelerate and expand (Masyuk, Kiryanov, Bushueva & Shakuev 2021).

AI is a transformative pillar within the digital economy, heralding new efficiencies, capabilities, and challenges. Its pervasive influence extends from the automation of routine tasks to the enhancement of complex decision-making frameworks. As AI continues to evolve and integrate into various facets of human activity, its role as a transformative agent is undeniable. The trajectory of AI promises not only a reshaping of existing industries and job functions but also the creation of novel opportunities and the need for innovative governance and ethical oversight (Ciarli, et al., 2021).

2.4.4 Big Data

Big data emerges as a critical element of digital transformation, by providing a foundation for the in-depth analysis of modern digital activities' copious amounts of data. The analytical power of big data is integral to refining business processes, informing organisational strategies, and forecasting future trends. The insights derived

from the big data analytics have a far-reaching impact, through shaping the development of innovative business models, novel products and services, and the overall trajectory of the organisation's level of innovation (Ciarli et al., 2021; Aslam, 2023).

Big data drives digital transformation by enabling businesses to dissect and understand massive datasets, as well as by revealing patterns and insights that can inform decision-making and by providing strategic direction (Ciarli et al., 2021). Big data is a game-changer in digital marketing, offering companies unprecedented insight into consumer behaviours and preferences. This information allows the businesses to make data-driven decisions, as well as tailor their marketing efforts, and achieve more targeted and effective consumer engagement (Aslam, 2023; Ramirez-Asis, Silva-Zapata, Ramirez-Asis, Sharma, Durga and Pant, 2022). Using big data in crafting digital marketing strategies is indispensable for segmenting consumers and delivering personalised offers, which are vital for customer acquisition and retention (Venger & Akhtonian, 2021). The businesses can craft bespoke marketing campaigns that resonate with individual preferences and buy habits by analysing consumer interactions and trends, thus increasing customer satisfaction and loyalty.

Within the digital economy, big data is both a product and a digitalisation tool. It has the potential to substantially augment the efficiency and profitability of traditional businesses, thus serving as a bridge between traditional practices and modern data-driven operations (Dziamulych, Shmatkovska & Borysiuk 2021). When paired with machine learning, big data transforms from a static asset into a dynamic resource, converting vast datasets into actionable knowledge (Huang, 2019). The strategic application of big data in business management has been shown to bolster economic benefits and to streamline costs. It enhances the decision-making processes, optimises operational efficiencies, and provides insights that can lead to cost-saving measures (Li, 2023).

The big data's role in the ongoing digital transformation is pivotal, as it equips businesses with the necessary insights to navigate the complexities of the modern economy. By harnessing big data's analytical capabilities, the organisations can

reimagine their existing processes and pave the way for a new era of business practices that are characterised by efficiency, personalisation, and strategic foresight.

2.4.5 Robotics Process Automation (RPA)

Robotics Process Automation (RPA) signifies a monumental shift in the technological capabilities of industries beyond its manufacturing heartland. As a beacon of the fourth industrial revolution, RPA has made significant inroads into service sectors such as retail and warehousing, especially in customer service where efficiency and precision are paramount (Ciarli et al., 2021). The historical perspective on technological advancements emphasises the need for strategic planning to manage the disruptions caused by automation and to ensure equitable distribution of its benefits (Frey, 2019).

RPA employs software robots to emulate and automate human tasks, particularly the repetitive and routine tasks. The companies across various sectors have adopted RPA to delegate such functions to 'bots', thereby enhancing productivity and freeing human workers to focus on more complex and strategic activities (Costa, 2022; Chauhan, 2021). This transition to automated processes is pivotal in transforming work environments, in streamlining operations, and in achieving greater efficiency. In manufacturing, deploying RPA in master data management has yielded substantial benefits. The organisations have reported significant reductions in processing times, minimised errors, and enhanced compliance, thus underlining the tangible value that RPA brings to industrial processes (Radke, Dang, & Tan 2020). These advancements reflect RPA's potential to refine and optimise critical manufacturing processes.

Despite its growing application, the literature on RPA remains nascent, and there is a clarion call for more comprehensive research on its broader application and ongoing development. Costa (2022) advocates for a deeper exploration into how RPA can be further integrated into business models and what that means for the future of work. The adoption of RPA has been gradual, primarily among the large corporations with the resources to invest in such technology. However, the momentum for RPA is building, and as more companies witness its advantages, its proliferation is expected to accelerate (Güner, Han & Juell-Skielse, 2020).

RPA's evolution from a manufacturing-centric tool to a cross-sectoral solution for service industries demonstrates its versatility and crucial role in digital transformation. As the technology continues to mature, its impact on the efficiency of business operations and the nature of work is poised to deepen. The future of RPA holds promise for further innovation, broader implementation, and significant contributions to optimising workflows across an array of industries (Ciarli et al., 2021; Costa, 2022; Chauhan, 2021).

2.5 Impact of Industry 4.0 on Digital Transformation (RQ1)

Digital transformation is a comprehensive overhaul of business, societal, and organisational activities, processes, competencies, as well as models to fully leverage the changes and opportunities of a mix of digital technologies. Industry 4.0 characterised by a fusion of technologies blurring the lines between the physical, digital, and biological spheres, is at the forefront of this sweeping change.

At the heart of digital transformation are key Industry 4.0 technologies which include, cloud computing, the IoT, AI, big data, and RPA. These technologies collectively facilitate the creation of cyber-physical systems that enable new levels of data-driven decision-making, operational efficiency, and customer engagement (Novikov & Sazonov, 2020). The Industry 4.0 technologies must be integrated carefully to balance innovation with societal impacts, thus ensuring that the technological advancements do not exacerbate the existing inequalities (Frey, 2019; Suleyman, 2023).

These transformative technologies are rewriting the traditional rules of production and competition. By integrating digital and physical systems, the companies can create nimble business models that adapt to market changes with unprecedented speed and agility, thereby enhancing their value chains and generating new revenue streams (Calabrese, Dora, Levialdi Ghiron, & Tiburzi, 2022; Egor, 2020).

However, integrating these technologies has its challenges. Standardised protocols often need to be improved, thus leading to fragmented systems that fail to communicate seamlessly. There is also a tendency to focus on the technological aspects rather than aligning them with the strategic business needs, leading to suboptimal outcomes (Butt, 2020).

The impact of Industry 4.0 technologies extends far beyond industrial applications. They hold the potential to drive social innovation and address broader societal challenges such as environmental sustainability and healthcare delivery (Cunha, 2021). The adoption and the impact of Industry 4.0 technologies vary widely across the different sectors and geographies. In the digital manufacturing industry for instance, the technology spill overs significantly influence how these innovations can be harnessed to improve processes and products (Miao, 2022).

In summary, the trajectory of digital transformation is irrevocably linked to the successful integration of the Industry 4.0 technologies. As the organisations grapple with the challenges and embrace these technologies' opportunities, they pave the way for a fundamentally altered future, thereby offering new efficiencies, business models, and solutions to the pressing global challenges. The ability to leverage cloud computing, the IoT, AI, big data, and RPA effectively dictates the pace and scale at which digital transformation reshapes the landscape of industries and societies (Novikov & Sazonov, 2020; Miao, 2022; Butt, 2020).

2.6 Impact of Industry 4.0 on Skills (RQ2)

The first industrial revolution contributed to the evolution of the mercantile city from one that is based on the exchange of products and goods obtained from farming to one that is based on increased productivity. Due to this transformation, the economic and social significance of agriculture has been taken over by industry, thus laying the groundwork for the modern world and transforming the social structure of human capital (Acemoglu & Restrepo, 2019; Sima, Gheorghe, Subić, & Nancu, 2020). There was a concern about technological unemployment. The first knitting machine was invented in 1589 by William Lee, and the first industrial revolution was several hundred years later. As a result of this revolution, the workers' skills were replaced by more straightforward tasks. The workers assumed that the supervisor's role was to supervise, regulate, and control the machines (Frey, 2019). The industrial city was transformed into a planned city during the second industrial revolution. As a result of the planned city, a new type of worker was exempted from participation in productive activities that required gross physical labour, which social and security services, machinery and automation have replaced. In the third industrial revolution, the planned

city gave way to the fragmented city where the industries moved further from the markets, thereby changing the economic systems and production methods (Bresnahan, 2019; Ciarli, Kenney, Massini, & Piscitello, 2021).

Consequently, a new economic-social order was born in the fragmented city, involving even greater separation between housing, employment, consumers, and urban life. A transition occurred between the fragmented and smart cities due to the fourth industrial revolution. Today's economic-social transformations are not rooted in discovering a new energy source but in the latest technological development which is digitalisation. The new technologies have enabled innovative products and services that have dramatically changed personal and professional lives, thus emphasising human-machine interaction (Sima, et al., 2020).

Since its introduction at the Hannover Exhibition in 2011, Industry 4.0 has attracted the attention of both producers and researchers alike (Sima, Gheorghe, Subić, & Nancu, 2020). Utilising the power of advanced communications technologies and innovative inventions to increase the efficiency of production technologies is a critical element of implementing the Industry 4.0 concept in the production sector (Calabrese, Dora, Levaldi Ghiron, & Tiburzi, 2022). By creating a reliable production environment, Industry 4.0 could positively ensure the development of the companies. Using the most advanced technologies enables faster data collection and interpretation procedures, thus resulting in correct decisions and timely implementations from intelligent data collection and interpretation (Ciarli, Kenney, Massini, & Piscitello, 2021). It is a network of advanced technologies that contributes to the value chain. Several elements will alter the landscape of businesses in different industries such as services, automation, robotics, artificial intelligence, the IoT, and additive manufacturing (Miao, 2022). The cyber-physical production systems result from a new wave of innovation in production systems, which blurs the boundary between the real world and virtual reality. The cyber-physical systems are essential in decentralising the operational decision-making process in Industry 4.0 by introducing autonomous machines and creating an intelligent modular factory structure (Pacchini, Lucato, Facchini, & Mummolo, 2019).

Through Industry 4.0, the manufacturing platforms that are open and intelligent can be built and used to integrate information into industrial networks, thus allowing businesses to innovate as crucial components of self-organised systems (Calabrese,

Dora, Levaldi Ghiron, & Tiburzi, 2022). A smart manufacturing system requires a high degree of autonomy and sociality. The physical, digital, and biological worlds are among the characteristics of Industry 4.0 that contribute significantly to improving the industrial environment. These improvements can positively affect the governments' economies and their development plans (Pacchini, Lucato, Facchini, & Mummolo, 2019). According to Schwab, a significant leap has occurred in the global industry and in the economy because of Industry 4.0 (Sima, Gheorghe, Subić, & Nancu, 2020). Industry 4.0 seeks to improve industrial processes to respond to global challenges using emerging technologies and the rapid development of machines and tools (Miao, 2022). By integrating engineering knowledge and advanced information technology, Industry 4.0 aims to implement the IoT. Ultimately, this results in increased production efficiency, the improved production efficiency of the production systems, and reduced problems and downtime, thereby reducing the costs (Ciarli, Kenney, Massini, & Piscitello, 2021). The outcome is a product that has a higher level of quality and is more comfortable and cost-effective in terms of its use as well as maintenance. Industry 4.0 provides opportunities for development and improves competitiveness (Chauhan, Singh, & Luthra, 2021). Staying competitive in any industry requires the use of Industry 4.0. Using advanced software and network sensors, modern machines and tools can be used to plan, predict, adjust, as well as to control business outcomes, thus reducing costs and improving efficiency (Butt, 2020).

Consequently, the production process becomes more dynamic. However, the disruption of the job market is a significant adverse effect. Science and technology are developing rapidly in conjunction with Industry 4.0, which will not only be reshaping commerce, culture, society, biology, and ethics (Sima, et al., 2020)

Every job will undoubtedly change, and many of these changes will be profound, with a vast majority of employees needing to develop new skills in the near future (Kweilin, Rahul, & Julian, 2020). Although preparing for the future of work is one of the most critical business challenges, most organisations still need to be ready for it (Acemoglu & Restrepo, 2019). Adapting to the new working environment will require two types of transformations: upskilling, where employees learn new skills to aid them in their current role, and reskilling, where employees must be able to take on entirely new or different roles (Peña-Jimenez, Battistelli, Odoardi, & Antino, 2021). There is a

particular need for reskilling in operationally intensive sectors, including manufacturing, transportation, and retail, as well as in occupations aligned with operations such as maintenance, claims processing, and warehouse order picking (Sima, Gheorghe, Subić, & Nancu, 2020). As a result of the large number of people employed in these sectors and occupations, as well as the predictability and repetitive nature of many operational tasks, these sectors and occupations are more likely to undergo more remarkable change than the global average (Frey, 2019).

What matters the most is the nature of the changes in the workplace roles and activities. The job skill profiles will change significantly as automation increases. The employers and the employees must deal with the implications of that. A company's automated equipment and digital processes will require people with the right skills to develop, maintain, and manage them. To access employment, the workers must have the necessary skills (Kweilin, et al., 2020). The need for reskilling and upskilling the workforce is critical to managing the transition to Industry 4.0, thus ensuring that the employees can handle new technologies and maintain job security (Frey, 2019; Kissinger et al., 2021).

Smart manufacturing is essential to the Industry 4.0 revolution. The interaction between employees and machines is now defined within this new context. A new intelligent production system is determined by the interconnections created between the various actors, and the interfaces between the workers and machines are regarded as key elements. For such environments to function appropriately, the workers must be creative, inventive, and equipped with the necessary expertise and skills. They can receive the desired education through a system fostering, creativity, inventiveness, and knowledge. New technologies and processes present new challenges to the human resources management in the context of Industry 4.0. Skills development is essential to meeting the present and future labour market needs. The workers must develop specific competencies, abilities, skills, knowledge, and attitudes to meet the new workplace challenges as defined by the smart manufacturing and Industry 4.0 revolution. They must become familiar with the Technology of Things (ToT), as well as be capable of interacting with humans and machines, access technology-technology interfaces, demonstrate a thorough understanding of the network's systems, be creative and innovative (Sima, et al., 2020)

2.7 Leadership preparation for the future workforce (RQ3)

The leadership in technology organisations plays a pivotal role in steering the workforce through the waves of digitisation. Strategic initiatives aimed at workforce development such as the creation of digital academies and the investment in continuous learning platforms, underscore the commitment to nurturing a digitally competent workforce (Kweilin, Rahul, & Julian, 2020). Effective leadership must balance leveraging technological advancements and addressing ethical considerations, thus ensuring that the workforce is prepared for the challenges and opportunities of Industry 4.0 (Suleyman, 2023).

2.7.1 In the business

Innovations will also require the development of skill sets that are not yet available in the labour market. There may also be a need for concrete skill sets that currently do not exist in the labour market to facilitate innovation. The workers are not directly motivated to learn these skills since they cannot be traded immediately. As a result, the employer is responsible for the costs that are associated with employee training (Acemoglu & Restrepo, 2019). A high market premium will be charged if the employer cannot fully utilise the value of innovation and imitators will enter the market. Thus, the skills that started off as being 'specific' could become 'general'. As a result of the uncertainty associated with new technologies and the heterogeneity of organisation capabilities, the rates of return to skills are likely to vary considerably and contain a large margin for error (Cirillo, et al., 2021).

To successfully integrate embodied technical change into the context of production processes, skills upgrading through training is beneficial to the adoption of new technologies (Bessen, 2019). Training is the most efficient approach when the skills requirements are organisation-specific or where labour market frictions are high. Training can also influence the workers' perceptions of a new technology and their attitude towards change in the complex cognitive process of adapting to radical new technologies (Bresnahan, 2019). Interestingly, there is evidence of a complementarity between the investment in information technology and training, whereas there is no evidence of this relationship in the literature on ICT adoption and training. Considering the potential for new digital technologies, there is a suggestion that the most plausible hypothesis is that the organisations' planning changes in production will prepare their

workers by updating or upgrading their skill sets to fully capitalise on these new technologies. The organisations should expect technologies to require contextual adjustments, even though there is always an element of uncertainty in technical change, and training programmes may benefit these organisations (Cirillo, et al., 2021).

There are several ways in which companies can address skill gaps. They can hire new staff with the required skills or retrain current employees to perform new tasks (Akhter & Naveed, 2023). They can also look outside the organisation and hire new staff with specialised expertise. A hybrid approach could also be taken, involving the use of contract workers to meet short-term needs while developing skills in-house (Peña-Jimenez, Battistelli, Odoardi, & Antino, 2021). Most organisations will likely adopt a mixed method of these models. As a result, they may rely on the external market for highly technical roles, such as data scientists, while attempting to fill new frontline roles, such as robot controllers and production exception handlers, from within their organisations (Kweilin, Rahul, & Julian, 2020). The shift in societal attitudes is causing companies to take more responsibility for retaining and retraining their existing workforce (Sima, Gheorghe, Subić, & Nancu, 2020).

There may be a long wait for the benefits of these global reskilling programs to be realised, but they are visible and significant investments. The reskilling efforts on a smaller scale are already yielding results for some companies. For instance, Tata Steel established an advanced analytics academy in Ijmuiden in the Netherlands, to train and certify hundreds of engineers on the new analytical approaches to manufacturing-process improvement. Despite the significant cost pressures in the global steel industry, the plant boosted profit before interest, taxes, depreciation, and amortisation by over 15% using the new techniques (Kweilin, et al., 2020).

It is not appropriate to assign all responsibility for the successful implementation of technology to employees, expecting them to be flexible, capable of fulfilling constantly changing roles, ensuring their education and training, negotiating their own employment conditions and job functions, and being available around the clock while supporting rather than resisting change (Demerouti, 2022; Akhter & Naveed, 2023). Following researchers' recommendations, organisations, authorities, and

policymakers are responsible for taking the necessary steps (Cirillo, Fanti, Mina, & Ricci, 2021; Butt, 2020). As a result, organisations need to redesign the entire system—tasks, knowledge, organisational structure, and decision-making processes—by incorporating the experiences and requirements of users into the design process. This will ensure that appropriate resources are provided to meet new demands and facilitate employee job creation, turning technology into a resource (Calabrese, Dora, Levaldi Ghiron, & Tiburzi, 2022; Peña-Jimenez, Battistelli, Odoardi, & Antino, 2021). To safeguard employees, governments and policymakers should establish norms that ensure a safe working environment, regulate working hours to prevent overload and exploitation, and guarantee adequate income (Kweilin, Rahul, & Julian, 2020; Frey, 2019). Additionally, policies should ensure employee privacy, training, and education (Maisiri & van Dyk, 2021). To avoid the deterioration of living and working conditions, flexible employment, self-employment, and employee-led flexibility should be protected through well-structured regulations (Pacchini, Lucato, Facchini, & Mummolo, 2019).

2.7.2 In government

Digitalisation will significantly impact the social and economic environment. Based on empirical evidence, this is not likely to result in mass unemployment. Employment levels have shown robust growth in terms of the number of employees and hours worked (Acemoglu & Restrepo, 2019; Frey, 2019). New roles will replace traditional ones, and new business models will emerge. A long-term evolutionary process such as digitisation has broad impacts on employment, including changes in occupational and job profiles, transformations in employment forms, and an increasing role for the platform economy, thereby posing challenges to social policy (Ciarli, Kenney, Massini, & Piscitello, 2021; Maisiri & van Dyk, 2021).

Technological advances have resulted in the automation of jobs and the rise of entrepreneurship, leading to radical changes in the labour market. Information technologies have driven qualitative changes in educational services, resulting in improved living conditions and increased comfort for individuals and communities (Pacchini, Lucato, Facchini, & Mummolo, 2019; Peña-Jimenez, Battistelli, Odoardi, & Antino, 2021). Consequently, the development of information technology plays a crucial role in career selection tailored to individual needs within smart cities' social,

educational, and communication environments (Calabrese, Dora, Levialedi Ghiron, & Tiburzi, 2022). Specialised training programs can be integrated to meet individual needs, support economic and social development, address local labour market demands, and align with the broader aspirations of the communities where they operate (Kweilin, Rahul, & Julian, 2020; Butt, 2020).

Furthermore, the government must change its institutions and processes to become more aligned with long-term perspectives and it must be more proactive in anticipating and shaping the future (as opposed to just the future of work and technology). Technology can thus be used to create wealth that can be distributed not only to the people who make it but also to the people who are responsible for using it. A final consideration is that the educational institutions should teach the individuals skills rather than (merely) knowledge and promote meta-skills (such as cooperation, creativity, and problem-solving capabilities) to prepare the students for (more) multi-track careers (Demerouti, 2022).

2.7.3 In a technology company

The digital sensors on the machines characterise this digitisation process, thus distinguishing it from the earlier waves of automation. It was suggested that by digitising its operations, the organisation's events and activities become transparent, thereby making it easier to optimise, connect to new machines, and reorganise according to the computer-based logic. Technology that exhibits these characteristics can coevolve with organisational innovation and organisational structure to enable the development of new business models and value propositions. Recombinant innovations are discovered as this process progresses, and they are sometimes unexpected (Ciarli, et al., 2021).

Several factors primarily drive technology adoption choices, and much has been written on how these choices translate into aggregate technology diffusion patterns. The factors on the supply side, such as the improvements in older technologies, result in incremental innovations or in changes on how existing technologies are used. Adopting new technologies has been determined by the technological complementarities between the producers and users as well as the adopters' tangible and intangible capital stocks. The co-evolution of organisational capabilities and the

economic environment determines the sources of competitive advantage (Cirillo, et al., 2021).

Technological advancements have led to the development of new skills and competencies within the human resources field. The adoption of Industry 4.0 is particularly beneficial for highly developed countries, which gain a competitive advantage. However, automation may also lead to increased unemployment, necessitating the creation of new employment opportunities that require different skills and competencies (Acemoglu & Restrepo, 2019; Frey, 2019). Education systems are transforming to support continuous learning rather than relying solely on initial qualifications. The shift is toward lifelong learning, where individuals accumulate knowledge and skills periodically through training programs. Consequently, new personal skills must be developed in areas such as management, risk management, leadership, self-organisation, communication, and emotional intelligence (Peña-Jimenez, Battistelli, Odoardi, & Antino, 2021; Maisiri & van Dyk, 2021).

Advancing technologies have enabled the division of traditional work tasks, supporting global and digital production, which has resulted in new employment models such as part-time, temporary, and on-demand work (Pacchini, Lucato, Facchini, & Mummolo, 2019). Some categories of workers benefit from these technological developments, as they provide greater flexibility. Online recruitment platforms also offer advantages, particularly for women, by granting access to previously restricted job markets and expanding opportunities in industries where they had a less prominent role (Calabrese, Dora, Levialedi Ghiron, & Tiburzi, 2022). However, digitalisation also increases risks and social insecurity, particularly for individuals with lower education levels and those from marginalised social groups. In high-tech industries such as the automobile sector, human capital strategies rely less on process technologies and more on workforce planning and skills development (Kweilin, Rahul, & Julian, 2020). Studies examining automation's impact on workplace skills also highlight the role of factories in the value chain and the international division of labour (Butt, 2020). Additionally, a company's institutional framework significantly influences its market position and overall workforce strategy (Ciarli, Kenney, Massini, & Piscitello, 2021).

2.7.4 Impact on people

Technology and society have played a significant role in several important contributions. From an evolutionary perspective, human capital may be proxied by the workers' education levels or as the workers' knowledge and routines. An employee's human capital can be built through investment in education, training, and other activities that enhance their ability to perform their job duties. Research has distinguished between 'special human capital' which refers to the skills or the valuable knowledge to a single employer, and 'general human capital' which is helpful to a wide range of employers. As far as the general skills are concerned, theory suggests that acquiring them will result in higher wages for the employee as determined by the market. As a result, the skilled employees contribute more value to the production process and share the cost of training (in terms of time or money). In contrast, specific skills are necessary only for a specific job and they are acquired ad hoc in a particular production environment (Cirillo, et al., 2021).

Technology can replace a significant amount of repetitive, complicated, or heavy work. However, some evidence indicates that job demands will change or increase in the short term. As a result of technology taking over the process of treating, manipulating, or assembling smaller objects, parts, or information, the human operators are forced to perform more mentally and cognitively demanding tasks that require a high level of information processing competence (Demerouti, 2022). As the employees assume responsibility for vigilance (i.e., tasks that require sustained attention and a timely reaction to a visual stimulus) and maintenance (i.e., tasks necessary to ensure that operational systems operate as they should), the nature of their job demands also changes. It is also necessary to acquire new knowledge to perform new tasks and routines. Since these changes do not occur automatically, the employees are subjected to increased demands due to implementing technology-induced changes, which are associated with an increased workload and security (Demerouti, 2022).

Over time, both may become less significant as the employees become more familiar with technology. Providing appropriate training and utilising support systems like help desks can reduce change-related demands (Kweilin, et al., 2020). It is still a challenging situation to be required to change work routines and to undergo training or to receive technical support. Finally, the increased demands may be the by-

products of technology introduction, as is the case when new tasks and old work designs mismatch or because technology facilitates intrusions into private life, work increases the experience of family conflict (Demerouti, 2022). Based on this framework, digital technologies are estimated to impact employment broadly. It is common for some people to express pessimism regarding the digital technologies, that they will primarily eliminate some jobs because of them. Other people express optimism, that the digital technologies will mainly enhance existing jobs or create new ones, and still others express neutrality, that the effects will be mixed (Ciarli, et al., 2021).

Table 2-1: Summary of Impact on business, government, and people

| Impact | Details |
|------------|--|
| Business | Innovations may require new skill sets that are not yet available in the labour market. The employers may be responsible for the costs that are associated with employee training. Training is beneficial for the adoption of new technologies. The companies can address the skill gaps by hiring new staff, retraining current employees, or by using contract workers. Reskilling programs can yield significant results for the companies (Cirillo, Fanti, Mina, & Ricci, 2021; Kweilin, Rahul, & Julian, 2020). |
| Government | Digitalisation significantly impacts the social and economic environment, particularly regarding employment. New roles will replace traditional roles, and new business models will emerge. Technological advances have resulted in the automation of jobs and in the rise of entrepreneurship. Information technologies can be crucial in selecting a profession that is tailored to an individual's needs (Sima, et al., 2020) |
| People | An employee's human capital can be built through investment in education, training, and in other activities. Technology can replace repetitive, complicated, or heavy work, but the job demands may change or increase in the short term. The employees may be required to perform more mentally and cognitively demanding tasks. Providing employees with appropriate training can reduce the change-related demands. Digital technologies are estimated to impact employment broadly (Cirillo, Fanti, Mina, & Ricci, 2021; Demerouti, 2022; Ciarli, et al., 2021). |
| | |

Source: Own elaboration

2.8 Strategic intent in the technology company (RQ4)

Various strategies have been proposed to equip the employees with Industry 4.0 skills. Engelmann (2018) and Gaudio, Refugio, Jurcic, Corte, James, Said, Sawicka, Mohan, Aravind, Umachandran, & Amuthalakshmi (2019) emphasise the importance of mobile learning and the need for lifelong learning (Gaudio, et al., 2019) specifically highlights the need for the employees with specific IoT and additive manufacturing skills. Fadhila, Aitouche, & Aksa (2020) and Adrian, Tăpîrdea, Feier, Chivu, and Drăghici (2021) underscore the need for strategic human resource management and developing highly qualified trainees. Peña-Jimenez, Battistelli, Odoardi & Antino (2021) as well as Safitri, Poernomo and Karyadi (2022) highlight the importance of cognitive, functional business, strategic, and managing people skills, with Safitri et al. (2022) emphasising the need for the companies to provide training programs. Lastly, Ras (2017) suggests using human performance augmentation tools such as augmented reality to bridge the skills gap. Adopting a balanced approach that integrates digital and analogue strategies can enhance organisational resilience and adaptability in the rapid technological changes (Dotzel et al., 2013; Hassan, et al., 2020).

Many studies have identified the key elements of successful programs for addressing future skill requirements. These include but are not limited to a focus on practical needs and industry integration Kalinowski, Escovedo, Pina, Vidal, Da Silva, Ponsirenas & Da Rocha (2023), the correlation of power skills with program success (Akhter & Naveed, 2023), and the importance of systematic investment in employee education (Popadić, 2022). Duan, Exter, Tagare, & Sabin (2022) emphasise the need for competencies in non-technical areas, while Madavi, Wadile, Varma, Gaonkar, and Khan (2022) underscore the relationship between training program effectiveness and employee productivity. The most successful programs in companies share certain core elements that have been undertaken to address future skill requirements on a large and systematic scale. They form an integral part of their organisation's overall digital strategy.

For the digital strategies to be successful, the senior executives cite talent as the most significant barrier. These two factors must be closely related. To ensure that a digital transformation delivers real value, it is accepted by the broader organisation, and it

can be implemented and sustained at scale. Many companies have learned that there are many moving parts to a digital transformation, with many elements that must all be addressed together. Nair and Bhattacharyya (2022) highlight the importance of creating a skill-focused climate and the need for a competency-based approach.

For example, the World Economic Forum's Global Lighthouse Network of advanced manufacturing companies has shown that while they use many smart technologies in their operations, they pay close attention to their management systems, people, and the business processes (Kweilin, et al., 2020). In addition, the programs address every level of the organisation. The efforts to automate and digitise an organisation are driven by the top management and involve most of the management. In addition, most successful companies tailor and customise their training to meet the needs of both the organisation and the individual learners. The technical and the business topics that are relevant to the individuals' new or changing roles are covered during training. A combination of classroom and online learning as well as real-world on-the-job experience is also used to deliver content using adult learning principles. A successful reskilling program does much more than teach technical content; as it helps the learners to change their mindsets by teaching them new ways of working and by emphasising the opportunities for personal and professional growth (Kweilin, et al., 2020).

2.9 Theoretical/Conceptual Framework

2.9.1 Technology Readiness and Acceptance Model

The Technology Readiness and Acceptance Model (TRAM) integrates two established models: The Technology Readiness Index (TRI) and the Technology Acceptance Model (TAM). This framework is widely used to understand how individuals and organisations adopt and adapt to new technologies. By combining TRI's focus on attitudes toward technology with TAM's emphasis on perceived usefulness and ease of use, TRAM provides a holistic approach to studying technology adoption (Parasuraman, 2000; Davis, 1989).

The TRI, developed by Parasuraman (2000), categorises individuals based on their attitudes toward technology through four key dimensions: optimism, reflecting positive

beliefs about how technology improves productivity and quality of life; innovativeness, the willingness to experiment with new technologies; discomfort, feelings of uncertainty or being overwhelmed by technology; and insecurity, scepticism about the reliability or safety of technology. On the other hand, the TAM, introduced by Davis (1989), focuses on two critical factors influencing technology adoption: perceived usefulness (PU), the extent to which a person believes that using technology enhances their job performance, and perceived ease of use (PEU), the extent to which a person believes that using technology is effortless.

TRAM combines these perspectives to create a holistic view of how individuals and organisations interact with technology. It not only examines how users perceive technology's practical value but also explores their psychological readiness to adopt it. This makes TRAM particularly relevant for analysing the challenges and opportunities associated with Industry 4.0 technologies in the workplace.

2.9.2 Application of TRAM in This Study

In this study, TRAM served as the guiding framework for both the design and analysis of data. Semi-structured interview questions were developed to explore the dimensions of TRAM, allowing for an in-depth examination of employee experiences with Industry 4.0 technologies. For example, questions related to perceived usefulness asked participants to reflect on how these technologies enhanced their productivity, while those addressing perceived ease of use focused on identifying challenges employees faced in learning and using these tools. To explore optimism and innovativeness, participants were asked about their attitudes toward being early adopters of new technologies, while questions about discomfort and insecurity probed concerns regarding the impact of automation on their job roles.

The data collected through these interviews were analysed thematically, with the findings mapped directly to the TRAM framework. For instance, employees often described automation tools as highly beneficial in streamlining tasks, which aligns with perceived usefulness. However, many also highlighted the steep learning curve associated with these tools, reflecting perceived ease of use concerns. Similarly, while some employees expressed enthusiasm about technological advancements, others

voiced fears about potential job displacement, illustrating the dimensions of optimism and insecurity.

2.9.3 Relevance of TRAM to Industry 4.0

The adoption of Industry 4.0 technologies, such as artificial intelligence, automation, and IoT, brings significant changes to workplaces, reshaping both job roles and organisational processes. TRAM offers a valuable lens for understanding these transitions, emphasising the need to consider employee readiness and acceptance as critical factors for successful implementation. For example, addressing insecurity by fostering transparent communication about the benefits and purposes of automation can help build trust among employees. Similarly, focusing on perceived ease of use through simplified interfaces and tailored training programs can ease the transition to new technologies (Parasuraman, 2000; Davis, 1989).

By using TRAM, this study bridges theoretical insights with the lived experiences of employees, providing a structured understanding of workforce readiness and the challenges of adopting Industry 4.0 technologies in a South African technology company.

2.10 Conclusion

As Chapter 2 is concluded, it is evident that the Industry 4.0 technologies, including cloud computing, the IoT, AI, big data, and RPA are at the heart of a profound transformation affecting businesses, governments, and individuals alike. These advancements offer unparalleled opportunities for innovation and growth, thereby enabling the organisations to redefine their operational paradigms, as well as develop new products and services, and enhance their competitive edge in a rapidly evolving digital landscape.

However, the journey through digital transformation has its challenges. The rapid pace of technological change demands a significant evolution in skills and employment practices, by necessitating a reimagining of the workforce development strategies. For the individuals, this means a continuous commitment to learning and adapting to the new roles that emerge from the digital economy. For businesses, it involves investing in the upskilling and in the reskilling of their employees to harness the full potential of Industry 4.0 technologies. For governments, it requires crafting policies that foster

innovation and growth as well as ensure that the benefits of digital transformation are widely shared, thus contributing to an inclusive and sustainable future.

Navigating these complexities necessitates a collaborative approach where organisations, policymakers, and educational institutions work hand in hand. By aligning efforts, sharing insights, and pooling resources, the stakeholders can build a robust ecosystem that supports continuous learning, fosters innovation, and prepares the workforce for the demands of the digital age. In doing so, they ensure that the digital transformation journey is marked by progress, inclusivity, and resilience.

Moving onto Chapter 3, the focus shifts to the research methodology underpinning the exploration of how the technology companies adapt to these changes, particularly within the telecommunications sector. The research delves into the employed strategies to overcome the Industry 4.0 challenges, how they foster skill development among their workforce, and the innovative practices driving their growth in the digital era. The aim was to comprehensively understand the practical implications of Industry 4.0 adoption for the South African technology companies through a detailed examination of research design, data collection methods, and analytical approaches.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Building on the foundation established in the initial chapter which critically examined the Industry 4.0 technologies, digital transformation, and their broad impact on jobs, this chapter delineates the methodological path that was embarked upon. The insights gleaned from the literature review underscored the critical role of Industry 4.0 in reshaping the technological framework and the organisations' socio-cultural and economic fabrics. In particular, the review highlighted the evolution of job roles and the consequent demand for new skills and strategies within the technological sector, thus setting the stage for a deeper empirical investigation.

This chapter presents a detailed research plan that was utilised to examine the real-world application and the implications of Industry 4.0 within a South African technology company in response to the reviewed scholarly discourse. The philosophical underpinnings of the study are articulated here, drawing from the constructivist and the interpretivist paradigms that prioritise the individuals' subjective experiences and perceptions amidst technological upheaval.

The qualitative research design was chosen for its inherent flexibility and exploratory nature, and it was well-suited to delve into the complex human dimensions Industry 4.0 invokes. This methodological approach facilitates a nuanced exploration of how various stakeholders live and interpret these technological shifts, each bringing their unique perspective influenced by distinct roles, backgrounds, and personal experiences (Creswell & Creswell 2017; Johnson, Adkins & Chauvin, 2020).

As such, this chapter maps out the research philosophy, the specific methods selected for data collection and analysis, and the ethical considerations that were integral to ensuring that the confidentiality and the integrity of the participants' contributions were upheld. This framework guides the research process, and it cements its scholarly rigour and relevance.

Thus, with a clear methodological structure, this chapter bridges the gap between theoretical exploration and empirical inquiry. The resultant data and its analysis, presented in subsequent chapters, sheds light on the intricate ways Industry 4.0 is influencing organisational structures, employee engagement, and the broader industry dynamics within the studied context.

3.2 Research Paradigm

The chosen philosophical underpinnings set the stage for a study that sought to observe, understand, and articulate the intricate implications of Industry 4.0 within a technology company in South Africa. They formed a coherent framework that aligns the research objectives with a methodological approach that is capable of capturing the complex, nuanced realities of digital transformation in the workplace. At the foundation of this study lies the research paradigm which is a constellation of beliefs that steer the researcher's vision of the world and informs the construction of the research framework. It provides the scaffolding upon which the theories are built and dictates the lens through which the world is viewed, interpreted, and understood (Aliyu, et al., 2015). The chosen paradigm, therefore, not only influenced the research's direction but also how its phenomena are connected and integrated within the broader fabric of academic inquiry.

3.2.1 Interpretivist Epistemology

The interpretivist epistemology, which is central to this research, posits that humans are fundamentally different from inert physical objects; as they are beings enmeshed in context, driven by consciousness, and defined by subjectivity (Saunders, Lewis, & Thornhill, 2009). This study aligns with this perspective, holding that the essence of Industry 4.0 and its implications can only be grasped through the rich tapestry of meanings that the organisational members attribute to their experiences. This subjective interpretation champions a methodological approach tailored to capture in-depth, personalised narratives, thus revealing the layers of meaning that are interwoven with adopting Industry 4.0 technologies.

3.2.2 Constructivist Ontology

In tandem with the interpretivist approach, the constructivist ontology guided this research by advocating that reality is not static or monolithic, but it is dynamically constructed through individual interactions and social engagements. This worldview

acknowledges the diversity in the experiences of Industry 4.0, recognising that a confluence of personal history, social interaction, and cultural background influences everyone's understanding. Thus, the research approach is flexible and open to the diversity of realities that Industry 4.0 manifests within the organisational landscape (Lee, 2012).

3.2.3 Axiological Considerations

The axiological component of the research acknowledges the influence of both the researcher's and the participants' values on the credibility and the outcome of the study (Saunders, Lewis, & Thornhill, 2009). This research upholds the principle that the values that are inherent in the research process such as integrity, transparency, and respect, shape the nature and the depth of the findings. Recognising this, the researcher engaged in a reflexive practice, constantly examining how personal values may colour the research process from data collection to data analysis.

3.2.4 Methodological Consistency and Practical Execution

The philosophical underpinnings of this study are more than theoretical concepts; as they are the bedrock of methodological consistency, ensuring that each aspect of the research data collection, analysis, and the interpretation resonates with the interpretivist and the constructivist ethos.

Table 3-1 provides a structured summary of the key research components, highlighting their conceptual foundations and methodological applications. The research paradigm shapes the investigative lens through which the study is conducted, reinforcing a qualitative and context-dependent approach. The interpretivist epistemology acknowledges that humans, unlike physical objects, interact within social and cultural contexts, making their experiences inherently subjective (Antwi & Hamza, 2015). Thus, Table 3-1 serves as a guiding framework for maintaining methodological coherence, ensuring that the study remains philosophically grounded, logically structured, and practically executable. This alignment not only enhances the study's rigor but also ensures that findings remain contextually rich, meaningful, and reflective of the complex human experiences under investigation.

Table 3-1: Summary of research components

| Research Component | Description |
|--|---|
| Research paradigm | A constellation of beliefs that steer the researcher's vision of the world and informs the construction of the research framework. |
| Interpretivist epistemology | Posits that the humans are fundamentally different from inert physical objects; as they are beings enmeshed in context, driven by consciousness, and defined by subjectivity. |
| Constructivist ontology | Advocates that reality is not static or monolithic but it is dynamically constructed through individual interactions and social engagements. |
| Axiological considerations | Acknowledges the influence of both the researcher's and the participants' values on the credibility and the outcome of the study. |
| Methodological consistency and practical execution | Ensures that each aspect of the research data collection, analysis, and interpretation resonates with the interpretivist and the constructivist ethos. |

Source: Own elaboration

This consistency is reflected in the data collection methods, such as the semi-structured interviews, that allow for an in-depth exploration of personal and collective meanings. Furthermore, it informs the analysis, where thematic exploration uncovers the patterns embedded in the subjective experiences.

3.3 Research Design

The selection of an inductive and exploratory research design was rooted in exploring the uncharted territory of Industry 4.0's implications for a South African technology company. This design was a strategic choice, reflecting the study's aim to generate new theories and frameworks that can more accurately reflect and explain the evolving digital landscape's impact on organisational structures, culture, and employee roles. Through this design, the research was positioned to yield rich, contextual findings that contribute meaningfully to the existing body of knowledge (Weyant, 2022).

3.3.1 Inductive Research Approach

This study employed an inductive research approach, which is a foundational strategy for theory development. Unlike deductive research, which tests existing theories, the inductive approach is rooted in observing empirical phenomena, from which theoretical insights are subsequently drawn. Essentially, it begins with specific observations and

measures, evolves into patterns, and culminates in forming hypotheses or theories (Bhattacharjee, 2012). This approach is particularly apt for exploring new or complex phenomena, such as the multifaceted impact of Industry 4.0 technologies within an organisational context where the pre-existing theories might not adequately capture the nuances of the subject matter (Al-Ababneh, 2020).

3.3.2 Exploratory Research Design

The exploratory nature of this study was characterised by its flexibility and adaptability, thereby making it ideal for delving into areas with limited pre-existing research. This type of research is oriented towards discovering new insights and understanding phenomena rather than confirming or disconfirming predetermined hypotheses. It allows for an open-ended inquiry, thus allowing the researcher to follow the data where it leads. It was particularly beneficial when addressing the novel and dynamic subject of Industry 4.0 in the South African technology sector (Al-Ababneh, 2020). The exploratory design was chosen for its potential to unveil intricate details and relationships that have not yet been widely studied or comprehensively understood (Akhtar, 2016).

3.3.3 Comparative Research Designs

While the exploratory approach guided this research, it is essential to differentiate it from other research designs for clarity. For instance, descriptive research systematically depicts a particular phenomenon or population's characteristics. It provides a snapshot of the variables of interest as they exist but does not delve into the underlying causes or relationships. Explanatory research, conversely, seeks to elucidate why and how certain phenomena occur, often aiming to establish cause-and-effect relationships (Creswell & Creswell 2017; Johnson, et al., 2020).

In contrast to the descriptive and explanatory designs, the exploratory approach in this study was not constrained by the need to quantify phenomena or test hypotheses strictly. Instead, it was utilised to garner a deeper understanding of the individuals' subjective and complex experiences as they navigate the challenges and opportunities of Industry 4.0 (Al-Ababneh, 2020; Akhtar, 2016).

3.4 Research Approach

The essence of this study's inquiry into the implications of Industry 4.0 within a South African technology company necessitated a research approach that transcends mere numerical data, by delving into the nuanced tapestry of human experiences, perceptions, and interactions. Thus, a qualitative research approach was meticulously chosen for its unparalleled ability to provide depth, context, and richness to exploring human behaviour and its interplay with technological advancements (Weyant, 2022).

3.4.1 Rationale for a Qualitative Methodology

The qualitative methodology stands out for its emphasis on the subjective aspects of human life, by focusing on the meanings, experiences, and interpretations that individuals attribute to their surroundings and the events in their lives. In the context of Industry 4.0, this approach allowed for an in-depth examination of how the employees, managers, and the other stakeholders perceive and adapt to rapid technological changes, thus revealing the underlying emotions, beliefs, and values that these changes evoke (Johnson, et al., 2020).

The inherent complexity and dynamism of the Industry 4.0 technologies, characterised by automation, digital connectivity, and smart systems, demand an approach that can capture the subtleties of human-technology interaction. A qualitative approach facilitates this by:

- **Capturing subjective experiences:** It enables the researcher to grasp the subjective experiences of the individuals as they navigate the evolving technological landscape, thus offering insights into how these technologies reshape job roles, work processes, and organizational culture.
- **Understanding context:** The qualitative approach acknowledges the significance of context, by allowing the researcher to understand how the specificities of the South African technology sector, including its socio-economic and cultural dimensions, influence the adoption and impact of the Industry 4.0 technologies.
- **Exploring complex dynamics:** It provides the tools to explore the complex dynamics between technology and humans, by including the resistance to change, the adaptation strategies, and the emergence of new forms of collaboration and leadership within the digitally transformed environments.

3.4.2 Depth and Context in Qualitative Inquiry

Qualitative research offers depth and context through the methodologies encouraging open, detailed narratives, such as semi-structured interviews, focus groups, and observational studies. These methods enable the participants to express themselves in their own words, by offering detailed descriptions of their experiences and perspectives. This depth is further enhanced by the researcher's active engagement with the data, where the patterns and themes are identified and interpreted within the broader context of the study's objectives (Creswell & Creswell 2017; Johnson, Adkins & Chauvin, 2020).

3.4.3 Richness in Understanding Human Behaviour

The richness of qualitative research lies in its ability to uncover the layers of meaning that inform human behaviour, particularly in response to the technological innovations. This research approach illuminates how the individuals adapt to the Industry 4.0 technologies and why they respond in particular ways, thereby revealing the motivations, fears, aspirations, and the cultural factors underpinning their behaviours. Such richness is indispensable for developing a comprehensive understanding of the human element in digital transformation.

The qualitative research approach was integral to this study's exploration of Industry 4.0 within a South African technology company. It provided the necessary depth, context, and richness to understand the multifaceted interactions between the humans and emerging technologies, thus offering valuable insights into the ongoing digital transformation process. Through this approach, the research aims to contribute nuanced understandings of the social and organisational implications of Industry 4.0, grounded in the lived experiences of those at the forefront of this technological evolution.

3.5 Population and Sampling

3.5.1 Target Population

The target population for this study encompassed a range of individuals within a South African technology company who are directly engaged with or affected by the adoption of the Industry 4.0 technologies. The target population for this study comprised employees across all levels of a South African technology company actively engaged

in the implementation and adaptation of Industry 4.0 digital technologies. This included frontline technical staff, middle management, and senior executives responsible for strategic technology-driven initiatives. The rationale for this broad target population was to capture a comprehensive view of the implications of Industry 4.0 across different roles and perspectives within the organisation.

3.6 Participant Demographics and Interview Process

This research was conducted with a group of professionals within the technology sector who hold senior management positions or higher, thus ensuring a comprehensive depth of insight into the organisation's adaptation to Industry 4.0. The participant base spanned a broad spectrum of tenure ranging from 17 to 30 years of industry experience, thereby reflecting a significant accumulation of sector-specific knowledge and leadership acumen.

The data was collated through a series of structured interviews, each tailored to the participant's role and breadth of experience. The interview lengths were carefully considered to allow enough time for a thorough exploration of topics without overwhelming the participants. The interviews lasted between 27 to 55 minutes. These discussions were designed to delve into the intricacies of digitalisation's impact on employment, the role of employees in leveraging Industry 4.0 innovations, leadership strategies in workforce preparation, and the formulation of skills development strategies.

Through these interviews, the study aimed to garner rich qualitative data, drawing on the seasoned expertise of the individuals at the forefront of navigating and implementing the technological advancements within their company. This approach provided a well-rounded perspective on the organisation's strategic and operational responses to the evolving technological landscape.

The interview process was conducted with the utmost respect for participant confidentiality, with all identifying information being meticulously anonymised to preserve the privacy and integrity of the contributors. The insights derived from these interviews were essential to understanding the real-world application of theoretical

frameworks and the actualisation of Industry 4.0 within the contemporary technology organisations.

A purposive sampling method was used to select a diverse group of 10 participants from the larger organisational population. The sample included:

- 3 senior managers involved in digital strategy implementation
- 4 middle managers overseeing operational changes
- 3 frontline staff engaging directly with Industry 4.0 tools

This distribution ensured representation across strategic, operational, and technical levels, consistent with the defined population. Below is the summary of the participants:

Table 3-2: Participants demographics

| | Title | Years in Industry | Length of Interview (in minutes) |
|----------------|-----------------|-------------------|----------------------------------|
| Participant 1 | Senior Manager | 37 | 35 |
| Participant 2 | Middle Manager | 22 | 33 |
| Participant 3 | Frontline Staff | 19 | 55 |
| Participant 4 | Frontline Staff | 21 | 53 |
| Participant 5 | Senior Manager | 24 | 40 |
| Participant 6 | Middle Manager | 19 | 37 |
| Participant 7 | Middle Manager | 26 | 43 |
| Participant 8 | Senior Manager | 30 | 30 |
| Participant 9 | Middle Manager | 20 | 27 |
| Participant 10 | Frontline Staff | 15 | 36 |

Source: Own elaboration

Qualitative research prioritises depth over breadth, and smaller sample sizes are common when rich, detailed insights are needed. According to Creswell and Poth (2018), a typical qualitative study may include 5 to 25 participants for phenomenological research. Similarly, Guest, Bunce, and Johnson (2006) argue that data saturation often occurs within the first 6–12 interviews. Given the focused scope of this case study and the goal of exploring organisational adaptation in depth, the

selected sample of 10 participants was deemed sufficient to capture the complexity of experiences and perceptions.

3.6.1 Sampling Technique: Purposive Sampling

Given the qualitative nature of this research and its focus on in-depth insights into the experiences and perceptions related to Industry 4.0, a purposive sampling technique was selected. Purposive sampling allows for the deliberate selection of participants based on specific criteria and characteristics that are relevant to the research questions (Sharma, 2017). This method is particularly suited to the exploratory studies where the aim is to gain a deep understanding of a phenomenon from the viewpoints of those who are most intimately involved or affected. Credible references, including Creswell and Creswell (2017), justify the sufficiency of qualitative samples, where depth and information-rich responses are prioritised over numerical generalizability. The sample effectively represents critical perspectives necessary to understand the nuanced implications of Industry 4.0 technologies in the organisation.

In this context, the participants were chosen based on their direct experience with or their influence over implementing and integrating the Industry 4.0 technologies within the company. This included the individuals who have been part of the teams rolling out new digital tools, the employees who have undergone significant changes in their job roles due to automation, and the leaders who have spearheaded digital transformation initiatives.

3.6.2 Linking Theory to Practice

The choice of purposive sampling was deeply intertwined with the study's theoretical underpinnings, which emphasise the construction of knowledge through the subjective experiences of individuals. By selecting the participants who offered diverse yet relevant insights into Industry 4.0, the research aimed to uncover the multifaceted ways these technologies are integrated into the organisational practices, shape work dynamics, and influence company culture.

This approach ensured that the sampling strategy was not only aligned with the research's qualitative and interpretivist orientation, but it also facilitated the collection

of rich, detailed data that could illuminate the complexities of digital transformation within the specific context of a South African technology organisation.

This study's population and sampling strategy were designed to ensure that the research captured a broad, yet focused spectrum of experiences and perceptions related to Industry 4.0 within the chosen technology company. By employing purposive sampling, the study aimed to engage with the participants who could provide valuable insights into the nuances of technological adoption and its implications, thereby grounding the theoretical exploration in the lived realities of the workforce. This deliberate alignment of theory and practice is crucial for the depth and relevance of the research findings, by contributing to a nuanced understanding of the interplay between technology and the human factors in the digital transformation era.

3.7 Data Collection Instruments

Following the population and sampling strategy delineation, discussing the instruments that facilitate qualitative data collection is essential. The study aimed to delve into the subjective experiences and the perceptions of Industry 4.0 technologies, so semi-structured interviews were selected as the primary data collection instrument. This choice was underpinned by the instrument's flexibility and the capacity to elicit rich, in-depth insights, thus making it particularly suited to qualitative research (Aborisade, 2013). While focus group discussions are a valuable method in qualitative research, this study deliberately chose semi-structured individual interviews to provide a more in-depth and private space for participants to reflect on sensitive organisational changes. Given the hierarchical structure of the organisation, group settings could have limited openness, especially among lower-level staff who may feel constrained by the presence of senior personnel. One-on-one interviews ensured confidentiality and allowed participants to share more nuanced perspectives, particularly regarding internal adaptation challenges and technological skill gaps.

3.7.1 Semi-Structured Interviews

The semi-structured interviews occupy a pivotal role in qualitative research due to their balanced structure. This format combines predetermined questions with the opportunity for open-ended responses and follow-up inquiries. This format allows the researcher to explore specific topics relevant to the research objectives while remaining open to new themes and perspectives that may emerge during the

conversation. Semi-structured interviews were selected due to their flexibility, allowing exploration of both anticipated and emergent themes. This method enabled capturing detailed narratives and in-depth insights into the personal experiences, perceptions, and challenges faced by employees across organisational levels. While focus groups could facilitate dynamic interactions, interviews were chosen to ensure candidness and depth, particularly when discussing sensitive issues like job security and organisational change.

The semi-structured interview process involved the following components:

- **Interview guide:** Based on the research questions and the literature review, a set of key questions and topics were prepared in advance. This guide served as a roadmap for the interviews, by ensuring that all the relevant areas are covered while allowing flexibility in the conversation flow.
- **Open-ended questions:** The questions were designed to encourage the participants to share their experiences, feelings, and thoughts in their own words. This approach facilitated the emergence of personal narratives and detailed accounts that provided valuable insights into the impact of the Industry 4.0 technologies.
- **Probing and follow-up:** The semi-structured interviews allowed the researcher to ask follow-up questions or to probe deeper into the responses. This flexibility was crucial for clarifying points, exploring complex issues in more detail, and for uncovering the underlying meanings.

3.7.2 Role in Qualitative Research

The semi-structured interviews are particularly effective in qualitative research because they aligned with the interpretivist and the constructivist paradigms underlying this study. They provided a platform for the participants to construct and communicate their realities, by offering the researcher a window into the subjective interpretations and the meanings that the individuals assign to their experiences with digital transformation.

Furthermore, the semi-structured interviews enable the researcher to engage with the nuances of human behaviour and organisational culture in the context of Industry 4.0, thereby capturing the diversity of perspectives within the target population. This

method is conducive to building rapport with the participants, thereby creating a space where they feel comfortable sharing candid reflections and insights.

The selection of semi-structured interviews as the primary data collection instrument was a deliberate methodological choice that reflected the study's qualitative and exploratory nature. By facilitating in-depth discussions and personal narratives, this instrument yielded rich data that could illuminate the multifaceted implications of Industry 4.0 within the selected technology company. Through this approach, the research aimed to capture a comprehensive understanding of how digital transformation is experienced and navigated by individuals at various levels of the organisation, thus contributing valuable insights to the broader discourse on technology and work.

3.8 Data Analysis

Data analysis in qualitative research is pivotal for distilling meaningful insights from collected data. It involves a nuanced process of understanding, describing, and interpreting data to yield credible findings (Delanunt & Maquire, 2018). This study employed thematic analysis due to its versatility in identifying and exploring patterns within the qualitative datasets. Thematic analysis stands out for its ability to adapt to diverse data sets, thereby making it an ideal choice for delving into the participants' views, opinions, knowledge, experiences, and values (Delanunt & Maquire, 2018; Braun & Clarke, 2006).

3.8.1 Thematic Analysis Framework

This study employed inductive thematic analysis, where themes were allowed to emerge organically from the data rather than being pre-imposed by existing theoretical frameworks. This approach aligns with the exploratory nature of the research and supports the interpretivist paradigm adopted. Thematic coding and analysis were conducted using NVivo 12 software, which facilitated data organisation, code development, and thematic mapping. The use of inductive analysis helped uncover patterns in participants' experiences with Industry 4.0 technology adoption and organisational adaptation without biasing the results toward pre-determined categories. The process of thematic analysis is delineated into six methodical steps, each crucial for the comprehensive examination of qualitative data (Delanunt & Maquire, 2018):

- **Familiarizing with the data:** The initial phase involves immersing oneself in the data through repeated readings of the collected material. This immersion is critical for understanding the data's depth and breadth, thus setting the foundation for subsequent analysis.
- **Generating initial codes:** Coding represents the organization of data into meaningful segments. This step breaks the data into manageable units by assigning codes encapsulating their essence. The coding process is influenced by the researcher's analytical perspective and the study's guiding questions.
- **Searching for themes:** Themes emerge from the collated codes, encapsulating significant patterns relevant to the research questions. This stage is about synthesizing and grouping codes into potential themes that reflect overarching insights within the data.
- **Reviewing themes:** In this critical step, themes are scrutinized and refined. The researcher evaluates whether the themes cohesively represent the coded data and the entire dataset, thus ensuring that they accurately convey the study's findings.
- **Defining and naming themes:** Each theme is clearly defined and named, describing what it represents and its relevance to the research inquiry. This process solidifies the themes as the critical findings of the study.
- **Producing the report:** The culmination of thematic analysis is the integration of the themes into a coherent narrative that addresses the research questions. This involves selecting illustrative quotes and discussing the implications of the findings within the broader context of existing literature and the study's objectives.

3.8.2 Utilising NVivo in Thematic Analysis

NVivo, a qualitative data analysis software, was employed to augment the rigour and organisation of the thematic analysis. Bonello and Meehan (2019) as well as Mozzato, Grzybovski and Teixeira (2017) highlight their role in facilitating a more structured and transparent approach to qualitative data analysis. Phillips and Lu (2018) as well as Mortelmans (2019) discuss its functionality, learnability, and role in data management, coding, and analysis. NVivo facilitated a more structured and efficient approach to managing and analysing qualitative data, thus aligning with the six-step framework outlined above:

- **Familiarizing with the data:** NVivo allowed the importation of various data formats, thereby enabling an interactive and immersive engagement with the material. The software's ability to organize and categorize data aided in a comprehensive understanding of the content.
- **Generating initial codes:** With NVivo, the initial codes were systematically applied to the data. The software's coding features supported identifying and labelling data segments, thus making the coding process more manageable and consistent.
- **Searching for themes:** The NVivo's query and search functions assisted in identifying patterns and relationships within the coded data, thereby facilitating the emergence of potential themes from the initially coded segments.
- **Reviewing themes:** The software's visualization tools, such as the mind maps and the word clouds provided a visual representation of the data, thus aiding in the review and in the refinement of the themes. NVivo allowed for the easy reorganization and the modification of themes as the analysis progressed.
- **Defining and naming themes:** The NVivo's framework matrices and coding structures offered a platform to define and elaborate on themes, ensuring that data robustly supported each theme.
- **Producing the report:** NVivo supported extracting pertinent quotes and synthesizing data into a coherent narrative. The software's output features enabled the creation of reports that effectively communicated the thematic analysis findings, ensuring clarity and depth in presenting the research outcomes.

Through the structured yet flexible thematic analysis approach, the study aimed to articulate a nuanced understanding of the impacts of Industry 4.0 within the chosen technology company. By rigorously following these analytical steps, the research provided a detailed exploration of the complex interplay between technology and human experiences, thereby enriching the discourse on digital transformation in the workplace. This iterative and reflective process ensured the credibility and the depth of the qualitative analysis, by contributing significantly to the study's overall findings. Integrating NVivo into the thematic analysis process benefited the research by offering a systematic approach to data management and analysis, thereby enhancing the

validity and the reliability of the findings. This integration underscored a commitment to rigorous qualitative analysis, leveraging technological tools to deepen the understanding of the data. NVivo was selected as the primary tool for data analysis due to its capacity to manage large volumes of qualitative data efficiently. It enabled the researcher to code transcripts systematically, track emerging themes, and visualise data relationships. These capabilities enhanced the rigour and transparency of the qualitative analysis, supporting validity through traceable and reproducible analytical steps.

3.9 Ethical Considerations

The ethical considerations are paramount in any research involving human subjects, serving as the bedrock to ensure their protection and rights throughout the study (Arifin, 2018). This study which explored the implications of Industry 4.0 within a South African technology company, was committed to upholding the highest ethical standards, guided by informed consent, confidentiality, anonymity, and harm minimisation.

3.9.1 Informed Consent

Central to ethical research is the informed consent, which ensures that the participants are fully briefed about the study's purpose, methodology, potential risks, and benefits (Arifin, 2018). This study provided the participants with detailed information packets and consent forms, clearly articulating the research objectives, participation, and the rights as participants, including the right to withdraw without penalty. The researcher obtained either verbal or written consent, thus ensuring that the participants are competent to consent and clearly understand their involvement in the study.

3.9.2 Confidentiality and Anonymity

Protecting the participants' confidentiality and anonymity is crucial to fostering a trustful environment where the individuals feel safe sharing their experiences and insights. As Arifin (2018) note, measures were taken to ensure that personal identifiers were not disclosed at any stage of the research process, from data collection to analysis and reporting. All the data was coded, and any potentially identifying information was altered or removed to maintain participant anonymity.

3.9.3 Minimisation of Harm

The well-being of the participants is a priority, with measures in place to minimise any form of harm; be it physical, emotional, or psychological (Fleming & Zegwaard, 2018). The research design and interview protocols were carefully crafted to avoid sensitive topics that could potentially cause distress. However, the participants can immediately pause or terminate their participation if discomfort arises during the interviews. Furthermore, the researcher debriefed the participants following their involvement to address any concerns or distress that may have arisen, by offering appropriate support or referrals as needed.

3.9.4 Ongoing Ethical Vigilance

The researcher acknowledges the dynamic nature of ethical considerations and remained vigilant to address the new ethical issues that emerged during the research process. This included being attuned to the subtle nuances of participant interactions, being prepared to adapt consent procedures, and ensuring transparent communication throughout the study.

Ethical integrity formed the cornerstone of this research, guiding each step of the process to safeguard all the participants' dignity, rights, and welfare. By adhering to these ethical principles, the study ensured the protection of the participants. It enhanced the credibility and the reliability of the research findings, by contributing valuable insights into the human aspects of Industry 4.0 within the organisational setting.

3.10 Conclusion

This chapter meticulously outlined the methodological framework underpinning this study, detailing the philosophical foundations, the research design, the approach, and the ethical considerations that guided the exploration of Industry 4.0's implications within a South African technology company. Central to this methodology was a commitment to capturing the individuals' nuanced, subjective experiences navigating the transformative landscape of digital technologies in the workplace.

Summary of methodological approach: The study is anchored in an interpretivist and constructivist paradigm, emphasising the importance of understanding the participants' subjective meanings and constructed realities. This theoretical stance

informed the selection of a qualitative research approach, which was deemed to be most suitable for delving into the complex, multifaceted nature of human interactions with the Industry 4.0 technologies. The exploratory nature of the research, facilitated by an inductive strategy, allowed for a flexible, open-ended inquiry into the emerging themes and the insights related to the digital transformation's impacts on organisational dynamics and employee roles.

Data collection and analysis: Semi-structured interviews were identified as the primary data collection instrument, and they were chosen for their ability to elicit rich, detailed narratives that reveal the depth of the participants' experiences, perceptions, and responses to Industry 4.0. This method aligned with the study's qualitative ethos, thus enabling a deep dive into the individuals' personal and collective journeys within the technology company. Thematic analysis was subsequently employed to identify, analyse systematically, and report patterns within the data, thereby ensuring a rigorous and insightful interpretation of the findings concerning the research questions and objectives.

Ethical considerations: Ethical integrity was paramount throughout the methodological planning, with comprehensive measures in place to ensure the protection, respect, and care of all the participants. Informed consent, confidentiality, anonymity, and harm minimisation formed the pillars of the study's ethical framework, thus reflecting a commitment to conducting methodologically sound and morally responsible research.

Setting the stage for empirical work: The methodology outlined in this chapter set a robust foundation for the following empirical investigation. It provided a clear, coherent roadmap for the study, by ensuring that each methodological choice was purposefully aligned with the overarching research questions and objectives. As the study moves to the empirical chapters, the insights garnered through this methodological approach promise to shed light on the intricate interplay between technology and the people, by offering valuable contributions to the discourse on Industry 4.0 and its ramifications for the future of work.

In summary, this methodology chapter has laid the groundwork for a comprehensive, ethically grounded investigation into the evolving dynamics of Industry 4.0 within the organisational context. It has paved the way for empirical findings that will enrich the understanding of digital transformation's impacts on the workforce and the workplace practices.

CHAPTER 4

RESULTS AND ANALYSIS

4.1 Introduction or overview of the chapter

This chapter presents the culmination of the empirical investigation conducted to understand the multifaceted impacts of digitalisation and Industry 4.0 within the context of a technology organisation. Drawing on the insights gathered from the structured interviews with the professionals at the telecoms company, the study delves into the core findings that respond to the research questions that are central to this study. The analysis unfolds the intricate layers of how digitalisation is shaping the employment dynamics and delineating the pivotal roles the employees play in leveraging the opportunities of Industry 4.0, and it also uncovers the strategic imperatives for leadership in fostering a workforce that is agile, competent, and ready for the challenges of a rapidly evolving technological landscape. Herein, the study synthesises the collected data, by offering a comprehensive examination of the emergent themes, the variances, and the patterns that shed light on the complex interplay between technological advancement and human capital development in contemporary organisational change.

The analysis in this chapter provides deeper thematic interpretation by explicitly connecting findings to the dimensions of the Technology Readiness and Acceptance Model (TRAM). Respondents identified significant benefits of adopting Industry 4.0 technologies, specifically highlighting the dimensions of Perceived Usefulness (PU) and Perceived Ease of Use (PEU). However, alongside these positive perceptions, notable themes emerged around discomfort and insecurity. Employees expressed concerns related to job security, skills adequacy, and the rapid pace of technological change, underscoring a critical tension in technology adoption and acceptance. This dual perspective indicates a need for targeted interventions within the organisation to support smoother transitions, improve confidence, and mitigate anxiety associated with digital transformation.

4.2 Findings

Following the introductory overview, the study proceeds with a detailed exposition of the thematic inquiries that underpin this analysis. For Research Question 1 (RQ1), the

research analyses how digitalisation is anticipated to sculpt employment within the organisation, focusing on emerging technological trends and their implications for job creation, productivity, and the evolution of workplace culture and collaboration. In Research Question 2 (RQ2), the attention pivots to the integral role of the employees in capitalising on the offerings of Industry 4.0. Here, the study explores the necessary skills, the adaptation strategies that are in place, and the innovative contributions of the workforce as they align with the new job roles and career trajectories.

In addressing Research Question 3 (RQ3), the spotlight shines on the leadership strategies for preparing the workforce for the advent of Industry 4.0. This includes cultivating a conducive learning environment, ensuring diversity, balancing automation with indispensable human skills, and engaging employees in embracing new technologies. Finally, Research Question 4 (RQ4) focuses on the strategic imperatives for a technology company to guarantee that the employees are sufficiently equipped with the skills that Industry 4.0 demands. This part of the investigation encompasses identifying specific skill sets, learning modalities' efficacy, skill advancement's motivational aspects, and the strategic recruitment of new talent to build a future-ready organisation.

Each research question unravels distinct yet interlinked dimensions of how digitalisation and Industry 4.0 are set to redefine the technological corporation's internal landscape, with a concerted focus on the human element within this digital transformation.

4.2.1 Research Question 1

How will digitalisation shape employment in a technology organisation?

This section presents the findings from the thematic analysis of the conducted interviews with the participants from the telecoms company, focusing on their perceptions of how digitalisation transforms employment within the technology organisations. The results highlight key trends, the impact on job roles, organisational adaptation strategies, and the necessary shifts in employee skill sets. The following subsection outlines the thematic analysis to explore how digitalisation shapes employment in a technology organisation, specifically within the telecoms company. The study involved a detailed review of the interview transcripts with various

participants, focusing on their experiences and insights related to the impact of digital technologies on the organisational roles and processes. The thematic analysis identified key themes and the associated codes that describe the nuances of how digitalisation influences the employment dynamics.

4.2.1.1 Presentation of codes and themes – RQ1

Theme 1(a): Technological Advancements

Description: This theme captures how the emerging technologies such as AI, IoT, cloud computing, and automation are integrated into workplace practices and strategies.

Codes:

- **AI implementation** refers to adopting and integrating artificial intelligence in various operational functions.
 - **Example:** "Artificial intelligence as holistic will be the future for us in the next two to five years" - Participant 7.
- **Automation of routine tasks:** Involves using technology to automate standardized and repetitive tasks.
 - **Example:** "We have automated our response on call centres... automated our operational centres" - Participant 7.
- **IoT and infrastructure resilience:** Focuses on using the IoT technologies to enhance infrastructure resilience and operational efficiency.
 - **Example:** "IoT and cloud are shaping us significantly, especially as we tackle power outages and other infrastructural issues" - Participant 6.

Theme 1(b): Impact on Employment

Description: Discusses the transformation and the creation of job roles due to digitalisation, by focusing on how the traditional jobs are evolving and new roles are emerging.

Codes:

- **Job evolution:** Describes how existing roles are changing to incorporate new technological skills and responsibilities.

- **Example:** "Organizations need to repurpose some of the skills that are becoming redundant while identifying new skills that will make an organization competitive in a digitized landscape" - Participant 2.
- **Creation of new roles:** Refers to the emergence of entirely new job categories driven by technological advancements.
 - **Example:** "Digitalization fosters job creation, especially in fields like software development and data analysis" - Participant 3.

Theme 1(c): Organisational Strategies and Employee Adaptation

Description: Explores how the organisations strategize and adapt their workforce in response to the demands of digitalisation.

Codes:

- **Learning and development strategies:** Focuses on the initiatives designed to facilitate continuous learning and skill development in alignment with the digital trends.
 - **Example:** "Organizations must craft learning paths for employees, showcasing future skill requirements and actively engaging employees in understanding and preparing for the future" - Participant 5.
- **Adaptation to automation:** How the employees adapt to increased automation and what this means for their roles and skill requirements.
 - **Example:** "Employees in sectors like manufacturing and agriculture should seek training in emerging technologies such as AI and IoT to adapt to changes brought about by Industry 4.0" - Participant 1.

The themes and codes derived from the thematic analysis provide a structured understanding of how digitalisation impacts employment within the technology organisations. Each theme is supported by specific codes, thus illustrating the breadth of the experienced changes and the employed strategies to navigate these changes effectively. This structured presentation of themes and codes sets the foundation for a detailed discussion of the findings in the subsequent sections.

4.2.1.2 Detailed Results for RQ1 Themes

- **Key technological trends:** The participants identified several technological trends that are pivotal to shaping employment in technology organizations, particularly AI, automation, the IoT, and cloud computing. These technologies are driving significant changes in how the organizations operate and compete. **Participant 7** emphasized the role of automation and AI: "We have automated our response on call centres...automated our operational centres. Artificial intelligence as a holistic approach will be our future in the next two to five years". **Participant 6** highlighted the impact of IoT and cloud technologies, noting their importance in overcoming infrastructure challenges and improving resilience, "IoT and cloud are shaping us significantly, especially as we tackle power outages and other infrastructural issues".
- **Impact on jobs:** The effect of digitalization on employment was predominantly viewed through the lens of transformation rather than displacement. The participants discussed how digitalization creates new job opportunities and transforms existing roles rather than merely reducing the headcount. **Participant 2** discussed the dual effect of digitalization on jobs, "Organizations need to repurpose some of the skills that are becoming redundant while identifying new skills that will make an organization competitive in a digitized landscape". **Participant 3** provided insights into how digitalization fosters job creation, especially in fields such as software development and data analysis which are critical to leveraging new technologies.
- **Organizational strategies and employee adaptation:** The consensus among the participants was that successful digitalization requires proactive organizational strategies and a strong focus on employee adaptation and skill development. Participant 5 underscored the importance of organizational learning strategies, "Organizations must craft learning paths for employees, showcasing future skill requirements and actively engaging employees in understanding and preparing for the future". Participant 1 advocated for upskilling, especially in the areas that are prone to automation, "Employees in sectors like manufacturing and agriculture should seek training in emerging technologies such as AI and IoT to adapt to changes brought about by Industry 4.0".

4.2.1.3 RQ1 Thematic Findings

The analysis revealed two major themes in response to this question: **reskilling opportunities** and **job displacement concerns**. Participants highlighted how digital transformation introduces both challenges and opportunities for the workforce.

1. **Reskilling Opportunities:** Many employees noted that digital tools and technologies provided avenues to develop new skills, making them more efficient and relevant in their roles. For instance, one participant explained, *“Automation allows me to focus on strategic tasks instead of repetitive work, but it also means I’ve had to learn how to use these new tools.”*
2. **Job Displacement Concerns:** On the other hand, a significant number of participants expressed fears about the potential loss of jobs due to automation. One participant remarked, *“The new systems are impressive, but they make me wonder if I’ll still have a role here in a few years.”*

4.2.1.4 RQ1: Mapping TRAM Dimensions to Findings

The findings align closely with the key dimensions of the Technology Readiness and Acceptance Model (TRAM), providing deeper insight into how employees perceive and adapt to digital transformation.

- **Perceived Usefulness (PU):** Employees frequently emphasized the tangible benefits of digital tools, such as improved efficiency and reduced workload. For example, automation was seen as a way to streamline processes and free up time for more complex tasks. This reflects PU’s focus on the belief that technology enhances job performance.
- **Perceived Ease of Use (PEU):** While participants acknowledged the advantages of digital transformation, they also noted initial difficulties in learning to use new tools. For example, one employee shared, *“It took me weeks to figure out how to use the new system effectively.”* This finding highlights how ease of use affects acceptance.
- **Optimism:** Some employees expressed a forward-looking attitude, viewing the changes as an opportunity to grow professionally. As one participant stated, *“If we adapt to this technology, we’ll remain competitive in the future.”* This optimism aligns with the TRI dimension of positive expectations about technology.

- **Insecurity:** The fear of job loss was a recurring concern among participants, reflecting insecurity about the impact of automation. Employees questioned whether their roles would remain relevant as machines take on more tasks. This aligns with the TRI dimension of insecurity, which reflects doubts about technology's impact on stability and control.

Table 4-1: RQ1 Thematic Findings Summary

| TRAM Dimension | Thematic Findings | Participant Insight (Examples) |
|------------------------------|---|---|
| Perceived Usefulness | Tools improving productivity and reducing workload | "Automation frees up time for strategic projects." |
| Perceived Ease of Use | Initial difficulty in learning new systems, importance of training | "It took weeks of trial and error to understand the new IoT system." |
| Optimism | Positive attitudes toward future technological advancements | "This is the future. If we adapt, we'll be indispensable." |
| Insecurity | Fear of job displacement and mistrust of management's motives in adopting Industry 4.0 technologies | "Automation feels like a threat to our roles, even if management says it's for growth." |

Source: Own elaboration

4.2.2 Research Question 2

What is the role of the employees in exploiting the potential of Industry 4.0?

This section of the chapter addresses how the employees within the technology organisations can effectively exploit the opportunities presented by Industry 4.0. The insights derived from the interviews with the participants from a telecoms organisation were used to illustrate the critical roles and responsibilities that the employees must adopt to navigate this technological frontier successfully.

4.2.2.1 Presentation of codes and themes – RQ2

Theme 2(a): Necessary Skills and Competencies

Description: This theme focused on the essential technical and soft skills that the employees must develop to engage effectively and leverage Industry 4.0 technologies.

The participants highlighted the need for a blend of technical skills such as data analytics and AI, alongside the critical soft skills such as adaptability and strategic thinking.

Codes

- **Interdisciplinary skills:** This encapsulates the integration of diverse technical and non-technical skill sets to innovate and solve complex problems in the Industry 4.0 era.
 - **Example:** As noted by Participant 1, “Navigating the complexities of Industry 4.0 requires digital fluency and strategic thinking”.
- **Continuous upskilling** refers to learning and developing new skills to stay current with the evolving industry standards and technologies.
 - **Example:** Participant 2 emphasized, "In the fast-paced environment of Industry 4.0, continuous learning is crucial to keep up with technological advances and anticipate future needs".

Theme 2(b): Adapting to Industry 4.0 Changes

Description: This theme captured the processes and the actions through which the employees modify their skills and workflows to align with the evolving demands of a digitally transformed industrial landscape.

Codes

- **Personal initiative:** This aspect describes the proactive efforts of the individuals to engage in their professional development and embrace new challenges autonomously.
 - **Example:** Participant 8 stated, "Employees must take charge of their learning journeys, utilizing both company-provided resources and external opportunities".
- **Organizational frameworks:** Refers to the structured systems and practices implemented by a company to support and guide the employees' integration and utilization of the Industry 4.0 technologies.

- **Example:** Participant 5 highlighted, "Companies must create frameworks that anticipate and integrate the learning needs of their employees into everyday workflows".

Theme 2(c): Organisational Support and Employee Initiative

Description: This theme reflects the dynamic interplay between a company's efforts to provide resources and frameworks for Industry 4.0 readiness and the employees' proactive engagement in leveraging these opportunities for personal and professional growth. The balance between organisational support and employee initiative reinforces the collaborative nature that is necessary for harnessing Industry 4.0's potential.

Codes:

- **Strategic training initiatives:** Refers to carefully planned and executed programs to develop the workforce's skills in alignment with the company's long-term goals for adapting to and leveraging the Industry 4.0 technologies.
 - **Example:** Participant 2 noted, "Organizations must proactively design training programs aligned with industry advancements".
- **Employee engagement in learning:** Denotes the active participation and investment of the employees in their development through educational programs and the resources provided by the organization to stay abreast of the Industry 4.0 advancements.
 - **Example:** Participant 1 and Participant 8 stressed the importance of proactive engagement in learning and development activities.

4.2.2.2 Detailed Results for RQ2 Themes

- **Necessary skills and competencies:** The participants highlighted the necessity of the technical and soft skills to exploit the Industry 4.0 technologies effectively. The discussions strongly agreed on the need for continuous upskilling and adaptability. Participant 2 stressed the importance of adaptability in the face of rapid technological changes: "In the fast-paced environment of Industry 4.0, employees must not only keep up with technological advances but also anticipate them, ensuring they remain ahead of the curve". Participant 1 and Participant 6 emphasized the growing importance of the interdisciplinary

skills, including digital fluency and strategic thinking which are crucial for navigating the complexities of Industry 4.0.

- **Adapting to Industry 4.0 changes:** The adaptation strategies were frequently discussed, focusing on organizational support and individual initiative in fostering a culture of continuous learning. **Participant 8** noted the necessity of personal initiative in professional development: "Employees must take charge of their learning journeys, utilizing both company-provided resources and external opportunities to enhance their skillsets". Participant 5 highlighted the organizational role in facilitating adaptation: "Companies must create frameworks that not only support but also anticipate the learning needs of their employees, integrating new technologies into everyday workflows to drive familiarity and expertise".
- **Organizational support and employee initiative:** The balance between organizational support and employee initiative was a recurring theme, with the participants noting that the successful exploitation of Industry 4.0 requires efforts from both sides. Participant 2 discussed the strategic initiatives the companies must undertake to support their workforce: "Organizations need to proactively design training programs that are closely aligned with industry advancements, thereby equipping employees with relevant skills". Participant 1 and Participant 8 stressed the importance of employee engagement in learning and development activities, thus advocating for a proactive approach to personal and professional growth.

4.2.2.3 RQ2 Thematic Findings

Analysis of the data revealed two key themes regarding employees' roles in the transition to Industry 4.0: **proactive learning** and **engagement with new technologies**. These themes highlight the active contribution of employees in adapting to and supporting technological changes.

1. **Proactive Learning:** Many participants noted the importance of continuous learning to remain relevant in a rapidly changing technological landscape. For example, one participant shared, *"I've enrolled in multiple online courses to improve my understanding of automation tools so that I can stay ahead."* This proactive attitude demonstrates employees' willingness to adapt and develop new skills to meet Industry 4.0 demands.

2. **Engagement with Technology:** Employees also highlighted their hands-on involvement with new technologies, often serving as early adopters or testers. One employee stated, *“I like trying out the new tools before others; it helps me understand how to use them in my role.”* However, this engagement came with challenges, as some employees struggled with the complexity of systems, requiring additional training and support.

4.2.2.4 RQ2: Mapping TRAM Dimensions to Findings

The findings align closely with TRAM dimensions, illustrating how employees' perceptions and behaviours influence their roles in Industry 4.0 transitions.

- **Optimism:** Employees expressed a positive outlook toward new tools and technologies, seeing them as opportunities for growth and innovation. For instance, one participant commented, *“These technologies are exciting; they push me to think creatively and explore new possibilities.”* This reflects the TRI dimension of optimism, which focuses on the belief that technology brings benefits.
- **Perceived Ease of Use (PEU):** While employees were generally eager to engage with new systems, they often noted the difficulties in understanding and applying them effectively. One participant remarked, *“The IoT systems are powerful, but they’re not always intuitive. I’ve had to spend hours figuring them out.”* This finding aligns with TAM’s focus on the ease with which users can adapt to technology.
- **Innovativeness:** Some employees demonstrated a natural tendency to experiment with and adopt new technologies. For example, participants who actively volunteered to test new systems highlighted their comfort with technology and their desire to contribute to organizational change. This behaviour aligns with the TRI dimension of innovativeness.
- **Discomfort:** A smaller group of participants expressed feelings of being overwhelmed by the constant introduction of new systems. One participant shared, *“I sometimes feel there’s too much change too fast, and it’s hard to keep up.”* This finding reflects TRI’s discomfort dimension, which captures apprehension toward technology.

Table 4-2: RQ2 Thematic Findings Summary

| TRAM Dimension | Thematic Findings | Participant (Examples) | Insight |
|------------------------------|--|--|----------------|
| Optimism | Positive attitudes toward future technological advancements | "These technologies are exciting; they push me to think creatively." | |
| Perceived Ease of Use | Challenges in understanding and applying new systems | "The IoT systems are powerful, but they're not always intuitive." | |
| Innovativeness | A natural tendency to experiment with and adopt new technologies | "I like trying out the new tools before others; it helps me understand how to use them." | |
| Discomfort | Apprehension about the rapid pace of technological change | "I sometimes feel there's too much change too fast, and it's hard to keep up." | |

Source: Own elaboration

4.2.3 Research Question 3

How can the leadership prepare the workforce for Industry 4.0 in a technology organisation?

This section delves into the pivotal role of the leadership in preparing the workforce for the challenges and the opportunities of Industry 4.0. The insights from the participants from the telecoms company highlight various strategies that the leadership can employ to ensure that their teams are ready and proficient in navigating this new technological era. The following subsection outlines the thematic analysis undertaken to understand how the leadership can prepare the workforce for Industry 4.0 in a technology organisation. The study reveals the insights from the interviews with the telecom company executives and managers, focusing on the leaders' strategies and behaviours to prepare their teams for the technological shifts associated with Industry 4.0.

4.2.3.1 Presentation of codes and themes – RQ3

Theme 1 3(a): Leadership Commitment and Vision

Description: This theme encompassed the crucial role of leadership in articulating and driving the organisation's vision for Industry 4.0.

Codes:

- **Visionary leadership involves the leaders projecting a clear, compelling future, and** integrating Industry 4.0 into the organizational strategy.
 - **Example:** "Leaders must articulate a vision that incorporates Industry 4.0, ensuring that the entire organization is aligned and moving towards these new technological goals" - Participant 5.
- **Proactive change management:** The leaders must advocate for and actively engage in adopting and implementing new technologies.
 - **Example:** "Leaders must lead by example, continuously updating their skills and demonstrating their commitment to embracing Industry 4.0 technologies" - Participant 2.

Theme 3(b): Cultivating a Learning Culture

Description: Focuses on the efforts by the leadership to establish and maintain an organisational culture that prioritises continuous learning and adaptability.

Codes:

- **Learning infrastructure:** The leaders create and maintain infrastructures that support continuous and effective learning.
 - Example: "Leaders must establish and nurture a culture where continuous learning is valued, providing resources and opportunities for employees to learn and grow" - Participant 1.
- **Relevance and accessibility of learning:** Ensuring that the learning opportunities are relevant to the employees' roles and are easily accessible within the work environment.
 - Example: "Leadership should facilitate learning that is directly applicable to the employees' roles and the challenges posed by Industry 4.0, making it an integral part of daily work processes" - Participant 8.

Theme 3(c): Employee Empowerment and Engagement

Description: This theme explored how the leaders engage and empower the employees to actively participate in the organisation's transition to Industry 4.0.

Codes:

- **Decision-making inclusion:** The leaders involve the employees in decision-making processes, thereby enhancing their commitment and ownership of the transformation initiatives.
 - Example: "Empowering employees to contribute ideas and solutions that drive the digital transformation agenda is critical for fostering a sense of ownership and engagement" - Participant 7.
- **Clear communication and expectations:** Effective communication from the leadership about the Industry 4.0 initiatives and setting clear expectations for the employee roles and contributions.
 - Example: "Leaders must communicate clearly about the changes Industry 4.0 brings, setting clear expectations and providing the support needed to meet these expectations" - Participant 9.

This presentation of themes and codes outlines a comprehensive view of the strategies and behaviours that are essential for leadership in preparing the workforce for Industry 4.0. Each theme is supported by specific examples illustrating the codes and practical implementations of these strategies at the telecoms company. By integrating these themes into the broader discussion of how leadership can facilitate a successful transition to Industry 4.0, this analysis provides valuable insights into the proactive roles that are required of the leaders within the technology organisations.

4.2.3.2 Detailed Results for RQ3 Themes

- **Leadership commitment and vision:** The interviews underscored the importance of strong, visionary leadership in driving the adoption of Industry 4.0 technologies within the organizations. Participant 2 emphasized the need for the leaders to embrace change, by advocating for a proactive leadership style and being deeply involved in personal upskilling: "Leaders must lead by example, continuously updating their skills and demonstrating their commitment to embracing Industry 4.0 technologies". Participant 5 discussed the strategic role of the leadership in crafting a clear vision for the future, one

that integrates Industry 4.0 into the organizational strategy: "Leaders must articulate a vision that incorporates Industry 4.0, ensuring that the entire organization is aligned and moving towards these new technological goals".

- **Cultivating a learning culture:** The participants highlighted the critical role of the leadership in fostering an environment that supports continuous learning and adaptation. Participant 1 noted the necessity of creating a culture that values and encourages learning: "Leaders must establish and nurture a culture where continuous learning is valued, providing resources and opportunities for employees to learn and grow". Participant 8 stressed the importance of making learning accessible and relevant: "Leadership should facilitate learning that is directly applicable to the employees' roles and the challenges posed by Industry 4.0, making it an integral part of daily work processes".
- **Employee empowerment and engagement:** Engaging and empowering the workforce is seen as a critical strategy for the leadership to enhance readiness for Industry 4.0. Participant 7 discussed the importance of empowering the employees through involvement in the decision-making processes: "Empowering employees to contribute ideas and solutions that drive the digital transformation agenda is critical for fostering a sense of ownership and engagement". Participant 9 highlighted the role of clear communication and setting expectations: "Leaders must communicate clearly about the changes Industry 4.0 brings, setting clear expectations and providing the support needed to meet these expectations".

4.2.3.3 RQ3 Thematic Findings

The analysis identified two main themes in response to this question: **tailored training programs** and **transparent communication strategies**. These themes reflect the importance of organizational efforts in facilitating employees' adaptation to Industry 4.0 technologies.

1. **Tailored Training Programs:** Participants emphasized the need for ongoing and role-specific training to help them understand and use new technologies effectively. One participant explained, "*The training sessions were helpful, but I wish they were more tailored to the specific tools I use in my role.*" This highlights the necessity for customized learning approaches that align with employees' daily tasks.

2. **Transparent Communication Strategies:** Many employees stressed the importance of clear and open communication from management regarding the goals and implications of digital transformation. As one employee stated, *“Knowing why these changes are happening and how they’ll benefit us makes it easier to adapt.”* This finding underscores how transparency can reduce resistance and foster trust during transitions.

4.2.3.4 RQ3: Mapping TRAM Dimensions to Findings

The findings align closely with TRAM dimensions, revealing how employees’ perceptions and organizational interventions interact to shape successful transitions.

- **Perceived Usefulness (PU):** Employees acknowledged that well-designed training programs significantly enhance their ability to use new technologies effectively. One participant noted, *“After the training, I could immediately see how the tools could improve my efficiency.”* This reflects the TAM concept of PU, which focuses on the practical benefits of technology.
- **Perceived Ease of Use (PEU):** Tailored training programs also address challenges related to the complexity of new systems. For instance, participants highlighted that step-by-step guidance made it easier to navigate the tools. This aligns with TAM’s emphasis on the ease of learning and using technology.
- **Insecurity:** Transparent communication strategies were found to reduce employees’ fears of job displacement. One participant shared, *“When management explained that these tools would enhance our roles rather than replace us, I felt more secure.”* This directly relates to TRI’s insecurity dimension, which captures doubts about the stability of one’s role in the face of technological change.
- **Optimism:** Employees who felt supported by their organizations expressed optimism about the future. For example, one participant remarked, *“It’s exciting to be part of a company that’s preparing us for the future with these changes.”* This reflects TRI’s optimism dimension, emphasizing positive attitudes toward technological advancement.

Table 4-3: RQ3 Thematic Findings Summary

| TRAM Dimension | Thematic Findings | Participant Insight (Examples) |
|------------------------------|---|---|
| Perceived Usefulness | Training programs enhance efficiency and productivity | "After the training, I could immediately see how the tools could improve my efficiency." |
| Perceived Ease of Use | Step-by-step guidance simplifies the learning process | "The training sessions made it much easier to navigate the tools." |
| Insecurity | Transparent communication reduces fears of job displacement | "When management explained that these tools would enhance our roles, I felt more secure." |
| Optimism | Support from the organization fosters enthusiasm about future opportunities | "It's exciting to be part of a company preparing us for the future with these changes." |

Source: Own elaboration

4.2.4 Research Question 4

Which strategy can a technology company propose to ensure that the employees are equipped with the demands of the Industry 4.0 skills?

This section explores the strategic approaches that the technology companies can implement to ensure that their workforce is adequately prepared for the technological demands of Industry 4.0. The insights gathered from the interviews with the telecom company professionals provide a comprehensive overview of the effective skill development and readiness strategies. The next subsection outlines the thematic analysis undertaken to answer RQ 4. Drawing on the interviews with the telecom company professionals, this analysis identifies the critical strategic approaches and the underlying principles that can enhance workforce readiness for the technological demands of Industry 4.0.

4.2.4.1 Presentation of codes and themes – RQ4

Theme 4(a): Strategic Skills Development

Description: Focuses on the need for targeted skills development programs meticulously aligned with the evolving requirements of Industry 4.0.

Codes:

- **Specialized training:** This program emphasizes on training in specific technological areas that are critical to Industry 4.0, such as AI, big data, and IoT.
 - **Example:** "Skills in AI, big data, and IoT are not optional; they are essential. We need tailored training programs that focus specifically on these areas to ensure our workforce is competent and ready" - Participant 1.
- **Integration into daily work:** Highlights the importance of integrating skills development into the daily workflow to enhance learning application and retention.
 - **Example:** "Training should not be an occasional activity but integrated into daily tasks. Real-time learning and application of skills in projects can significantly enhance skill acquisition and retention" – Participant 6.

Theme 4(b): Customised Learning Pathways

Description: Discusses the necessity of tailoring the learning experiences to meet the individual needs of the employees, thereby enhancing their role-specific competencies and career aspirations.

Codes:

- **Personalization of learning:** Focuses on customizing the learning paths based on individual employee profiles and needs.
 - **Example:** "Each employee's learning path should be customized based on their current skills, job requirements, and career aspirations, which will help in bridging the skill gap more effectively" – Participant 5.
- **Adaptive learning technologies:** Advocates for using advanced learning technologies that adapt to the employees' unique learning styles and paces.

- **Example:** "Adopting digital platforms that offer adaptive learning can be a game-changer. These platforms customize content to meet the unique needs of each learner, making the learning experience more relevant and engaging" - Participant 4.

Theme 4(c): Fostering Innovation and Creativity

Description: Encourages cultivating an organisational culture that promotes creativity and innovation to leverage the Industry 4.0 technologies fully.

Codes:

- **Creative thinking in technology application:** Emphasizes the importance of innovative thinking in applying new technologies to enhance business processes.
 - **Example:** "We must foster an environment where creative thinking is encouraged. This way, employees can think innovatively about how to apply Industry 4.0 technologies in ways that enhance our operations and service delivery" - Participant 2.
- **Supportive environment for innovation:** Stresses the need for a supportive workplace that allows the employees to experiment and learn from failures without fear.
 - **Example:** "It is not just about having the skills but also the right environment that encourages experimentation and learning from failures without fear of repercussions" – Participant 9.

Theme 4(d): Leadership and Vision in Talent Development

Description: Highlights the critical role of the leadership in shaping and driving the talent development strategy to align with Industry 4.0.

Codes:

- **Visionary leadership:** The leaders must articulate and drive a clear vision for the future skills landscape of the organization.

- **Example:** "Leaders must clearly articulate the skills future of the organization and ensure that all talent development initiatives are closely aligned with this vision" - Participant 7.
- **Leader participation in learning:** The leaders should actively participate in the learning initiatives to better understand the technologies and to set an example for their teams.
 - **Example:** "Leaders themselves should engage in these training programs to not only better understand the technologies but also to set an example for their teams" - Participant 1.

This structured presentation of themes and codes provides a comprehensive view of the strategic approaches that are necessary for preparing the employees for Industry 4.0. It illustrates how a combination of targeted skill development, customised learning pathways, innovative culture fostering, and visionary leadership can collectively ensure that a technology company's workforce is ready to meet the demands of the digital future. This analysis identifies the key strategies and offers practical examples of how these strategies are being implemented at a telecoms company, by providing valuable insights for other organisations navigating similar transformations.

4.2.4.2 Detailed Results for RQ4 Themes

- **Strategic skills development:** A key theme that emerged from the interviews is the necessity for targeted skills development programs aligned with the specific needs of Industry 4.0. Participant 1 highlighted the importance of specialized training in critical technological areas: "Skills in AI, big data, and IoT are not optional; they are essential. We need tailored training programs focusing specifically on these areas to ensure our workforce is competent and ready." Participant 6 emphasized integrating skills development into daily work: "Training should not be an occasional activity but integrated into daily tasks. Real-time learning and application of project skills can significantly enhance skill acquisition and retention".
- **Customized learning pathways:** The necessity for personalized learning experiences tailored to individual employee roles and career aspirations was consistently emphasized. Participant 5 discussed the effectiveness of personalized learning pathways: "Each employee's learning path should be

customized based on their current skills, job requirements, and career aspirations, which will help in bridging the skill gap more effectively". Participant 4 advocated using technology to enhance learning: "Adopting digital platforms that offer adaptive learning can be a game-changer. These platforms can customize content to meet the unique needs of each learner, making the learning experience more relevant and engaging".

- **Fostering innovation and creativity:** Encouraging a culture of innovation and creativity is essential for fully leveraging the capabilities of Industry 4.0 technologies. Participant 2 stressed the role of creativity in utilizing technology: "We need to foster an environment where creative thinking is encouraged. This way, employees can think innovatively about how to apply Industry 4.0 technologies in ways that enhance our operations and service delivery". Participant 9 discussed the importance of a supportive environment for innovation: "It is not just about having the skills but also the right environment that encourages experimentation and learning from failures without fear of repercussions".
- **Leadership and vision in talent development:** The leadership plays a crucial role in driving the strategic direction for talent development in line with the Industry 4.0 demands. Participant 7 highlighted the importance of visionary leadership: "Leaders must clearly articulate the skills future of the organization and ensure that all talent development initiatives are closely aligned with this vision". Participant 1 added that the leadership should actively participate in the learning initiatives: "Leaders should engage in these training programs to better understand the technologies and set an example for their teams".

4.2.4.3 RQ4 Thematic Findings

The analysis uncovered two key themes in response to this question: **incentivizing innovation** and **fostering collaborative environments**. These themes highlight the importance of actively engaging employees through targeted strategies.

1. **Incentivizing Innovation:** Participants emphasized that recognizing and rewarding employees for adopting and innovating with new technologies encourages active engagement. For instance, one employee shared, "When

my idea for improving automation was implemented, it motivated me to keep experimenting with the tools.”

2. **Fostering Collaborative Environments:** Employees also highlighted the value of teamwork in navigating Industry 4.0 transitions. Collaborative projects and peer learning opportunities were frequently cited as essential for easing the adaptation process. One participant remarked, *“When we work together on these new systems, it feels less daunting, and we learn from each other.”*

4.2.4.4 RQ4: Mapping TRAM Dimensions to Findings

The findings align with the dimensions of TRAM, demonstrating how strategies can shape employees’ engagement with Industry 4.0 technologies.

- **Optimism:** Incentivizing innovation promotes a positive outlook toward new technologies. For example, one participant noted, *“Being rewarded for my contributions shows that the company values our input and the opportunities these tools bring.”* This aligns with TRI’s optimism dimension, highlighting how recognition fosters enthusiasm for technological advancements.
- **Innovativeness:** Employees who were encouraged to experiment with technologies showed a willingness to adopt and innovate. One participant said, *“I feel confident trying new tools because the organization supports creative ideas.”* This reflects TRI’s innovativeness dimension, which captures a readiness to explore and embrace technology.
- **Perceived Ease of Use (PEU):** Collaborative environments made it easier for employees to understand and adapt to complex systems. Peer learning and teamwork reduced barriers to technology use, with one employee stating, *“Working with colleagues on these systems helps me pick up skills faster.”* This aligns with TAM’s focus on how ease of use affects adoption.
- **Perceived Usefulness (PU):** Employees who participated in collaborative projects often discovered new ways to leverage technologies for their roles. For example, one participant explained, *“By collaborating with my team, I realized how these tools could improve not only my work but our entire department’s output.”* This finding reflects PU’s emphasis on perceived benefits of technology.

Table 4-4: RQ4 Thematic Findings Summary

| TRAM Dimension | Thematic Findings | Participant Insight (Examples) |
|------------------------------|--|--|
| Optimism | Recognition of contributions fosters enthusiasm for new technologies | "Being rewarded for my contributions shows that the company values our input." |
| Innovativeness | Encouragement to experiment promotes adoption and innovation | "I feel confident trying new tools because the organization supports creative ideas." |
| Perceived Ease of Use | Collaboration simplifies understanding and adaptation | "Working with colleagues on these systems helps me pick up skills faster." |
| Perceived Usefulness | Teamwork highlights how technologies can improve individual and team performance | "I realized how these tools could improve not only my work but our entire department." |

Source: Own elaboration

CHAPTER 5

DISCUSSIONS

5.1 Introduction

This chapter discusses the key findings of the study, integrating them with relevant theoretical frameworks to provide a deeper understanding of how Industry 4.0 is shaping the workforce and organisational strategies. The study explored how employees, leadership, and organisational structures are adapting to digital transformation and technological advancements. The discussion first examines how the empirical findings align with or diverge from existing theories on digitalisation, workforce readiness, and organisational change. The impact of Industry 4.0 on employees' skills, job roles, and overall employment trends is assessed, highlighting both opportunities and challenges. The chapter also evaluates how leadership is preparing the workforce for digital transformation, focusing on the Technology Readiness and Acceptance Model (TRAM) and transformational leadership theories.

Additionally, this chapter presents strategic recommendations for organisations to develop workforce skills, enhance employee engagement, and foster a culture of continuous learning. The study findings also contribute to refining existing theoretical models by emphasising the need for ongoing skills adaptation and leadership evolution in the digital era. By synthesising these insights, this chapter provides a comprehensive perspective on how organisations can successfully navigate Industry 4.0. The aim is to bridge the gap between theory and practice, ensuring that businesses and employees are well-equipped for the ongoing digital transformation.

5.2 Integration of Empirical Findings with Theoretical Frameworks

This section explores how the empirical findings from the study align with, diverge from, or expand upon the theoretical frameworks introduced at the outset of this research. It examines the intersection between the qualitative data gathered from the telecom company professionals and the established theories regarding technological adaptation and workforce readiness in the era of digitalisation and Industry 4.0.

5.3 Implications for Workforce Readiness and Organizational Change

The TRAM-based analysis highlights the complex interplay between employee attitudes and organizational strategies during digital transformation. Each dimension

of TRAM, that is, Perceived Usefulness (PU), Perceived Ease of Use (PEU), Optimism, Innovativeness, Discomfort, and Insecurity—offers actionable insights for workforce development and organizational adaptation.

- **Perceived Usefulness (PU):** Employees who recognize the practical benefits of Industry 4.0 technologies are more likely to adopt them. For instance, findings show that employees valued automation tools for improving productivity and reducing routine tasks. Organizations can leverage this by clearly communicating the specific advantages of new technologies and demonstrating their relevance to individual roles. Tailored training programs that emphasize real-world applications can further enhance this perception, fostering a sense of purpose and alignment with technological advancements.
- **Perceived Ease of Use (PEU):** The ease with which employees can learn and use new systems significantly affects their engagement and readiness. Findings revealed that initial challenges in understanding complex technologies often created barriers to adoption. To address this, organizations should focus on simplifying interfaces, providing step-by-step guidance, and offering role-specific support. Collaborative environments, where employees can learn from peers, also play a critical role in reducing these barriers and increasing confidence in using new tools.
- **Optimism and Innovativeness:** Optimism and innovativeness emerged as critical drivers of proactive engagement with Industry 4.0 technologies. Employees who felt supported and encouraged by their organizations expressed enthusiasm for experimenting with and adopting new tools. Incentivizing innovation through recognition and rewards can strengthen this attitude, creating a culture of experimentation and growth. Moreover, fostering a sense of shared purpose through collaborative projects can amplify these positive attitudes, positioning employees as active contributors to technological transformation.
- **Insecurity and Discomfort:** Negative perceptions, such as insecurity about job displacement and discomfort with rapid technological change, were also significant. Transparent communication strategies emerged as a key solution, with employees reporting reduced fears when organizations provided clear explanations of how new technologies would complement rather than replace

their roles. Addressing discomfort requires a long-term commitment to building trust, ensuring that employees feel included in the transformation process, and providing consistent opportunities for reskilling.

5.4 Workforce Strategies for Successful Organizational Change

The findings of the assessment of the impact of digitalisation on employment (Research Question 1) align with the Technology Readiness and Acceptance Model (TRAM) principles. The employees' readiness to adapt to digital changes underscores the TRAM's emphasis on perceived usefulness and ease of use. The necessity of continuous upskilling resonates with the idea that acceptance is an ongoing process, thereby suggesting that the acceptance models could benefit from incorporating an element of continuous adaptation to maintain relevance over time.

Research Question 2 which focused on the role of the employees in exploiting Industry 4.0, revealed that proactive initiatives and interdisciplinary skill integration are critical factors. Employee proactive engagement further emphasises the need for individual initiative in personal and professional growth.

The study's findings related to the leadership's role in fostering workforce readiness for Industry 4.0 (Research Question 3) echo that there are leaders at a telecoms company who effectively communicate a vision for digital transformation and encourage a learning culture that exemplifies transformational leadership traits. These observations suggest that transformational leadership is integral to successfully navigating the Industry 4.0 challenges. Lastly, Research Question 4's insights into the strategic skills development approaches emphasise a greater focus on emerging digital skills. Consequently, this research suggests potential enhancements to these frameworks. For example, the TRAM could be extended to include continuous learning aspects, while the transformational leadership theory might be expanded to incorporate digital literacy as a leadership competency.

The empirical data from this study supports existing theoretical constructs and adds nuanced perspectives that could inform future theoretical development. Integrating empirical findings with theoretical frameworks provides a deeper understanding of the

complex dynamics as the organisations and employees navigate the transformative landscape of Industry 4.0.

The findings suggest several workforce strategies that align with TRAM dimensions to ensure successful transitions:

- **Customized Training Programs:** Training initiatives should focus on both technical skills and practical applications, aligning with employees' roles and the organization's goals.
- **Transparent Communication:** Open dialogue about the purpose, benefits, and limitations of new technologies can mitigate fears and build trust.
- **Incentivizing Engagement:** Recognizing and rewarding employee contributions encourages active participation and fosters a positive outlook on change.
- **Collaborative Learning Environments:** Providing opportunities for teamwork and peer learning simplifies the adoption process and strengthens interpersonal support.

5.5 Industry 4.0 Impacts and Theoretical Implications

This section examines the repercussions of Industry 4.0 on organisational operations and employee functions, as revealed by the study, and it contemplates their theoretical implications within the broader scope of digital transformation literature.

The empirical evidence underscores the substantial impact of Industry 4.0 on the nature of work and the skills required within the technology organisations. The study contributes to the existing body of literature by providing a ground-level view of how these changes materialise within a leading technology company. It substantiates the widespread notion of Industry 4.0 as a driver of job evolution rather than displacement, thus adding depth to the discourse on digital transformation's role in redefining jobs and the entire business ecosystems.

A notable divergence is observed when comparing scholarly predictions with the actual organisational practices exposed in this research. Literature often speaks of a seamless transition towards digitised operations. Yet, the findings reveal this process

to be more nuanced, and marked by significant efforts to align organisational culture, employee capabilities, and leadership visions with technological imperatives. This research illustrates the involved challenges and complexities, by offering a more tempered and pragmatic view of the Industry 4.0 adoption process.

New theoretical insights emerged from the study, notably the interplay between employee agency and organisational structure in the effective deployment of the Industry 4.0 initiatives. The traditional perspectives on technology adoption and skill development are expanded by emphasising the critical role of individual employee initiative and the development of a continuous learning ethos. These insights suggest that while the established models provide a solid foundation, they may benefit from incorporating elements that address the evolving demands for flexibility, resilience, and ongoing professional self-direction in the digital age.

Furthermore, this study highlights the symbiotic relationship between technological proficiency and the soft skills such as adaptability, thereby suggesting a conceptual expansion of readiness models to account for the composite nature of skill sets required in an Industry 4.0-driven workplace (Duan, et al., 2022). The nuanced understanding of the leadership roles within this digital transformation underscores the necessity for the theoretical models to reflect the multifaceted and dynamic nature of leading in a technologically fluid environment.

In essence, the study reinforces and enriches the existing literature on Industry 4.0 by intertwining the empirical findings with the theoretical constructs. It offers a comprehensive picture of digital transformation's practical impacts and exposes areas where the theoretical models may evolve to fully capture the industry's ongoing changes.

5.6 Answering Research Questions

5.6.1 Research Question 1:

How is digitalisation shaping employment in a technology organisation?

The findings of this study offer a comprehensive look at the transformative effects of digitalisation on employment within a technology organisation. The data highlighted a

shift towards a more dynamic, skill-centric workforce where the traditional roles are augmented by new technologies such as AI, automation, IoT, and cloud computing.

Digitalisation, as evidenced by the thematic analysis, shapes employment by necessitating both the reconfiguration of existing job roles and the creation of new ones. This evolution is marked by a growing need for the employees to possess a combination of advanced technical skills and adaptable soft skills. An unexpected finding was the extent to which the soft skills such as adaptability, problem-solving, and continuous learning are valued, even in highly technical domains. This suggests that the human element is becoming increasingly significant in the digital workplace (Duan, et al., 2022).

This research contributes to filling a gap in the literature regarding the practical implications of digitalisation for the employee roles and the required competencies in the actual workplace setting. By providing detailed insights into how one technology organisation responds to these changes, the study adds to the body of knowledge on the real-world impact of digitalisation on employment beyond theoretical models and predictions.

The findings confirm and extend the literature by showing that digitalisation leads to a more interconnected and flexible workforce. However, they also introduce the idea that the nature of work in the context of digitalisation is not only about technology integration but it is also about cultural and strategic adaptation, which is a relatively underexplored area in the current literature.

5.6.2 Research Question 2:

What is the role of the employees in exploiting the potential of Industry 4.0?

The research revealed that the employees are central to the successful exploitation of Industry 4.0, serving as catalysts for change and innovation within their organisations. In the context of the telecoms company, the employees are expected to understand and operate new technologies and drive their applications to create value. The findings indicated that skills development and adaptability are not only dynamic goals, but they are ongoing processes that the employees must actively pursue.

A key role for the employees in this new industrial paradigm is to balance deepening their technical expertise and broadening their collaborative and problem-solving skills. The data pointed towards a trend of the employees taking personal initiative to upskill and reskill in anticipation of the future demands rather than reacting to current needs. This proactive approach to skills development especially in the interdisciplinary areas is vital for staying competitive in the Industry 4.0 landscape.

Unexpectedly, the findings also suggested that while the organisations invest in employee training initiatives, the employees have a significant onus to take the initiative for personal development. This has implications for the field, thereby indicating that the responsibility for readiness for Industry 4.0 is shared between the organisation and the individual.

These insights address a gap in the literature that often overemphasises the role of organisations in preparing the employees for Industry 4.0 without adequately recognising the employees' agency. This study thus contributes to a more nuanced understanding of the employee-organisation dynamic in the context of technological advancement, by suggesting a model where employee initiative and organisational support are interdependent and equally critical.

5.6.3 Research Question 3:

How is the leadership preparing the workforce for Industry 4.0?

The research conducted at a telecoms company provides a clear picture of how the leadership is pivotal in steering the workforce toward Industry 4.0 readiness. The leaders are taking active steps to create a conducive learning environment and to develop the necessary digital skills for the future. This is achieved through strategic planning, where the leaders communicate a vision that includes the digital transformation goals and involve the employees in the journey towards these goals.

A significant strategy involves cultivating a learning culture that encourages continuous skill enhancement, as observed in the telecoms company's initiatives for providing resources and learning opportunities. The leaders are also focusing on breaking down the traditional barriers to learning, by promoting an inclusive approach

that recognises diverse learning needs and preferences. Doing so sets the stage for an organisational culture where ongoing learning is the norm rather than the exception.

Leadership at the chosen telecoms company is about setting strategies and embodying change. The research findings indicated that the leaders increasingly participate in learning initiatives alongside their teams, thus demonstrating a commitment to understanding and mastering the technologies driving Industry 4.0. This approach boosts their credibility and inspires the employees to engage in their development.

In contrast to some literature that presumes a top-down approach to preparing for Industry 4.0, the findings from the telecoms company suggest a more collaborative approach where the leaders and the employees co-create the future. This has significant implications for the field, thereby highlighting the need for leadership models that integrate technological acumen with traditional leadership competencies.

The study addresses the gaps in the literature related to leadership actions and strategies that effectively support workforce transition in the face of rapid technological advancement. By providing empirical evidence of successful strategies and leadership behaviours, the research contributes practical insights into the preparation for Industry 4.0, thereby enriching the theoretical discourse with actionable intelligence.

5.6.4 Research Question 4:

What strategic approaches are proposed for equipping the employees with Industry 4.0 skills, and what are their potential effectiveness and implementation challenges?

The study's findings regarding the strategic approaches to skill development for Industry 4.0 highlight the necessity of targeted, adaptable, and forward-looking training programs. The methods proposed at the telecoms company involve a blend of personalised learning pathways, strategic skills development initiatives, and fostering an organisational culture that emphasises innovation and creativity.

The proposed strategies are grounded in recognising that the technical skills in AI, big data, and in the IoT are critical for the employees. However, they must be

complemented by a culture that promotes and rewards continuous learning and innovation. The leaders at the telecoms company are designing training programs that are closely aligned with industry advancements and adopting new methodologies, such as the adaptive learning technologies to personalise the learning experience.

The effectiveness of these strategies is contingent upon their alignment with the company's strategic vision and integration into the daily work processes. These approaches demonstrate a commitment to equipping the employees with the necessary skills to thrive in the evolving Industry 4.0 landscape, and they represent a shift from the traditional training models to more dynamic and responsive development frameworks.

However, implementing these strategies does not come without challenges. Some potential hurdles include aligning these initiatives with the pace of technological change, ensuring employee engagement and motivation, and measuring the impact of these programs on performance and innovation. Additionally, scalability and the ability to adapt these strategies across different departments and roles within the organisation are challenging.

These strategic approaches, emphasising both skill acquisition and fostering a conducive learning environment, offer potential solutions to the gaps identified in the literature regarding effective workforce development for Industry 4.0. By outlining these strategies and reflecting on their possible implications, the study contributes valuable insights into the practical aspects of preparing the employees for the demands of the fourth industrial revolution.

5.7 Synthesis of Industry 4.0's Organisational Impact

This section examines the consolidated view of Industry 4.0's organisational impact, weaving together the insights from the thematic analysis and the literature review. The synthesis highlights the multifaceted influence of Industry 4.0 on organisational structure, culture, and the workforce.

Integrating advanced technologies such as AI, IoT, and big data analytics has initiated transformative changes in the organisational operations. This transformation extends beyond mere technological upgrades, thus prompting the re-evaluation of business

strategies, workflows, and job roles. The literature anticipated these shifts, suggesting that Industry 4.0 would lead to more data-driven decision-making, increased efficiency, and the development of new services and products.

However, the thematic analysis of the telecoms company's response to Industry 4.0 reveals that the heart of this transformation lies within the human factors, the skill development of the employees, the adaptive and transformative roles of leadership, and the importance of employee engagement in the change process. The real-world application of the Industry 4.0 technologies has underscored the necessity for continuous learning and adaptability among the workforce, a theme that is echoed in both the empirical and the literature findings.

Leadership has emerged as a cornerstone in this transition. It plays a critical role in championing the adoption of these technologies and supporting the workforce through this change. Their role in articulating a clear vision and fostering a culture that values innovation and learning is crucial for leveraging the full potential of Industry 4.0.

Employee engagement is also a critical component of a successful transition. The organisations must provide the tools and training for their workforce to adapt and actively engage them in the transformation process. This involves creating a sense of employee ownership and empowerment to explore and apply new technologies.

The interplay between technology, organisational change, and human factors suggests that Industry 4.0's impact on the organisations is profound and pervasive. It requires a holistic response considering the intricate balance between the new technologies' capabilities and the human systems' agility. The gained insights point to the need for integrated strategies encompassing technology implementation, skill development, leadership evolution, and employee engagement to successfully navigate the complex landscape of Industry 4.0.

This synthesis reaffirms the literature findings and provides a more nuanced understanding based on the lived experiences of the telecom company professionals. It underscores the view that the journey towards Industry 4.0 is not solely a technological challenge, but it is also a strategic imperative involving every organisational layer.

5.8 Practical Implications and Strategic Recommendations

In confronting the advancements of Industry 4.0, the technology organisations are at a pivotal juncture that necessitates decisive action and strategic foresight. This study's findings have profound and manifold practical implications, providing a roadmap for navigating the complexities of this new industrial revolution.

5.8.1 Practical Implications:

- **Skills development:** A core implication for the technology organizations is the need for comprehensive skills development programs. These programs must prioritize the technical skills that are pertinent to Industry 4.0 technologies and the soft skills that facilitate innovation, adaptability, and cross-functional collaboration.
- **Learning culture:** the organizations must strive to cultivate a learning culture that can adapt to and absorb the rapid pace of technological change. This culture should champion lifelong learning as a core value and provide various platforms for knowledge sharing and skill enhancement.
- **Leadership evolution:** The leadership within the technology organizations must evolve to meet the demands of Industry 4.0. The leaders should be role models for adaptability and continuous learning, thereby demonstrating a commitment to mastering new technologies and encouraging their teams to do the same.

5.8.2 Strategic Recommendations:

- **Customized learning pathways:** Develop personalized learning pathways that align with individual career goals and the organization's technological needs. The adaptive learning platforms can facilitate this personalization, thus ensuring that each employee's development is relevant and effective.
- **Employee engagement:** Actively engage the employees in the digital transformation process. This involves not just the top-down communication but also creating channels for employee feedback, idea submission, and participation in decision-making, thus fostering a sense of ownership over the occurring changes.
- **Innovation ecosystem:** Establish an ecosystem that nurtures innovation. Provide resources and opportunities for experimentation, and create a safe environment where risk-taking is encouraged, and failure is seen as a learning opportunity.

- **Cross-functional collaboration:** Encourage cross-functional teams and projects that combine diverse skills and perspectives. Such collaboration can lead to more creative solutions to the challenges posed by Industry 4.0 and can break down silos within the organization.
- **Continuous adaptation strategy:** Implement a strategy for continuous adaptation that regularly assesses and responds to the evolving technological landscape. This includes revisiting and updating training programs, reassessing skill needs, and being agile in strategy implementation.
- **Technology integration in operations:** Integrate Industry 4.0 technologies into everyday business operations to increase familiarity and competence across the workforce. Practical application will drive skill acquisition and operational efficiencies.

By grounding these strategic recommendations in the data collected from the telecoms company professionals, the technology organisations can develop actionable plans that are not merely aspirational but are based on proven approaches to navigating Industry 4.0. These strategies that are underpinned by empirical evidence, provide a strong foundation for the technology organisations aiming to transform their operations and workforce to thrive in the Industry 4.0 era.

5.9 Limitations and Future Research Directions

Every research study has limitations and acknowledging them is crucial for a balanced understanding of the research outcomes and for guiding future inquiries.

5.9.1 Limitations of the Study:

- **Sample scope:** The study's insights were derived primarily from the telecoms company, and while they provide in-depth perspectives, they may need to fully represent the diversity of experiences and strategies across different technology organizations or industries.
- **Cross-sectional design:** The research captured a snapshot in time, so it did not account for the longitudinal effects of Industry 4.0 integration, which may unfold over extended periods.

- **Qualitative focus:** The study's qualitative nature allowed for detailed exploration of the participants' perspectives but limited the ability to quantify findings and apply statistical generalization.
- **Regional Context:** The research was conducted within a specific regional and organizational context, which may have influenced the findings. The cultural and economic factors that affect the adoption of Industry 4.0 in other regions or organizational settings are yet to be fully captured.

5.9.2 Future Research Directions:

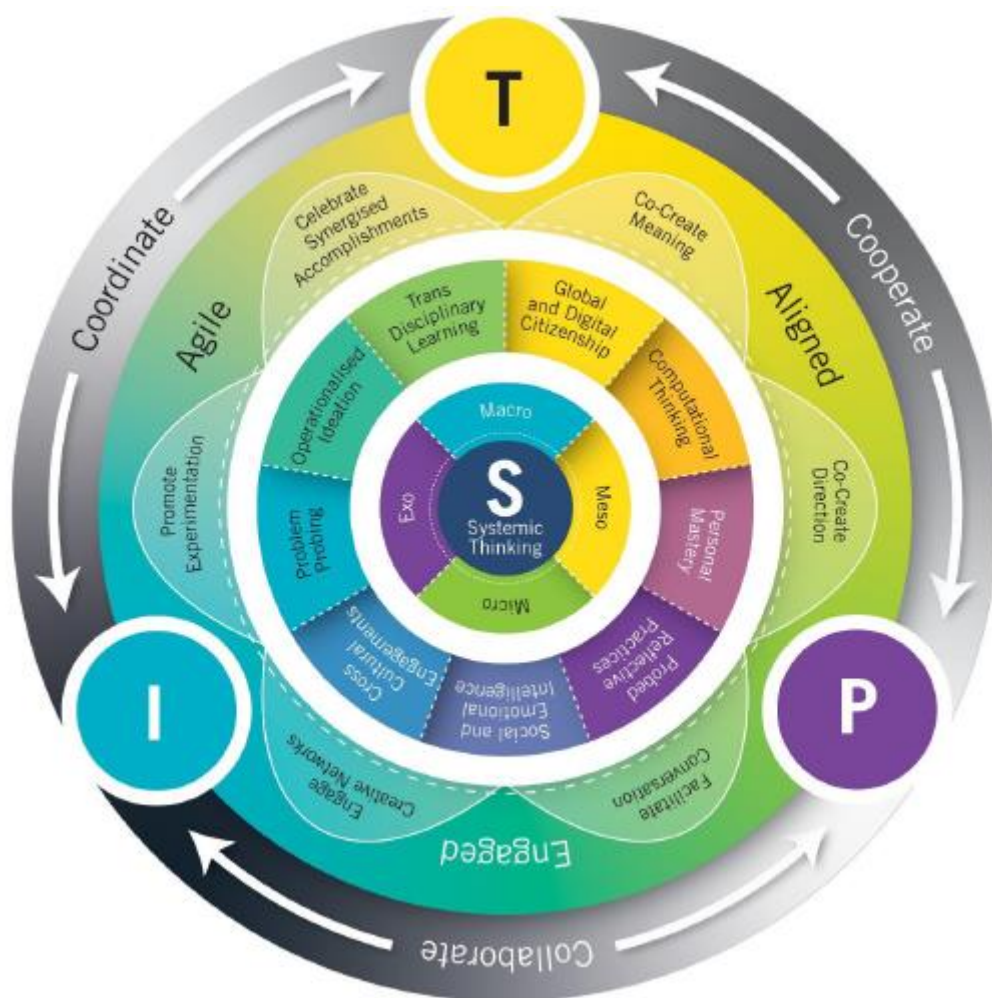
- **Broader industry sampling:** Future studies can expand the research to include a variety of technology organizations across different industries and regions to enhance the generalizability of the findings.
- **Longitudinal studies:** To capture Industry 4.0's evolving impact, longitudinal research could provide valuable insights into how adoption and integration efforts progress over time and how strategies may need to adapt.
- **Quantitative analysis:** Incorporating quantitative methods could complement the qualitative data, thereby offering a broader view of Industry 4.0's impact and allowing for the statistical analysis of trends and correlations.
- **Cross-cultural comparisons:** Examining how different cultural and economic contexts influence Industry 4.0 readiness could highlight the unique challenges and solutions, thus enriching the understanding of global and local dynamics.
- **Employee-centric studies:** Further research might focus on the employee experience of adapting to Industry 4.0, including the psychological and social aspects of transitioning to new work paradigms.
- **Impact measurement:** Investigating methods to measure the impact of Industry 4.0 skill development programs on organizational performance could be beneficial for assessing such initiatives' Return on Investment (ROI).
- **Technological impact assessment:** Exploring the actual versus the anticipated impacts of specific Industry 4.0 technologies on organizational processes and employment could clarify the direct implications of these technologies.

By addressing these limitations and exploring the suggested directions, future research can build upon the work presented in this study to provide a more

comprehensive understanding of Industry 4.0's implications for technology organisations and their workforce.

5.10 Analysis Through the TIPS™ Framework Perspective

The Da Vinci Institute's Technology, Innovation, People and Systems™ (TIPS™) Managerial Leadership Framework provides a complex, systematic lens to an organisation's multiple subsystems. The core layers of the TIPS™ framework are illustrated in Figure 5-1. The study analysed digitalisation in a technology company through the focal lens of the TIPS™ framework concerning the four elements: technology, innovation, people, and systems thinking. The aim was to make sense of the realities facing the technology company in understanding Industry 4.0's implications (Da Vinci Institute, 2024).



Source: (Da Vinci Institute, 2024)

Figure 5.1: TIPS™ Managerial Framework.

5.10.1 *Management of Technology*

The management of technology represents the integration of multiple factors including tools and procedures to ensure their collaborative functioning and to provide the organisation with a competitive advantage. Digitalisation in a technology company significantly influences the employment dynamics by requiring the reconfiguration of the existing job roles and the creation of new ones. This transformation is characterised by an increasing demand for the employees to possess diverse advanced technical skills that are essential for navigating the evolving workplace landscape.

Integrating advanced technologies, such as AI, the IoT, and big data analytics, has catalysed transformative changes in the organisational operations. These changes go beyond simple technological upgrades; as they necessitate a comprehensive re-evaluation of business strategies, workflows, and job roles. The organisations must strategically manage these technological integrations to enhance operational efficiency and maintain competitive advantage.

Moreover, the practical application of Industry 4.0 technologies underscores the critical need for continuous learning and the adaptability within the workforce. As the organisations adopt these innovative technologies, the employees must engage in ongoing professional development to keep pace with the rapid advancements. This emphasis on lifelong learning is essential for individual career growth and for ensuring organisational resilience in an increasingly complex technological environment. Therefore, effective technology management must foster a culture that encourages continuous skill development and adaptability among the employees, thereby equipping them to thrive in a dynamic landscape that is marked by constant change and innovation.

5.10.2 *Management of Innovation*

Innovation management is an organisation's approach to encouraging and capitalising on the ideation process to create valuable products or services. The successful exploitation of Industry 4.0 hinges significantly on the role of the employees, who act as catalysts for change and innovation within their organisations. In the telecom sector,

the employees are expected to comprehend and utilise new technologies and drive their applications in ways that create substantial value. This highlights the organisations' need to invest in continuous learning and development, thereby enabling their workforce to navigate the complexities of advanced technological landscapes.

The leadership emerges as a cornerstone in this transformative process. Influential leaders play a pivotal role in championing the adoption of innovative technologies, by articulating a clear vision that aligns with the organisational goals, and fostering a culture that prioritises innovation and continuous learning. Such leaders empower their workforce, by providing the necessary support and resources to facilitate a smooth transition into the realities of Industry 4.0. Establishing an ecosystem that nurtures innovation is critical. The organisations must provide resources and opportunities for experimentation, thus creating an environment where risk-taking is encouraged and failure is reframed as a valuable learning opportunity. By cultivating this culture, the organisations can harness the full potential of Industry 4.0, by positioning themselves at the forefront of the technological advancements and ensuring long-term competitiveness in the evolving market landscape.

Innovation management in Industry 4.0 requires a multifaceted approach that prioritises employee engagement, visionary leadership, and a supportive innovation ecosystem. By combining these elements, the organisations can effectively navigate the challenges and opportunities that are presented by this new industrial paradigm.

5.10.3 *Management of People*

The discipline of people management broadens the concepts related to individual performance and integrates elements of organisational transformation. Furthermore, it embeds principles and practices to foster organisational growth and wellness. The study revealed a surprising emphasis on soft skills such as adaptability, problem-solving, and continuous learning within highly technical domains. This shift indicates that the human element is gaining prominence in the digital workplace, thus underscoring the need for the technology organisations to prioritise the holistic development of their workforce.

A core implication for the technology organisations is implementing comprehensive skills development programs. These programs should not only focus on the technical competencies that are essential for navigating the complexities of Industry 4.0 technologies, but they must also emphasise the cultivation of the soft skills. Fostering abilities that encourage innovation, adaptability, and cross-functional collaboration is crucial in equipping the employees to thrive in an evolving technological landscape.

As the digital workplace continues to evolve, people management must adapt to emphasise both technical and soft skills, thus creating a workforce capable of meeting the future challenges and opportunities.

5.10.4 *Management of Systems*

By viewing the organisation and its environment as a dynamic system, systems thinking encourages a holistic perspective considering internal and external factors. The advent of Industry 4.0 represents a significant paradigm shift for the organisations, driven by the intricate interplay of technology, organisational change, and human factors. A systematic perspective on the management of these systems highlights the necessity for an integrated approach that aligns technological capabilities with the agility of the human systems. This approach acknowledges that the organisations are complex, interrelated systems where the changes in one component can significantly influence the others.

To harness Industry 4.0's potential, organisations must systematically incorporate advanced technologies such as the IoT, artificial intelligence, and big data analytics into their core business processes. This integration should be approached not merely as an addition of tools but as a transformative change in how work is conducted. By embedding these technologies into the daily operations, the organisations facilitate familiarity and competence among the workforce, thus enhancing their ability to adapt to the new systems and processes.

By strategically integrating new technologies and cultivating an adaptable workforce, the organisations can effectively navigate the complexities of this transformative landscape and position themselves for sustained success in an evolving environment.

5.10.1 Overall Interpretation of Findings through TRAM

The application of the TRAM framework revealed a nuanced understanding of how employees perceive and respond to Industry 4.0 digital technologies. Overall, the organisation demonstrated a moderate-to-high level of technology readiness, particularly through employee expressions of Optimism and Perceived Usefulness of AI, IoT, and automation tools. These sentiments were strongest among senior managers and tech-savvy staff.

However, Perceived Ease of Use varied significantly across levels, with some frontline employees expressing a steep learning curve and workflow disruptions. This links directly to instances of Insecurity, where concerns about job displacement and lack of adequate training emerged.

Collectively, these dynamics suggest that while there is broad support and strategic buy-in for Industry 4.0, successful organisational adaptation hinges on targeted interventions to reduce insecurity and build confidence in new systems. The TRAM framework therefore supports the conclusion that employee readiness is not uniform, and adaptation strategies must address the psychological and skill-based barriers to change.

Table 5-1: TRAM Summary

| TRAM Dimension | Key Themes Identified | Implications |
|-----------------------|--|--|
| Perceived Usefulness | Increased efficiency, better decision-making | Employees value tech integration |
| Perceived Ease of Use | Mixed views; some usability challenges | Training needed to smooth adoption |
| Optimism | Belief in tech's future potential | Leverage this to boost engagement |
| Insecurity | Job security fears, lack of training | Address via communication & reskilling |

Source: Own elaboration

5.11 Conclusion

This study ventured into the complex and evolving terrain of Industry 4.0 and its diverse impacts on the technology organisations, mainly focusing on employment, employee roles, leadership, and strategic skill development within the telecoms

company. The research underscored the significance of digitisation in reshaping the employment landscape, revealing a transition to more dynamic roles that blend technical acumen with enhanced soft skills. It has illuminated the proactive roles the employees must embrace to leverage the opportunities presented by Industry 4.0, not as passive participants but as active contributors to innovation and change.

The leadership's preparatory role is vital. Influential leaders need to craft clear visions, foster cultures of continuous learning, and empower their workforce to embrace and drive digital transformation. This study contributes to the existing discourse by providing insights into how these roles manifest within a leading technology organisation and offers a model for leadership in the era of Industry 4.0 that may inform leadership practices across various sectors.

The strategic approaches for skill development have been identified, with a strong recommendation for personalised learning pathways and fostering cultures that support innovation, creativity, and proactive learning. These findings offer practical guidelines for the organisations seeking to navigate the complexities of the fourth industrial revolution.

The contribution of this research to the field of technology management and innovation is manifold. It provides a grounded perspective on the practical realities of Industry 4.0, thereby enhancing the understanding of how the organisations can adapt to and flourish in this new era. It highlights the importance of human factors such as leadership, employee engagement, and fosters a supportive culture in successfully integrating the emerging technologies. Moreover, the study extends theoretical frameworks by incorporating the lived experiences of the professionals within a technology organisation, thus bridging the gap between theory and practice. It suggests that while technology is the driver of change, the human elements of adaptability, learning, and leadership are the navigators of this journey.

This chapter synthesises the findings with the literature and theoretical frameworks to recapitulate the results and add a deeper understanding of their broader implications. It sets forth the considerations for technology management that reflect the current practices and are aspirational in anticipating future needs. As the organisations and

their workforces progress through the age of Industry 4.0, the insights from this study will remain relevant, thus offering guidance and inspiration for those seeking to harness the full potential of this transformative era.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the conclusion and recommendations of the study, summarizing the key findings and their implications for workforce adaptation in the era of Industry 4.0. It reflects on how employees and organizations navigate digital transformation, with a particular focus on workforce readiness, strategic skill development, and leadership approaches. The discussion integrates insights from the Technology Readiness and Acceptance Model (TRAM) to explain how employees perceive and respond to technological change. While digitalisation offers new opportunities for efficiency and innovation, it also introduces challenges related to job security, skills development, and organisational culture. The study highlights both the psychological and practical aspects of technology adoption, offering a holistic view of Industry 4.0's impact on the workforce.

The chapter then provides practical recommendations for organizations aiming to foster digital adaptability, enhance employee engagement, and develop effective training strategies. It also outlines directions for future research, suggesting areas where further exploration can deepen understanding of workforce dynamics in Industry 4.0. Finally, the chapter evaluates the influence of TRAM-based findings on future studies, demonstrating how the framework can be expanded to address emerging technological and organizational challenges. Through this conclusion, the study reinforces the importance of strategic workforce planning in digital transformation and provides a roadmap for organizations seeking to balance technological advancements with employee empowerment and long-term growth.

6.2 Conclusion

This study explored the implications of digital transformation and Industry 4.0 technologies on workforce dynamics, focusing on how employees perceive and adapt to these changes. Using the Technology Readiness and Acceptance Model (TRAM)

as a guiding framework, the study revealed critical insights into employee readiness, engagement, and the strategies organizations can employ to support transitions.

The findings demonstrate that digital transformation presents a dual-edged scenario: while it offers opportunities for productivity and innovation, it also poses challenges related to workforce preparedness and job security. By integrating TRAM dimensions, the study underscored the importance of addressing both psychological readiness and practical acceptance to ensure successful technological adoption. This dual focus provides a valuable foundation for organizational strategies aimed at fostering employee engagement and enhancing overall adaptability.

The findings provide actionable insights into the strategic approaches that are required for equipping the employees with the necessary skills to meet the demands of Industry 4.0. This study has filled literature gaps by detailing the practical implementation of strategies within a major technology organisation and highlighting the crucial role of employee initiative in this process.

6.3 Recommendations for Practice

Based on the empirical findings and the TRAM framework analysis, the following practice-level recommendations are proposed to enhance organisational adaptation to Industry 4.0 technologies:

1. Targeted Training Programmes

- **Finding link:** Employees reported challenges with Perceived Ease of Use and voiced Insecurity about new tech tools.
- **Recommendation:** Design and implement tailored, role-specific training interventions focused on skills gaps in AI, IoT, and automation. Leverage micro-learning and peer-led sessions to ensure accessibility and relevance.

2. Structured Internal Communication Channels

- **Finding link:** Participants mentioned confusion and anxiety about how new systems would affect their roles.
- **Recommendation:** Establish dedicated communication platforms or change ambassadors to share updates, explain tech changes, and reduce fear of the unknown.

3. Digital Transformation Champions

- **Finding link:** Optimism was strong among some groups (especially middle management) and could be harnessed.
- **Recommendation:** Identify and empower “digital champions” within teams who can support others, serve as peer trainers, and offer feedback loops to management.

4. Inclusive Tech Adoption Planning

- **Finding link:** Some staff felt excluded from decision-making processes.

Recommendation: Involve cross-functional employee groups in pilot testing and feedback on new tech tools before full-scale rollouts.

6.4 Recommendations for Policy and Broader Ecosystem

While internal strategies are important, broader systemic support is required to ensure sustainable adaptation in the digital era.

1. Collaboration with Higher Education Institutions

- **Finding link:** Lack of readiness among frontline employees.
- **Recommendation:** Partner with universities and technical colleges to co-develop Industry 4.0 curricula and create internship pipelines.

2. Engagement with National Skills Development Initiatives

- **Finding link:** Skill gaps extend beyond one company.
- **Recommendation:** Align reskilling strategies with the South African government’s National Digital and Future Skills Strategy to access funding, trainers, and national certifications.

3. Technology Vendor Accountability

- **Finding link:** Some tools introduced were perceived as complex.
- **Recommendation:** Develop service-level agreements (SLAs) that require vendors to include comprehensive onboarding and contextual training support when deploying new systems.

Table 6-1: Recommendations Summary

| Finding Theme | TRAM Link | Recommendation |
|------------------------------|-------------|--|
| Skills gaps in digital tools | Ease of Use | Create role-based training with micro-learning |

| | | |
|----------------------------|-------------------|---|
| Employee anxiety | Insecurity | Launch ongoing communication and engagement forums |
| Tech optimism | Optimism | Empower “digital champions” internally |
| Limited external alignment | Not TRAM-specific | Engage with national skills programmes and academia |

Source: Own elaboration

6.5 The Influence of TRAM-Based Findings on Future Studies

The TRAM framework has proven to be a valuable lens for analysing employee readiness and acceptance during digital transformation. Its dimensions provide a structured way to assess psychological and practical factors influencing technology adoption. Future studies can expand on this by:

- Using TRAM to explore emerging technologies such as artificial intelligence and blockchain.
- Investigating how TRAM dimensions interact with organizational culture and leadership styles.
- Applying TRAM in cross-disciplinary studies that combine technological readiness with emotional and social dynamics.

By building on the TRAM-based findings, researchers and practitioners can develop more effective strategies for navigating the complexities of Industry 4.0 and fostering sustainable workforce transformation.

The study has shed light on the complex transformation journey the technology organisations are undertaking in Industry 4.0 era. The findings and recommendations summarise the undertaken research and provide a pathway for organisations striving to successfully navigate this new industrial landscape.

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APPENDICES

APPENDIX A: Request for permission to conduct research at the organization

Request for consent to conduct research within the organization

Dear: Vodacom

Research topic: A critical analysis of the implications of Industry 4.0 digital technologies on organizational adaptation in a technology company.

Ethical Clearance number: 00623

Introduction to the study:

My name is Aubrey Ramaphosa. I am a Master's candidate at the Da Vinci Institute for Technology Management for a Master of Management in Technology and Innovation. I am seeking permission to do research at Vodacom.

Purpose of the research

The purpose of the study is to critical analyze the penetration and consequent implications of Industry 4.0 in a technology organization to create a better understanding of the effect on workers and their skills. Industry 4.0 success not only depends on technology but also on the people.

Intended research participants:

The aim is to interview participants within the Vodacom Enterprise Business Unit who are managers of technology teams that utilizes Industry 4.0 technologies. The interview will last between 45 – 60 minutes.

The study seeks to explain employees' acceptance and use of Industry 4.0 technologies. By evaluating their optimism, innovativeness, discomfort, and insecurity, the research assesses their attitudes toward these technologies.

There are no risks associated with this study. Participation is voluntary and information of participants will be kept confidential. There will be no reimbursement or any incentives for participation in the research. Feedback procedure will entail written feedback to participants.

Researcher name: Aubrey Ramaphosa

Researcher email address: 15105@davinci.ac.za

Supervisor name: Bernard van Zijl

Supervisor email address: bernardv@davinci.ac.za

APPENDIX B: Request for permission to conduct research direct report

Good day

As part of my Master's dissertation with Da Vinci Institute of Technology Management I am required to collect data to finalise the research, see attached (ethical clearance certificate), I will be collecting research data from Vodacom employees once internal approval is granted. Vodacom requires that I should have a sponsor that is someone internal who will assist in securing interviews and sourcing relevant information, I would like to request if you are available to facilitate this role?

Research details below;

Research topic: A critical analysis of the implications of Industry 4.0 digital technologies on organizational adaptation in a technology company.

Purpose of the research:

The purpose of the study is to critical analyze the penetration and consequent implications of Industry 4.0 in a technology organization to create a better understanding of the effect on workers and their skills. Industry 4.0 success not only depends on technology but also on the people.

Intended research participants:

The study seeks to explain employees' acceptance and use of Industry 4.0 technologies. By evaluating their optimism, innovativeness, discomfort, and insecurity, the research assesses their attitudes toward these technologies.

Interview Questions:

See attached

Supervisor Details:

| |
|-----------------------|
| Prof Bernard van Zijl |
| |
| |

APPENDIX D: Consent Return Slip



Consent/assent return slip to participate in a study

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the interview.

I have received a signed copy of the informed consent agreement.


Participant Name & Surname (please print)

Participant Signature

Date

Researcher's Name & Surname:

Aubrey Ramaphosa
Name in Print


Signature

18 April 2023
Date Signed

15105@davinci.ac.za
Email

Supervisor's Name & Surname:

B van Zijl

Name in Print



Signature

20 April 2023

Date signed

bernardv@davinci.ac.za

Email

APPENDIX E: Semi-Structured Interview Questions

1.1. How have Industry 4.0 digital technologies influenced organizational adaptation in a technology company?

- 1.2. What are the key technological trends shaping the organization, and how will they impact your job?
- 1.3. What can be done by the organization to leverage digitalization to create new job opportunities and to enhance employee productivity and satisfaction?
- 1.4. In what ways will digitalization affect employees collaboration and communication?
- 1.5. What impact will digitalization have on the organization culture and employee engagement?
- 1.6. In what ways will digitalization impact the training and development of employees?

2. How have these technologies impacted operational processes and workforce roles?

- 2.1. Are there any skills and competencies that employees will need in order to thrive in the industry of the future?
- 2.2. What is the best approach for employees to adapt to the changes brought about by Industry 4.0?
- 2.3. Industry 4.0 requires organizations to train and develop their employees. How can organizations prepare their employees for success?
- 2.4. In what ways does Industry 4.0 affect job roles and career paths, and what can employees do to adapt?
- 2.5. What are the best ways for employees to make a contribution to Industry 4.0 innovation and continuous improvement?

3. How is the organizational culture evolving in response to digital technology adoption?

- 3.1. Is there a way for leaders to create a culture of continuous learning and development in their organizations?
- 3.2. To support innovation and agility in Industry 4.0, how can leaders promote diversity and inclusivity?

- 3.3. In an age of Industry 4.0, how can leaders balance automation and technology with human skills and creativity?
- 3.4. In Industry 4.0, how can this organization engage and motivate employees to embrace new technologies and work styles?
- 3.5. What can leaders do to identify the skill and competency gaps in their workforce?

4. What strategies are being used to support workforce adaptation and reskilling in Industry 4.0?

- 4.1. Can you tell me what specific skills are needed in each job role within your department in order to be successful?
- 4.2. Depending on the employee and the skill set, what type of learning opportunities would be most effective?
- 4.3. Is there an incentive or reward most effective at motivating employees to upgrade their skills?
- 4.4. Is there a recruitment strategy that can be used to attract a new pool of talent with skills related to Industry 4.0?

APPENDIX F: Ethical Clearance

The Da Vinci Institute for
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THE DAVINCI INSTITUTE
for technology management

Reference: 00623

Date: 17 May 2023

Ethical Declaration

I, the undersigned, hereby declare that the Master's Research of the student named below has received ethical clearance from The Da Vinci Institute Ethics Committee. The student and supervisor will be expected to continue to uphold the Da Vinci Institute's Research Ethics Policy as indicated during the application.

Proposed Title: A critical analysis on implications of digitisation and adoption of Industry 4.0 technologies in a technology company.

Student Name: Ramaphosa Aubrey

Student Number: 15105

Supervisor: Prof Van Zijl Bernard

Co-Supervisor: N/A

Period: Ethics approval is granted from 2023/05/17 to 2025/03/23

A handwritten signature in black ink, appearing to read "Prof Paul Singh".

Chairperson: Research & Ethics Committee

Prof Paul Singh

Directors: R Anderson, N Fildesa, J Landman (Chairperson), R Steenberg

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