Impact of digital technologies on entrepreneurship education within institutions of higher education in the industry 4.0 era: A South African case study

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I declare that the above dissertation is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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ABSTRACT

The study investigates the integration of Industry 4.0 digital technologies within entrepreneurship education (EE) at higher education institutions (HEIs). The research examined the impact of advanced technologies, including artificial intelligence (AI), virtual reality (VR), big data analytics, and the Internet of Things, in reshaping EE and fostering an entrepreneurial mindset among students by employing a qualitative methodology. The research study upon which this thesis is based has employed an interpretive approach to the collection, analysis and interpretation of primary data obtained from the South African higher education institution, including seventeen semi-structured interviews with students and faculty members. Due to the relatively small sample size, thematic analysis rather than phenomenography was employed to analyse findings. Thematic analysis, employing colour coding techniques, was utilised to identify recurring patterns in the data. Based upon the findings of this research study, key factors promoting the adoption of 4.0 digital technologies in EE, included enhanced learning experiences, increased student engagement, and alignment with the evolving needs of industries. However, the study also identified several significant barriers, including inadequate digital infrastructure, resistance to change, and a lack of pedagogical preparedness among faculty members. Both faculty and students demonstrated optimism towards 4.0 digital technologies, although varying levels of digital literacy were observed. This emphasizes the importance of customised training programmes aimed at improving digital competencies. Based on the study, an innovative model called the Digital Entrepreneurship Enrichment Model (DEEM) was established. This model provides a structured framework for HEIs incorporating Industry 4.0 technologies into EE. The DEEM assists institutions in effectively embracing Industry 4.0 transformation in the field of EE. This pioneering framework outlines a comprehensive approach to equipping students with entrepreneurial thinking and essential digital skills that align with the evolving entrepreneurial landscape. Finally, the study provides several strategic recommendations to overcome barriers that hinder the adoption of Industry 4.0 technologies in EE including the modernisation of digital infrastructure within HEIs, the assessment of stakeholder digital literacy, the provision of tailored training programs, the cultivation of industry partnerships, and the ongoing monitoring of integration efforts. By implementing these recommendations, institutions can effectively integrate Industry 4.0 technologies into EE. Policy implications include modernising HEI digital infrastructure, assessing

stakeholder digital literacy, providing tailored training, cultivating industry partnerships, and monitoring integration efforts. Effective implementation can equip students with entrepreneurial thinking and essential digital skills for the evolving entrepreneurial landscape.

Key Terms: Industry 4.0, Digital Technologies, Entrepreneurship Education, Higher Education, Artificial Intelligence, Big Data, Internet of Things, Cloud Computing and Virtual Reality.

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Glossary of ACRONYMS

Industry 4.0 – Fourth Industrial Revolution

EE – Entrepreneurship Education

DT – Digital Technology

AI – Artificial Intelligence

IoT – Internet of Things

DL – Digital Literacy

HE – Higher Education

HEI - Higher Education Institution

DHET – Department of Higher Education and Training

SSA – Statistics of South Africa

SA – South Africa

ICT – Information and Communication Technology

VR – Virtual Reality

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CHAPTER 1: ORIENTATION TO THE STUDY

1.1 Introduction

Digital technologies have emerged as significant catalysts for transformation across various sectors in the rapidly evolving landscape of the Fourth Industrial Revolution (Industry 4.0). These technologies have revolutionised how people communicate, work, study, and shape every sphere of life (Schwab, 2017). In this context, higher education institutions (HEIs) play a crucial role in preparing the next generation of students to navigate this dynamic environment. As the world embraces Industry 4.0, it is fundamental to examine the profound implications of 4.0 digital technologies on entrepreneurship education (EE) within HEIs. For example, advancements in artificial intelligence (AI), big data, virtual reality (VR), cloud computing, and the Internet of Things (IoT) have fundamentally altered the way scholars interact, collaborate and study (Pinto & Leite, 2020; Akour & Alenezi, 2022). These technologies have disrupted traditional business models and have created new opportunities for entrepreneurial ventures (de Waal & Maritz, 2022). Given these transformations, it is imperative to investigate how EE can effectively integrate and leverage 4.0 digital technologies to equip students with the skills and competencies necessary to thrive in the entrepreneurial landscape of Industry 4.0.

This doctoral thesis examines the complex interplay between 4.0 digital technologies and EE, with a specific emphasis on the case of South Africa (SA). Considering SA's distinct economic, social, and cultural milieu, this unique combination of factors may lead to different dynamics, challenges, or opportunities when it comes to leveraging digital technologies for EE compared to other contexts or countries with different economic, social, and cultural environments. Hence SA presents an intriguing environment to explore the nuanced effects of 4.0 digital technologies (Wessels, 2020). Studies confirm that the most highly-ranked universities in SA have embraced the industry 4.0 technologies (Hlobo, Moloi & Mhlanga, 2021; Khoza, 2020; Mpungose, 2020; Yende, 2021). By delving into the South African context, this research offers valuable insights that can enhance the local higher education (HE)

landscape and contribute to the wider global comprehension of harnessing 4.0 digital technologies in EE.

Policymakers and societies must adapt to and prepare for future technological advancements or risk lags. To do so effectively, leaders of HEIs need to thoroughly know how technology affects the global economy and society currently and over the next decade (Manyika, Chui, Bughin, Dobbs, Bisson & Marrs, 2013). This prompts HEIs to determine their investment approach towards new educational infrastructure, the influence of disruptive technological changes on the nature of educational infrastructure, and the effects of such changes on entrepreneurship ecosystems. This has led to the initiation of a phase of the transformation process from a traditional university to a modern university through novel digitally influenced pedagogical models and learning environments (Makrakis, 2017). Thus, HEIs must set their goals of adapting to the new Industrial Revolution 4.0 as the world leaps quickly (Mudin, 2018). This trend suggests that the EE landscape is undergoing massive transformation because of the evolution of digital technologies in the 4.0 era.

The expeditious integration of technological advancements in HEIs has brought revolutionary changes in the entrepreneurial sphere. These advancements, commonly called “4.0 digital technologies,” provide novel resources and avenues for knowledge dissemination, significantly altering the EE landscape. Integrating these technologies fundamentally alters the entrepreneurial process and reshapes the navigation and management of uncertainty. Nambisan’s study (2017) reinforces this notion by affirming that these 4.0 digital technologies usher in a new era of entrepreneurship, challenging and redefining traditional approaches to seizing entrepreneurial opportunities. Consequently, the symbiotic relationship between 4.0 digital technologies and entrepreneurship has spawned many research questions in digital entrepreneurship. These questions necessitate a meticulous examination of the impact of 4.0 digital technologies and their unique characteristics that significantly shape EE.

HEIs, often hailed as testbeds for creativity and innovation, are not immune to the far-reaching effects of the ongoing revolution driven by 4.0 digital technologies (AbuMezied, 2016). This is particularly noteworthy in Africa, where industry 4.0 is

exerting its influence on the HE sectors through a confluence of technologies like AI, IoT, big data, VR, and cloud computing, among others (Sergi, Popkova, Bogoviz, & Litvinova, 2019). It is crucial to recognise that Industry 4.0 represents a substantial departure from previous digital revolutions regarding its speed, scale, and transformative impact (Sakhapov & Absalyamova, 2018). In contrast, Ochoa, Fortino, and Di Fatta (2017) argue that Industry 4.0 builds upon the foundation of the third industrial revolution, relying on digital technologies that evolved from information and communication technologies (ICT). This substantiates the notion that Industry 4.0 is an evolutionary progression. Nevertheless, it is vital to acknowledge that Industry 4.0 is rapidly advancing exponentially, as Schwab (2016) exemplifies the infinite possibility of connecting billions of people through mobile devices. Consequently, the primary focus of Industry 4.0 lies in creating intelligent (smart) products, procedures, and processes (Ochoa, Fortino & Di Fatta, 2017).

This study adopted a qualitative research approach grounded in the interpretivism/constructivism philosophy. An inductive approach was employed to derive insights from observed patterns and experiences. The research strategy utilised a case study approach, focusing on a specific open distance learning university in South Africa as a relevant case for examining the impact of 4.0 digital technologies on entrepreneurship education. Data were collected through 17 semi-structured interviews with purposively sampled faculty members and final-year entrepreneurship students at the university. The interview data were transcribed and analysed thematically to understand participants' experiences and perspectives on the impact of 4.0 digital technologies on EE at their institution.

Since digital technologies have become deeply embedded in the fabric of societies and industries in Industry 4.0, EE must adapt swiftly. Failure to do so may result in being left behind by the rapid developments in the field. Hence, the interconnected nature of these technologies necessitates a comprehensive understanding and proactive response from HEIs to effectively integrate them into the EE ecosystem and equip students with the skills and knowledge required for an evolving entrepreneurial landscape. Having introduced and established the transformative impact of Industry 4.0 and the urgent need for EE to adapt to these changes effectively, it is essential to

delve into the background of the study, providing a comprehensive understanding of the context and motivations behind the research.

1.2 Background to the study

African economies are grappling with the challenge of generating sufficient formal and quality employment opportunities that align with the annual influx of graduates entering the labour market, as highlighted by Fox and Gandhi (2021). Moreover, HEIs across Africa face challenges in swiftly adjusting and equipping the economy with the skills necessary for 21st-century progress. This situation further worsens existing challenges. Amidst this backdrop, Brixiova, Ncube, Bicaba (2015) and Tunio (2020) stress the urgent need to stimulate entrepreneurial activity, particularly among youth, as a vital growth strategy to address unemployment and the accompanying economic challenges. Recognising shrinking employment opportunities in Industry 4.0, the South African Department of Higher Education and Training (DHET) has implemented measures to foster entrepreneurship development. These initiatives aim to empower students with self-reliance skills that align with the demands of the current economic landscape and the 21st century.

HEIs possess a unique capacity to act as catalysts for entrepreneurship and innovation, fostering the growth of a more resilient economy. Creating a dynamic entrepreneurship ecosystem within South African HEIs could substantially influence students to consider entrepreneurship a viable career option. Scholars like Gyamfi (2014), Igwe, Okolie, and Nwokoro (2021), along with think tank Sala-i-Martín (2016), emphasize this potential. Collectively, they underscore the transformative power of entrepreneurship in tackling diverse socio-economic challenges such as unemployment, challenging economic conditions, and poverty.

Over the past decade (2012-2022), there have been substantial transformations in the integration of 4.0 digital technology within HE, aimed at improving the effectiveness of teaching and learning. HEIs have significantly invested in hardware, software, broadband access, and training initiatives to integrate digital technologies with faculty members and students (Stringer, Lewin & Coleman, 2019). Despite the remarkable increase in the adoption of digital technology in HE, scholars continue to believe that

faculty members, universities, and the education sector struggle to fully exploit the potential of these emerging technologies (Johnston, MacNeill & Smyth, 2019).

The rapid advancements in 4.0 technology have profoundly impacted institutions and entrepreneurial landscapes worldwide, driving significant transformations. However, concerns arise regarding African HEIs' readiness to leverage 4.0 digital technologies to enhance EE effectively. It is crucial to address the challenges and barriers that African HEIs face when embracing and integrating these technologies into their educational practices.

One area that requires attention is EE, which has gained increasing recognition owing to its vital role in fostering economic growth. Policymakers and governments globally have acknowledged the significance of entrepreneurship in driving economic development (Pugh, Soetanto, Jack & Hamilton, 2021). Recognising the vital link between entrepreneurship and economic growth, policymakers at various government levels have implemented supportive policies and practices to stimulate demand for EE (Mahto, McDowell, Sen, & Ahluwalia, 2018). This growing recognition of and support for EE has intensified the drive to boost EE programs. Recognising the transformative effects of 4.0 digital technologies and their potential for EE, it is imperative to delve into the challenges and barriers African HEIs encounter when embracing and integrating these technologies. By addressing these obstacles, academia can pave the way for more effective and inclusive use of 4.0 digital technologies to enhance EE in African HEIs.

1.3 Problem Statement

The Bantu Education Act of 1948 was implemented in 1953 to restrict educational and socioeconomic opportunities for most South Africans through their past policies from 1948-1990 (Naicker, 2000). Arguably, this education system affected most black South Africans' employment and socio-economic opportunities during and after apartheid through its lack of educational inclusivity of skills delivery, such as entrepreneurship skills. During the Bantu Education system, students were taught how to perform various repetitive tasks that produced unskilled or semi-skilled workers but did not equip them with advanced and entrepreneurial skills (Naicker, 2000). This was

partially implemented to retain students within their respective communities, as well as to address the demand for unskilled and semi-skilled labour in the South African economy, thereby potentially limiting their exposure to entrepreneurial prospects. Given the state of HE at the end of apartheid in 1994, it is unsurprising that most of the attention paid to democracy over the past twenty-five years (1994-2021) has been transforming and developing HE as a system. However, the colonial and apartheid models of education and knowledge systems are still lingering in post-apartheid SA as they have not been rectified more severely on the demise of apartheid (Le Grange, 2016). As much as the education sector has transformed from the apartheid era to a certain extent, the HE sector has found itself in the throes of digital transformation expedited by exponentially technological advancements in the Industry 4.0 era, thereby significantly impacting EE.

In the post-apartheid era, the field of EE in SA has witnessed unprecedented volatility, primarily driven by exponential technological advancements, particularly in the context of Industry 4.0. Such massive growth in 4.0 digital technologies has transformed the EE landscape significantly and modified conventional institutional policies, models, and processes. (Bharadwaj, El Sawy, Pavlou & Venkatraman, 2013; Brondoni & Zaninotto, 2018). Despite the growing significance of 4.0 digital technologies in shaping various industries, there is a lack of comprehensive understanding of their effective integration and impact on EE within South African HEIs. This knowledge gap raises questions about the extent of adoption, benefits, challenges, and strategies associated with incorporating 4.0 digital technologies into EE, hindering the development of informed pedagogical practices and potentially affecting graduates' readiness for the evolving entrepreneurial landscape in the country and globally. Although extensive research has been conducted on Industry 4.0, EE remains a grey area for further inquiry in African nations, where the impact of 4.0 digital technologies requires thorough exploration.

1.4 Research Questions

Primary research question for the study

i. How do 4.0 digital technologies effect the development of an entrepreneurial pedagogical framework that fosters an entrepreneurial mindset among students within the SA context?

Investigative Questions

ii. What key factors drive Industry 4.0 digital technology adoption and hinder its implementation in EE at HEIs within SA context?

iii. What are faculty members' and students' viewpoints regarding digital technologies in Industry 4.0 within SA context?

iv. What is the requisite level of digital literacy required to navigate and thrive in Industry 4.0 within SA context?

1.5 Research Objectives

1.5.1 Primary objective

i. To investigate the effect of 4.0 digital technologies on developing an entrepreneurial pedagogical framework that fosters an entrepreneurial mindset within SA context.

1.5.2 Secondary objectives

ii. To identify and analyse the significant drivers facilitating the adoption of Industry 4.0 digital technologies and the barriers that impede their practical implementation in EE at HEIs within SA context.

iii. To investigate faculty members' and students' viewpoints and approaches towards industry 4.0 digital technologies, including their perceptions, attitudes, and practices within SA context.

iv. To determine the level of digital literacy required for individuals to navigate and effectively excel in the era of Industry 4.0 within SA context.

v. To formulate recommendations for HEIs to improve EE through Industry 4.0 technologies within SA context.

1.6 Significance of the Study

This study's ability to generate impactful insights for various stakeholders in academia and practice underscores its significance. By examining the impact of 4.0 digital technologies on EE outcomes in HEIs in South Africa, this study advances pedagogical methods and directly enhances students' readiness for a rapidly evolving entrepreneurial landscape. Through well-informed findings, this study guides educational policies, encourage collaboration between industry and academia, and effectively address skill gaps by aligning educational offerings with market demands.

Its contribution to the academic literature enriches the global understanding of the intricate relationship between 4.0 digital technologies and EE. Ultimately, this study aligns with national development goals by promoting innovation, technological literacy, and entrepreneurship as drivers of economic growth, bridging the gap between cutting-edge knowledge and tangible societal impacts.

1.7 Delimitations of the study

The study's delimitations offer a clear perception of its scope and boundaries, distinct from its limitations. These boundaries are intentional decisions made by the researcher to establish the scope of the study.

Geographically, the research focuses specifically on South Africa and its higher education institutions (HEIs). The unique characteristics and challenges present in the South African educational landscape and entrepreneurial ecosystem make it difficult to directly apply the findings and conclusions to other countries or regions.

The study is limited to the exact time periods when data gathering, and analysis occurred. The results and implications correspond to the present status of 4.0 digital technologies and EE in South African HEIs during the research period. Nevertheless, with the advancements in technology and changes in educational methods, these results may no longer reflect upcoming changes.

The results of the research come from a specific group of participants chosen from South African HEI, such as educators and students. The study does not include perspectives and experiences of individuals beyond this sample. Moreover, the findings may not be generalisable to all South African HEIs due to the limited sample size and selection criteria used.

In terms of methodology, the study is constrained by the particular research methods and data collection techniques utilised, including qualitative case studies and semi-structured interviews. Different research methods or approaches could offer varied insights and perspectives on how 4.0 digital technologies affect EE.

Moreover, the research is institutionally limited, with a main focus on the influence of 4.0 digital technologies on EE in HEIs. Even though the study recognises the wider societal and economic impacts of these technologies, it does not thoroughly investigate these factors. Rather, the results mainly pertain to the academic and

educational components of EE in the chosen establishment. These delimitations provide a clear understanding of the study's boundaries and ensure that the findings and conclusions are interpreted within the appropriate context, acknowledging the study's scope and limitations.

1.8. Definition of key terms

Fourth Industrial Revolution/Industry 4.0

According to Schwab (2016), exponential technological advancements result from integrating the physical, digital, and biological worlds. These developments have caused significant changes in various industries, leading to the emergence of new business models that impact every aspect of society.

Digital Technologies

Digital technologies encompass a diverse array of electronic tools, systems, devices, and platforms that leverage information and communication technologies (ICTs) to facilitate a multitude of functions and processes (Barnewold & Lottermoser, 2020). Furthermore, these technologies include hardware, software, and networks that facilitate the creation, storage, retrieval, manipulation, and dissemination of digital data, as well as user communication and interaction (Barnewold & Lottermoser, 2020).

Entrepreneurship

According to the narrow definition of entrepreneurship, it encompasses various aspects such as opportunity identification, business development, self-employment, venture creation, and growth. In other words, it entails the process of becoming an entrepreneur (Fayolle & Gailly, 2008). While Lakéus, (2015) defines entrepreneurship as encompassing various aspects such as personal growth, innovation, independence, proactivity, and a focus on acting. It involves the process of becoming entrepreneurial.

Entrepreneurship Education

Bae, Qian, Miao, and Fiet (2014) coined the term "education for entrepreneurial attitudes and skills" to describe this concept of EE. In contrast, Lackeus (2015) defined EE as fostering students' creativity, opportunity-seeking mindset, proactivity, and innovativeness.

Higher Education

Tertiary education, also known as post-secondary, third-level, or tertiary education, refers to the pursuit of an academic degree. It serves as an optional and final phase of formal learning following the completion of secondary education (Marginson, 2011).

Artificial Intelligence

An area within the field of computer science that focuses on developing software replicating human comprehension, intelligence, and behaviour to address practical, real-world challenges (Webber & Nilsson, 2014).

Digital Literacy

Digital literacy effectively uses, understands, and critically evaluates digital technology and information. It involves the skills, knowledge, and competencies required to navigate, utilise, and communicate digitally (Buckingham, 2020).

Big data

Daniel (2019) defines the term “big data” which encompasses its recent emergence and the presence of data sets with significant magnitude. Likewise, Hussain and Cambria (2018) characterise big data as a substantial volume of data resulting from technological advancements and the ongoing activities and interactions of users in digital environments.

Cloud Computing

Cloud Computing is an internet-based platform that allows computer resources via a computer network and provides end-users with versatile, scalable, and on-demand services by centralising the bandwidth of storage and network and memory processing. (Cubillo, Marten & Castro, 2011).

1.9. Thesis structure

Chapter 1 – Introduction - This section introduces the research topic, background to the study, its significance, research objectives, and rationale.

Chapter 2 – Research Context – This chapter introduces the research context of this study. It outlines the broader higher educational landscape, mainly focusing on EE within HEIs in SA. This research establishes the significance of the context, highlighting the importance of understanding Industry 4.0.

Chapter 3 – Literature review –This chapter focuses on a comprehensive literature review and synthesises an account of the existing body of knowledge on 4.0 digital technologies and EE. It provides a detailed review of the literature on entrepreneurship, including its context and evolution. Furthermore, this study explores the drivers and barriers to adopting 4.0 digital technologies in HE. In addition, this study discusses Industry 4.0 technologies such as AI, Big Data, Cloud computing, and IoT. Finally, this study examined faculty members' and students' perspectives and practices.

Chapter 4 – Theoretical Framework: This section presents the theoretical framework that guides the study and builds on the literature review. It outlines the theoretical perspectives, models, or frameworks employed to analyse the impact of 4.0 digital technologies on EE. Two theoretical frameworks formed this study's foundation: the Technology Acceptance Model (TAM) and Technological Pedagogical Content and Knowledge (TPACK).

Chapter 5 – Research design and methodology: This section explains the research design, data collection methods, and analysis techniques used in the study. It discusses the selection of the participants' data-gathering instruments. The methodology section outlines a clear roadmap of how the research was conducted.

Chapter 6 – Data Analysis - This chapter introduces the reader to the context of the research participants. The chapter begins with a detailed description of how the researcher analysed the collected data. It concludes with a comprehensive interpretive narrative of the data analysis, which involves formulating themes and sub-themes.

Chapter 7 – Findings and Discussion: This chapter presents the study's findings. The study revisited the research questions and demonstrated how they were answered. The discussion of the findings relates to the research objectives and is supported by the relevant evidence and data.

Chapter 8 – Conclusions and recommendations - This section summarises the main findings, reiterates the research objectives, and provides a concluding statement on the overall study. This also highlights the practical implications and contributions of this study. The study's findings lead to recommendations for HEIs, policymakers, or other relevant stakeholders. These recommendations aim to enhance the integration of 4.0 digital technologies in EE and suggest ways to address the identified challenges or gaps.

1.10 Ethical Considerations

Given that the researcher did not have direct contact with the groups or sites, the study necessitated the identification of gatekeepers to aid in gaining access, conducting the study, and obtaining participant information. The researcher reached out to the members of the selected institutions who served as gatekeepers and assisted in contacting eligible participants according to the research criteria. Gatekeepers played a crucial role, given that the researcher lacked access to participants' contact information or databases. Furthermore, the researcher had to fulfill the criteria and secure approval from the institutions' Research and Integrity Committee before initiating data collection. Gatekeepers received information regarding the purpose and requirements of the study, ensuring transparency and compliance with ethical considerations. The gatekeepers were informed of the:

- The intended purpose of the study and the significance of the participants.
- The reason(s) why the specific institution was chosen.
- The possible benefits for the institutions.
- Time frame and information required for the study.
- Potential risks, if any, of the study.
- How the research findings would be utilised.

Any reputable academic research necessitates the voluntary involvement of participants. Therefore, this study sought consent from students and faculty members at the selected university to participate, informing them of their right to withdraw

without incurring physical or psychological harm. The privacy and confidentiality of all participants was strictly maintained throughout the research process through allocating pseudonyms to participants. Initially, it was crucial to approach the university's gatekeeper for permission to interview students and faculty members, considering the potential ethical challenges of research within the university context. The researcher conducted this research with full ethical clearance granted by the UNISA Human Ethics Committee and Research Ethics and Integrity Committee.

1.11 Conclusion

In conclusion, Chapter 1 established the foundational context and significance of this research study. It highlighted the rapid transformations occurring in the EE landscape due to the integration of 4.0 digital technologies, both globally and within the specific context of South African HEIs. The chapter articulated the research problem, which centres on examining the impact of these digital technologies on fostering an entrepreneurial mindset and developing a pedagogical framework for EE. By outlining the research questions, objectives and limitations, Chapter 1 clearly delineates the scope and boundaries of this inquiry. Furthermore, it has acknowledged the ethical considerations that guide the research process and has provided definitions of key terms to ensure conceptual clarity. With this comprehensive introduction, the stage is set for delving deeper into the relevant literature, theoretical foundations and methodological approaches that shape the ensuing investigation into this critical issue at the intersection of technology and entrepreneurship pedagogy.

CHAPTER 2: RESEARCH CONTEXT

2.1 Introduction

This chapter provides a nuanced overview of essential key terms and themes that underpin the study. Its purpose extends beyond mere introduction, aiming to establish a comprehensive context for the study by delving into HE, entrepreneurship, EE, and industrial revolutions. Beginning with an in-depth exploration of the current landscape of HE in SA, the chapter subsequently conducts an examination of entrepreneurship, elucidating various definitions associated with the concept. Furthermore, the chapter addresses EE and delineates the historical evolution of industrial revolutions. The chapter endeavours to construct a robust knowledge foundation by methodically covering these critical areas, facilitating a profound grasp of the central research problem and objectives.

2.2 Higher Education in South Africa

The HE system in SA has been plagued by a multitude of challenges stemming from a colonial history and the apartheid regime. Under the apartheid administration, the HE system was structured to serve the needs of black and white population groups differently, as a means to perpetuate racial segregation. Hence, the HE landscapes in SA has undergone significant changes over the past two decades since the country's democratic transition in 1994 (Ng'ambi, Brown, Bozalek, Gachago, & Wood, 2016). During this period, skill development was strongly emphasised to drive economic advancement and enhance technological integration in HE amid the growing student population.

The HEIs have been influenced by various factors throughout history, including colonialism, apartheid, scientific and technological advancements, internationalisation, and globalisation (Wangenge-Ouma & Kupe, 2020). More recently, the COVID-19 pandemic has brought significant changes to the global HE sector (Aristovnik, Keržič, Ravšelj, Tomaževič & Umek, 2021). In terms of teaching and learning, HEIs have been compelled to transition to online modes of instruction due to the pandemic. However, this transition has not been without challenges, particularly in terms of resource availability in some institutions. Nonetheless, the shift to online teaching and learning remains a priority given the uncertainties of the future.

Wangenge-Ouma and Kupe (2020) emphasise that investing in online learning offers the advantage of ensuring continuity during disruptions such as the COVID-19 pandemic. As a result, HEIs need to embrace online teaching and learning as part of reimagining the new HE models in order to carry out academic activities (Mtshweni, 2022).

The massification and globalisation of HE has transformed traditional educational institutions into 21st-century learning environments where access to knowledge, data sharing, and global connectivity are paramount (South Africa Council on Higher Education, 2016). However, despite the adoption of emerging technologies by South African HEIs, their impact on the quality of EE remains uncertain. There is a lack of information and feedback on the influence of these technologies on EE. Van Tonder (2015) suggests this may be due to a lack of a framework and policy guidelines for technology facilitation in South African HE.

HE in post-apartheid SA has experienced considerable volatility, yet it has also made significant progress in achieving the national goals of quality, equity, and transformation (Council on Higher Education, 2020). It has successfully integrated its fragmented state, established an independent quality assurance and advisory body, consolidated its national department, transformed the institutional landscape, and increased access to a more diverse student population, including an over 80% rise in African student enrolment (DHET, 2020). However, the HE sector now faces the challenges posed by digital technologies in the era of Industry 4.0. Consequently, gaining a comprehensive understanding of the external environment and the direction in the industry 4.0 era is crucial to inform future actions and decision-making within EE.

2.2.1 Higher Education and Technology

The incorporation of technology is an area that has witnessed significant transformations in teaching and learning practices. From 1994 to 1998, technology usage in South African HE primarily revolved around computer-aided instruction, often employing behaviourist drills and practice techniques (Ng'ambi et al., 2016). Furthermore, Ng'ambi et al., (2016) stated that between 1999 and 2003, South African

HEIs focused on bolstering their ICT infrastructures. However, this era also marked the growing realisation of the digital divide among academics, highlighting disparities in technological access between institutions and students. Therefore, this phase fostered heightened awareness among certain institutions of the internet's potential to democratise access to information through technology.

From 2004 to 2008, South African HEIs formulated strategic plans aimed at incorporating information and communication technologies (ICTs) into their instructional and learning methodologies. As a result, the period between 2009 and 2019 witnessed a significant increase in the utilisation of mobile learning, social media platforms, and the bring your own device (BYOD) approach, predominantly among students (Ng'ambi, 2016). The emergence of cloud-based ICT infrastructure and open educational resources (OERs) has also presented opportunities to shift technology away from institutional control, facilitating ubiquitous and flexible learning experiences (Garbers, 2018). Although mobile social media platforms and OERs have provided avenues for flexible and accessible learning, traditional teaching and learning methods have persisted within the HE realm in South Africa. Despite the potential to revolutionise EE through digital tools, the adoption and integration of these technologies into mainstream pedagogical practices have been limited. This can be attributed, at least partially, to persistent challenges such as the digital divide and limited funding for digital infrastructure development, among other pertinent factors (Gabriel, Marrone, Van Sebille, Kovanovic & de Laat, 2022).

Over the last two decades (2000-2020), the higher education (HE) system has undergone significant transformations driven mainly by technological advancements (Ng'ambi et al., 2016). One notable transformation has been the widespread adoption of online and distance learning programmes facilitated by internet and digital technologies. This allowed for more flexible and accessible education, enabling students to pursue courses and degrees remotely, breaking down geographical barriers (Van Staden & Naidoo, 2022). These changes have also profoundly impacted collegial academic relationships, leading to notable shifts in collaborative practices. For instance, the proliferation of cloud-based applications such as Figma has revolutionised collaborative work in product design. Presently, two students in different cities can collaborate in real-time and seamlessly work on product design (Mayer,

Chardonnet, Häfner & Ovtcharova, 2023). This illustrates how technology has transcended continental divides, thus enabling real-time collaboration.

Technological advancements have facilitated the joint authorship of research articles and transcending geographical boundaries. Scholars from different parts of the world can now collaborate as if they were physically present in the same room despite being thousands of miles apart. This enhanced ability for synchronous collaboration has opened up new possibilities for international research partnerships and knowledge exchange (Agarwal et al.,2020). These transformative changes highlight the significant impact of technology on fostering collaboration and breaking down traditional barriers in the academic community. However, it is crucial to investigate how these advancements have influenced collegial relationships and overall dynamics within the EE ecosystem. To delve into entrepreneurship and its relevance, it is crucial to establish the origins and precise definitions that underpin its understanding.

2.3 Structure of the South African Higher Education Sector

South Africa's pathway to advanced education involves three institutional branches. Standing at the top are the 26 public universities in the nation - leading in research and academics. Renowned institutions such as the University of South Africa, University of Cape Town and University of Witwatersrand attract students in various fields seeking undergraduate, postgraduate and doctoral degrees. The six universities of technology are operating simultaneously. These campuses prioritise vocational training, providing students with instruction focused on their future careers. Technical diplomas and degrees equip graduates to propel SA's industries and economy ahead (Department of Higher Education & Training (DHET), 2020).

The third avenue runs through the nation's fifty public TVET colleges. Covering all nine provinces, these institutions provide vocational skills and education through national diplomas, certificates, and specialised programs. They aim to create a team of qualified tradespeople and skilled workers. The DHET supervises this triple-tiered HE system. This organisation oversees the distribution of governmental funds to public HEIs. It also oversees quality control by the Council on Higher Education (CHE).

Even with support from government funding, the expense of education is still a barrier for some students due to tuition fees. The National Student Financial Aid Scheme (NSFAS) helps by providing financial aid to eligible students from underprivileged backgrounds (Mthimunye & Daniels, 2020).

2.4 Meaning of the term entrepreneurship

Although entrepreneurship is frequently associated with initiating a novel business venture, Lackeus (2015) posits that it encompasses a much broader scope than merely establishing a company. Lackeus (2015) explicitly underscores the significance of creativity, seizing opportunities, proactive measures, and driving innovation as integral components of entrepreneurship. Therefore, according to Lackeus, entrepreneurship goes beyond simply founding start-ups. Gartner (1990) corroborates this view by indicating that students tend to constrain their understanding of entrepreneurship to launch new ventures. However, Shane and Venkataraman (2000) argue that entrepreneurship, also referred to as corporate entrepreneurship, can materialise within pre-existing companies. Additionally, they contend that entrepreneurship incorporates the association between individuals and opportunities, not just individual entrepreneurs. Consequently, while establishing a new business is one possible manifestation, entrepreneurship is more extensive, encompassing the development of an innovative mindset, recognising opportunities, and creating value in both new and established enterprises.

In the domain of EE, two distinct perspectives on the terms “entrepreneur” and “entrepreneurial” exist, and there are narrow and broad perspectives (Lackeus, 2015). This narrow perspective focuses on identifying, developing, establishing, and growing new ventures (Fayolle & Gailly, 2008). On the other hand, the broad perspective emphasises personal development, creativity, self-reliance, and initiative-taking. It focuses on individuals becoming more entrepreneurial (Mwasalwiba, 2010). The selection of a definition has a significant impact on course content, teaching methods, objectives, and student assessment procedures, resulting in various approaches. Both perspectives were considered in this study. This section provided an overview of the

definitions of entrepreneurship. The following section discusses EE and its associated aspects.

2.5 Entrepreneurial Education

Globally, EE has witnessed a significant increase, driven by government initiatives promoting entrepreneurship in HE (Campos, Braga, Correira, Ratten & Marques, 2021). Consequently, EE has gained wide acceptance among academics and politicians as a solution to various social and economic challenges (Volkmann, 2004; Kuratko, 2005; Fayolle, 2018). Singer, Amorós, and Arreola (2015) further emphasise the crucial role of entrepreneurship in economic growth and development, highlighting its potential as an engine of economic and social progress (Fayolle, Verzat & Wapshott, 2016).

However, there is a need for robust intellectual frameworks at both theoretical and methodological levels to support the shift towards a more constructivist understanding of EE among faculty members (Pittaway & Cope, 2007). Existing research on EE demonstrates a clear distinction between practitioner-based research and the implementation of educational theory to support and conceptualise it. This is particularly relevant given that many entrepreneurship faculty members have limited technological literacy and modern pedagogical training and rely on their conventional pedagogic practices (Lackéus, Lundqvist, & Middleton, 2016; Neck & Corbett, 2018). The pedagogical competence of faculty members plays a critical role in delivering high-quality EE and fostering students' learning and skill development in the Industry 4.0 era (Macht & Ball, 2016).

Lackéus and Williams-Middleton (2015) state that students must engage in entrepreneurial activities to develop entrepreneurial capabilities and acquire practical knowledge in the digital era. Therefore, experience-based learning is essential for students to practice entrepreneurial skills and prepare for their future careers (Simmons, 2021). Various countries and HEIs adopt different objectives, target audiences, formats, and pedagogical techniques to promote entrepreneurial attitudes among university students (Fayolle, 2018). However, in conjunction with the expansion and strategic significance of EE, advanced digital technologies are experiencing a

growing impact on the innovation and production processes (Alcácer, Cantwell & Piscitello, 2016). Nonetheless, harnessing the complete potential of these emerging 4.0 digital and smart technologies continues to present a substantial challenge for EE. It is crucial to raise awareness about the potential role of digital and smart technologies and explore their application in entrepreneurship practices to enhance stakeholder competitiveness, sustainability, and value optimisation (Lombardi, 2019).

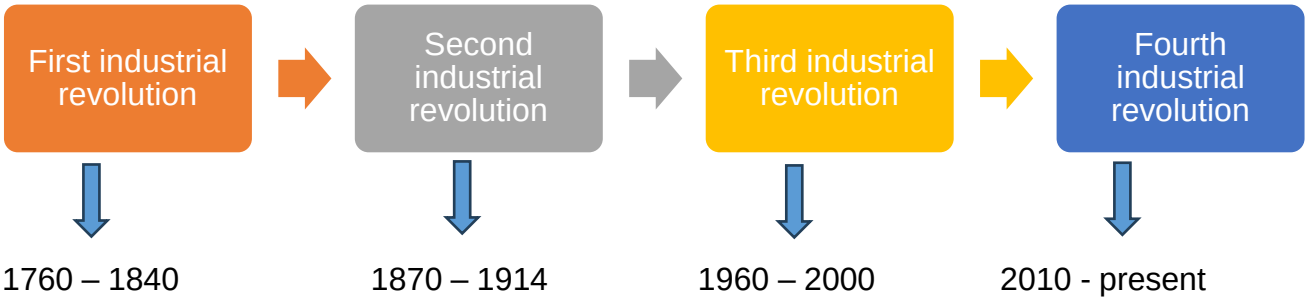
Categorising entrepreneurship teaching involves two approaches: “for” and “about” entrepreneurship, necessitating a distinction. This determination closely relates to whether the goal enhances students’ practical abilities to engage in entrepreneurial action or to instruct entrepreneurship as an academic subject (Berglund & Holmgren, 2013). While this distinction may appear simplistic, it is evident that specific programs emphasise practical application while others focus on conceptual development (Lackéus, 2015). Therefore, an important question arises regarding theories on entrepreneurship teaching. Despite the potentially outdated nature of these studies, these questions remain relevant in the current HE landscape, which still needs to transform its entrepreneurial pedagogical approaches to adapt to the demands of Industry 4.0.

While numerous studies have examined the strategic impact and role of digital technologies in market orientation (Mihardjo, Sasmoko, Alamsjah, & Elidjen, 2019), there is a conspicuous gap in our understanding of how EE can effectively embrace these technological innovations within the context of market orientation. The untapped potentialities and profound implications of these technological advancements in EE are yet to be fully explored and comprehended.

2.6 Industrial Revolutions

The industrial revolutions represent the major technological and economic shifts that transformed production processes over the past few centuries, as depicted in Figure 2.1 below.

Figure 2.1 Industrial revolutions timeline



Over the past three centuries, the industrial revolution has been recognised as the most significant transformation in human history (Stearns, 2020). Each industrial revolution, marked by distinct technological advancements, has profoundly affected the economy, government operations, and societal well-being (Kayembe & Nel, 2019). The first industrial revolution (1IR) took place between 1760 and 1840 and introduced innovations such as steam engines and the construction of railroads. This period laid the foundation for improvements in mechanisation and transportation.

The second industrial revolution (2IR) occurred in the late nineteenth and early twentieth century. It was characterised by the emergence of electricity and assembly line production, enabling mass manufacturing (Kayembe & Nel, 2019). The advent of electricity revolutionised industries and accelerated productivity. In the 1960s, the third industrial revolution (3IR), also known as the “computer or digital” revolution, began with the introduction of semiconductors, computers, and the internet. These technological advancements have ushered in a new era of information exchange and computing power.

Arguably, the fourth industrial revolution (4IR/industry 4.0) began around 2010, encompassing the convergence of various technologies, including nanotechnology, cloud computing, machine learning, and AI (Schwab, 2016). This revolution involves the integration of physical, digital, and biological domains and transforming industries on a global scale. The significance of the era of Industry 4.0 lies in its far-reaching impact on virtually every industry and country. This breadth and depth of transformation necessitate significant modifications in production processes, management systems, and public governance (Pellini, Weyrauch, Malho, & Carden, 2019). To truly grasp the magnitude and significance of the current industrial

revolution, it becomes imperative to embark on a journey toward exploring its defining characteristics at a much deeper level.

Industry 4.0 has significantly impacted education, industry, entrepreneurship, and people's daily lives (Kamaruzaman, Hamid, Mutalib, & Rasul, 2019). This revolution builds upon the success of previous industrial revolutions, presenting new possibilities and opportunities that require innovative ideas to address the unique challenges of the 21st century. However, some argue that this revolution may hinder progress rather than drive it forward, as Dumitrescu and Prisecaru (2020) advocated. They claim that relying too heavily on technology and innovation can lead to unforeseen consequences and dependence on machines over human labour. Additionally, these advancements may exacerbate inequality by only benefiting those with access to advanced technologies, thus widening the gap between developed and developing nations. Furthermore, there are concerns regarding job displacement caused by automation, which could result in unemployment among many individuals who lack the skills required in this technological era.

As countries prepare for a transformative shift in how people interact with the world, HEIs must adapt and enhance their abilities to keep pace with rapid technological advancements and the resulting economic and social shifts (Hu & Chang, 2019). Thus, this industry 4.0 revolution extends well beyond the usage of smart technology and computer systems, as it is fundamentally different from the previous revolutions in that it fuses technologies from the physical, digital, and biological domains (Schwab, 2016). In the context of HE, the rapid rise of 4.0 digital technologies has led to HEIs adopting a multidisciplinary approach. According to some recent reports, the convergence of technological and globalisation forces is posed to transform HE from a collection of traditional 20th-century institutions dedicated to the pursuit of knowledge in a variety of fields to entirely new models of an institution that seek to capitalise on these changed circumstances in order to become globally competitive entities (Coetzee, Neneh, Stemmet, Lamprecht, Motsitsi, & Sereeco, 2021). One concrete example is the integration of VR in classroom settings. These immersive technologies provide students with experiential learning opportunities that were previously inaccessible. For instance, through VR simulations, entrepreneurship students can engage in virtual business environments to make critical decisions, test different strategies, and

experience the consequences of their choices (Orel, 2020). These simulations can cover various aspects of entrepreneurship, such as market analysis, product development, financial management, and business planning (Barnaby, 2021).

Another evidence of the impact of 4IR in EE is the rise of online learning platforms and Massive Open Online Courses (MOOCs). Digital platforms offer flexible and scalable educational opportunities for students worldwide (Zhang, 2023). Research findings indicate that MOOCs have contributed to increased access to HE, enabling learners to acquire knowledge and skills remotely (Alexander et al., 2019). As an illustration, Coursera, one of the prominent MOOC platforms, collaborates with esteemed universities to provide an extensive array of courses that reach millions of students worldwide.

Despite these new opportunities, numerous challenges hinder the complete realisation of the potential provided by 4.0 digital technologies, even in the most advanced countries. These challenges encompass the deficiencies in digital literacy among both faculty members and students, the relatively limited recognition of innovation in teaching and learning, and the necessity to construct practical and pedagogically advanced course models. Moreover, there is also a growing digital divide regarding access to technology, mainly because the global drive to increase participation rates in HE increases the number of students who may not have the background to succeed without additional technological support (Carrim, 2022).

2.7 South Africa's Response to Industry 4.0

In the era of Industry 4.0, the transformation of the South African HE discourse goes beyond mere demographic changes among students and faculty members. It ventures into a realm that transcends numerical shifts and delves into digital culture. This dimension of transformation involves a profound reconfiguration of the HE system, driven by implementing policies to align it with a visionary digital landscape (Johnson, 2020). The impetus behind these transformative changes is creating a state of affairs that diverges from the inequalities ingrained in the apartheid era. Within the context of 4IR, South African HEIs are undergoing a paradigm shift in which digital culture plays a pivotal role. Integrating advanced technologies such as AI, IoT, VR, and big data

analytics reshapes the educational landscape, redefines teaching and learning methods, and propels HE into a new frontier of knowledge dissemination and acquisition. The objective is to embrace the potential of these emerging technologies to bridge historical gaps, enable access to quality education, and foster inclusive learning environments (Carrim,2022).

By embracing 4.0 digital technologies, South African HEIs aim to transform their systems and align themselves with Industry 4.0 principles. These institutions strive to bridge gaps in access, improve educational outcomes, and enhance their overall learning experience by integrating digital advancements into their practices (Mtotywa et al., 2022). This entails implementing online learning platforms, utilising educational technologies, and leveraging digital resources to expand educational opportunities beyond the traditional classroom settings.

Embracing the digital culture within Industry 4.0 propels South African HEIs towards a vision in which physical boundaries and traditional instructional methods do not solely define education (Mhlongo, Mbatha, Ramatsetse & Dlamini, 2023). The goal is to foster an ecosystem in which digital tools, VR, online platforms, and immersive experiences are integral to the educational journey. This transformative approach aims to empower students with the skills needed to thrive in the digital age, promote critical thinking, nurture creativity, and equip them with the dexterity to adapt to the rapidly evolving technological landscape (Wei, 2023).

In the era of industry 4.0, a deep-rooted desire to rectify past injustices drives the transformation of the discourse in South African HE (Van der Merwe & Van Reenen, 2016). By harnessing the power of digital culture, HEIs aim to break free from the shackles of apartheid-era inequalities and forge a path towards an equitable, inclusive, and future-focused educational system (Dlamini & Mhlongo, 2023). This vision is underpinned by the intention to empower students from all walks of life with tools to unlock their potential, contributing meaningfully to society, and actively participating in the nation's digital transformation. In doing so, SA aspires to redress historical inequities and build a brighter future for its citizens through education that embraces technology while promoting fairness and social progress (Adam, 2020).

The forthcoming literature review delves into existing scholarly insights to strengthen this study's theoretical foundation. It engages critically with the pertinent academic discourse surrounding education, equity, and technological progress to better understand the strategies, challenges, and outcomes associated with 4.0 digital technologies, EE, and HE. This situates the research within the ongoing academic dialogue on these topics.

CHAPTER 3: LITERATURE REVIEW

3.1 Introduction

The preceding chapter provides a context for the study by summarising and synthesising existing knowledge related to the topic. It helps the researcher and readers understand the current state of knowledge, fundamental theories, and relevant concepts in the field. This chapter also helped the researcher position their work within the broader academic landscape.

3.2 The evolution of entrepreneurship education

Over the years, entrepreneurship has become increasingly prevalent and widely recognised (Becker, Knudsen & Swedberg, 2012). While there was once a belief that entrepreneurs were solely born and not made, recent research has debunked this notion, challenging the “entrepreneurial mystique” proposed by Peter Drucker, a respected management guru (Tomozyk, Cechrova, Vacek, Kozakova & Marosna, 2016). It is now widely acknowledged that entrepreneurship is a discipline that can be taught and learned, similar to any other subject (Drucker, 1985).

Despite the growing acknowledgement of EE, there has been limited exploration of its evolving nature (Katz 2003). Academic literature indicates that the first course in entrepreneurship was offered at Harvard Business School in 1947, followed by Peter Drucker's course at New York University in 1953 (Alberti, Sciascia & Poli, 2004). However, it was not until 1968 that Babson College introduced entrepreneurship courses to undergraduate students, and EE in HEIs began to gain traction (Katz 2003). Since then, EE has experienced exponential global growth, with over 1,200 business schools in the United States offering EE in 2001 (Katz, 2008). This number has surpassed 3,000 worldwide (Kuratko & Morris, 2018).

While the proliferation of EE programmes is evident, there remains an ongoing discussion regarding EE's scope, approaches, methodologies, and impact (Fayolle, 2013; Kuckertz, 2013; Daniel, 2016). Traditional approaches to EE have persisted as the predominant method for over a century, possibly because of the prioritisation of functionality over idealism (Neck & Greene, 2011). However, exploring how EE has transitioned across different industrial revolutions is essential for providing a more comprehensive understanding of its development.

Education policies have long stressed the importance of measurement, performativity, and the traditional modes of education. These policies remain strong today rather than showing signs of waning influence (Lackéus, 2020). However, despite the growing number of EE programs implemented globally, scholarly attention towards examining their technological impact remains insufficiently explored. There is an evident need for more research in this domain to fully understand how technology interacts with EE initiatives and shapes their outcomes (Tomozyk et al., 2016).

EE has made substantial progress and received acknowledgement. However, additional efforts should be made to adopt a more structured approach to comprehend EE's development, range of applications, methodologies employed, and overall impact. Moreover, exploring the contribution of technology to EE advancement is imperative for effectively adapting and optimising EE initiatives within the constantly evolving realms of business and innovation.

3.3 Entrepreneurship as an Economic Growth Driver

Scholars widely recognise entrepreneurship as a fundamental driving force of economic activity in economies worldwide (Almodóvar-González, Fernández-Portillo & Díaz-Casero, 2020). This significance is particularly relevant in South Africa, which faces high youth unemployment and sluggish economic growth (StatsSA, 2021). To tackle these challenges, the South African government has prioritised entrepreneurship to stimulate economic growth and employment, especially among the youth (Francke & Alexander, 2019). Entrepreneurship enhances competitiveness, promotes economic growth, fosters creativity, and drives innovation (Obaji & Olugu, 2014). Consequently, EE needs to be improved to meet these goals.

According to Schumpeter (1934), entrepreneurship has been linked to positive economic growth, as entrepreneurs drive technological advancement through innovation and introducing new products and services (Mahadea & Kaseeram, 2018). However, the significance of entrepreneurship as a crucial driver of economic growth and social development has been undervalued for many years in certain nations (Malatjie, 2020). In comparison to other emerging economies, South Africa's total early-stage entrepreneurial activity rate (TEA) rankings have consistently been relatively low (StatsSA, 2019).

The South African Department of Trade and Industry (DTI) recognises that limited entrepreneurial capacity and skill shortage have further constrained employment growth (DTI, 2018).

While researchers have extensively studied the benefits of entrepreneurship, they have paid limited attention to the technological impacts on pedagogical processes in entrepreneurship, especially in a rapidly changing entrepreneurial landscape. Addressing this significant area has become crucial as technological disruptions transform various aspects of human activity, including the entrepreneurship ecosystem. The following section discusses the utilisation of digital technologies in HEIs.

3.4 Digital Technologies in HEI

Nambisan (2017) cited the widespread recognition of the impact of 4.0 digital technology on entrepreneurial processes and the academic environment. In the present era, faculty members are increasingly expected to integrate technology into their teaching and learning approaches, given the rapid progress and widespread use of digital technologies (Koehler & Mishra, 2005; Martin, Polly, Coles & Wang, 2020). Therefore, incorporating 4.0 digital technologies into HE offers several advantages, including improved accessibility, collaboration, communication, diversified value, active and social learning, self-direction, content engagement, project-based learning, and exposure to a global context (Dabbagh,2018).

Nevertheless, it is crucial to differentiate between learning with technology and learning about technology. The approach to teaching technology varies among faculty members based on their comprehension of these concepts. While learning with technologies stresses the pedagogical aspect, learning about technologies primarily emphasises the technology itself (Ng'ambi, Brown, Bozalek, Gachago & Wood, 2016). This understanding is crucial for the faculty members and the HEIs as they develop curriculum and implement technology enhancement in the learning environment.

In today's educational landscape, incorporating digital technology has become an integral part of teaching and learning, driven by the demands of the twenty-first century (Fahlvik, 2014). While there is a growing recognition of the importance of developing

advanced technological skills in a rapidly changing world, it is crucial to acknowledge the potential challenges that arise from this integration. These challenges include issues of access and equity, the need for continuous professional development for faculty members, and concerns regarding privacy and digital safety (Núñez-Canal, de Obesso & Pérez-Rivero, 2022). Therefore, when considering technology in education, it is vital to start with the desired learning outcomes and work backwards, asking pedagogical questions that align with different approaches, such as blended learning, flipped classrooms, or project-based learning (Ng'ambi, 2013). In doing so, faculty members can evaluate teaching strategies and assess how technology can effectively support meaningful learning experiences. However, it is essential to acknowledge that while technology can enhance education, it is not a panacea for all educational challenges (Díaz et al., 2020). It is essential to address the limitations and potential pitfalls associated with an overreliance on technology, such as decreased human interaction or passive information consumption (Hassani, Huang & Silva, 2021). By striking a balance and critically examining the role of digital technology in EE, faculty members can harness its benefits and mitigate its drawbacks.

Integrating 4.0 digital technologies into the EE raises valid concerns about their impact on teaching and learning when the necessary resources and support are lacking. Hence, one must carefully consider the infrastructure's up-time, availability, and support (Van der Merwe, Bozalek, Ivala, Peté, Vanker & Nagel, 2015). In the late 1800s, traditional classrooms followed a one-size-fits-all approach to preparing students for employment in an industrial economy (Arnett, 2013). However, in the twenty-first century, the EE landscape has rapidly evolved owing to Industry 4.0 technological advancements. These technological advancements have significantly transformed the entrepreneurship ecosystem leading to new opportunities and challenges for EE (Elia, Margherita & Passiante, 2020). In this context, it is critical to explore the impact of 4.0 digital technologies on EE and how faculty members adapt their curriculum and pedagogy to effectively prepare students for the evolving entrepreneurial landscape.

Nonetheless, it is crucial to focus on EE goals rather than being swept away by technological possibilities alone. Hence, effective learning should be the primary consideration when incorporating 4.0 digital technologies (Van Tonder, 2015). As such, Arnett (2013) emphasises that HE should involve guiding students to learn and

lead technology rather than solely adapting to what technology offers. This balanced approach ensures that technology serves as a tool to enhance and facilitate learning outcomes.

The Bring Your Own Device (BYOD) movement is an emerging trend that exemplifies technological integration into HE. Students bringing their personal laptops, tablets, smartphones, or other mobile devices to class allows for seamless integration of technology into the learning process (Harerimana & Mtshali, 2021). This practice enables faculty members to leverage student devices for active learning. For example, by using mobile devices, faculty members can implement virtual classroom response systems, such as polling apps, online quizzes, and gamification, to increase participation and engagement during lectures. Additionally, back channels facilitated by digital devices provide spaces for students to ask questions, share insights, and collaborate in real-time, enhancing the learning experience.

3.4.1 Challenges of Digital Technology Integration

It is essential to acknowledge and delve into the potential challenges associated with 4.0 digital technologies to provide a more comprehensive and balanced analysis. While 4.0 digital technologies offer numerous advantages, addressing concerns about equitable access, technological infrastructure, and the need for digital literacy support is crucial. By addressing these concerns, it can be ensured that the integration of 4.0 digital technologies promotes inclusivity and effectively supports diverse groups of students (Robertsone & Lapina, 2022).

The HE landscapes in SA are confronted with a multifaceted predicament, grappling with systemic contextual obstacles stemming from historical and educational policies while simultaneously witnessing a generation brimming with potential owing to the emergence of new technologies (Le Grange, 2023). The advent of the Industry 4.0 era has ushered in many opportunities, yet it has also presented inherent challenges that demand attention. These challenges call for a comprehensive examination of various aspects, including the prevailing financial situation, infrastructural and technical constraints, digital skills gap, and pedagogical and cultural factors, as highlighted by Lubinga, Maramura, and Masiya (2023) and Amanda and Dhaou (2019).

3.4.1.1 Financial Barriers: The cost of acquiring and integrating advanced technologies

In the realm of HEIs, the adoption of 4.0 digital technologies holds tremendous potential for enhancing student learning and preparing students for the demands of the digital era. However, one of the significant barriers HEIs face in effectively adopting these technologies is the substantial costs associated with their acquisition and integration (Liguori & Winkler, 2020). This section delves into a discussion of the financial barriers, such as upfront investments and budget constraints, integration costs and scalability, and maintenance and upkeep expenses involved, presenting discussions from the existing literature to support the notion that cost poses a significant hindrance to the successful implementation of 4.0 digital technologies in HEIs.

Acquiring advanced technologies requires significant upfront investments, encompassing the procurement of specialised equipment, software licenses, and the development of compatible IT infrastructure. The studies conducted by Liguori and Winkler (2020) shed light on the budget constraints HEIs face, which hinder their ability to allocate sufficient funds for these expenditures. This limitation significantly hampers the adoption of 4.0 digital technologies as HEIs struggle to overcome financial barriers and secure the necessary resources. Without adequate funding, HEIs may find it challenging to invest in technologies required for effective EE (Liguori & Winkler, 2020).

Integrating advanced technologies into existing curricula and learning environments incurs additional costs. This process often involves hiring specialised personnel, providing comprehensive training programs for faculty, and ensuring seamless integration with existing systems. Mohamed-Hashim, Tlemsani & Matthews, (2021) highlight the significance of scalability in successful integration, stressing the need for sustained investments. Financial constraints present a considerable challenge, as HEIs must balance competing financial priorities while aiming for sustainable and scalable adoption (Okoye et al., 2023). Limited resources can impede the smooth integration of advanced technologies, thus hindering their transformative impact on EE.

Acquiring and integrating advanced technologies into HEIs is not a one-time investment but an ongoing commitment that demands continuous financial support for maintenance, repairs, and technology infrastructure upgrades. Alzahrani, Bahaitham, Andejany and Elshennawy (2021) shed light on budgeting for ongoing expenses related to software updates, equipment maintenance, and infrastructure enhancements. This perspective emphasises the importance of ensuring the continuous functionality and relevance of 4.0 digital technologies in the educational environment. However, inadequate financial resources can pose significant challenges. As Halabieh et al., (2022) highlighted, insufficient funding may result in outdated or malfunctioning systems, impairing the effective utilisation of 4.0 digital technologies in HEIs. This insight reveals that the financial aspect of maintaining advanced technologies is crucial as it directly impacts their overall influence on EE.

Moreover, insufficient funding for maintenance can also lead to missed opportunities to fully leverage the potential of these technologies (Smale & Regalado, 2016). By not allocating adequate resources for upkeep and upgrades, HEIs risk limiting the transformative benefits that 4.0 digital technologies can bring to teaching, learning, and research.

3.4.1.2 Infrastructure and Technical Challenges

The successful adoption of 4.0 digital technologies in HEIs holds great promise for advancing EE but comes with its share of challenges. The existing infrastructure and technical limitations of many HEIs create hurdles that must be addressed to harness the transformative power of these technologies fully (Kerroum, Khiat, Bahnasse & Aoula, 2020). One significant obstacle is the deficiency in digital infrastructure, where inadequate technological resources, such as slow internet connectivity and outdated hardware, hinder the seamless integration and utilisation of advanced technologies (Schaffhauser, 2017). Outdated equipment, limited network infrastructure, and inadequate digital resources can impede the effective use of digital technologies in HE (Øvrelid, 2022; Tamer & Knidiri, 2023). For example, HEIs lacking sufficient devices or reliable internet connectivity may struggle to leverage the benefits of digital learning fully. This calls attention to investing in robust technological infrastructure and ensuring that institutions have the necessary resources that enable more seamless integration of digital technologies into the learning environment.

Limaj and Bilali (2018) confirmed that a high-speed internet connection is a precondition for effectively integrating ICT into the teaching-learning system. They emphasise the importance of the internet in enabling students and lecturers to access education at any time and from anywhere, utilising it for video conferences, online learning, live presentations, and video courses. These capabilities are pivotal in enhancing the educational experience and leveraging the benefits of 4.0 digital technologies in HEIs. However, without adequate digital infrastructure, the potential of these technologies remains elusive.

Substantial investments are essential to overcome the limitation of deficient digital infrastructure (Aditya, Ferdiana & Kusumawardani, 2021). Upgrading infrastructure and creating an environment that fosters the effective implementation of 4.0 digital technologies are crucial for capitalising on their transformative potential in HEIs. For this purpose, strategic planning and resource allocation are imperative to bridge this gap and ensure equitable access to these technologies for all stakeholders.

Furthermore, the prevalence of legacy systems in HEIs introduces compatibility issues with a new generation of digital technologies (Gkrimpizi & Peristeras, 2022). These legacy systems, relics of earlier technological eras, may lack the interoperability required to seamlessly integrate with 4.0 digital technologies, creating friction in the integration process. Consequently, significant efforts and investments are necessary to bridge the gap between these older systems and new technologies, enabling a more efficient and cohesive digital ecosystem within HEIs (Aditya et al., 2022). Therefore, significant technological infrastructure upgrades are required to establish technology-enhanced learning to accommodate the projected 1.6 million HE students in SA by 2030 (Council on Higher Education, 2016). This upgrade ensures seamless and effective integration of digital technologies into learning, benefiting students and faculty members. While integrating technology in HE holds great potential for students and faculty members, it is equally important to consider EE efficacy in preparing students to meet the evolving demands of the modern economy.

In addition to technical challenges, cybersecurity concerns are critical for successfully adopting 4.0 digital technologies in HEIs (Microsoft, 2017). The escalated reliance on digital tools and data storage increases the vulnerability of HEIs to potential cybersecurity risks, encompassing data breaches and unauthorised access to

sensitive information (Robertsone & Lapina, 2022.). Consequently, safeguarding an institution's digital infrastructure and data has become a paramount concern, aiming to preserve the privacy, integrity, and confidentiality of vital academic and research-related information (Gkrimpizi & Peristeras, 2022). As HEIs embrace the opportunities of 4.0 digital technologies, addressing cybersecurity concerns is crucial in maintaining a secure and trustworthy educational environment.

3.4.1.3 Digital Skill Gap

Integrating industry 4.0 technologies into HEIs is pivotal in advancing teaching, learning, and research in the digital age (Saragih, Tjakraatmadja & Pratama, 2023). However, this endeavour faces significant challenges due to the prevalent skills gap in digital literacy and competencies. This multifaceted skills gap is evident in deficiencies in faculty training, student readiness challenges, and resistance to change across HEIs (Alenezi, 2021). Undoubtedly, HEIs encounter difficulties providing adequate professional development and training opportunities to equip their faculty members with the digital skills to proficiently utilise Industry 4.0 technologies in academic and administrative tasks (Alenezi, 2021). Similarly, students often lack the foundational digital competencies required to fully harness and benefit from these advanced technologies in their learning journeys (Robertson & Lapina, 2022). Bridging the skill gap among students is imperative to ensure the successful implementation of Industry 4.0. Urgent targeted interventions through digital skills training and entrepreneurial curriculum reform are necessary to enhance the digital literacy of all stakeholders in HEIs. Failure to address these skills gaps risks exacerbating digital disparities and poses the threat of EE falling behind in effectively harnessing emerging technologies. So then, proactive measures are crucial to integrate industry 4.0 technologies in HEIs.

The first aspect of the digital skills gap revolves around faculty-staff training. HEIs often face obstacles in providing adequate training and professional development opportunities to enhance the digital competencies of their academic and administrative members. This challenge arises due to limited resources, lack of specialised training programs, and institutional resistance to adopting new teaching and administrative methodologies (Fernández, Gómez, Binjaku & Meçe, 2023).

Another significant dimension of the digital skills gap is students' readiness to enter HEIs. Many students lack the essential digital literacy and skills to navigate the 4.0 digital landscape proficiently. This deficiency can undermine their ability to fully engage with digital learning resources, participate effectively in virtual environments, and harness the potential benefits of digital technologies for their academic growth and future careers (Fernández et al., 2023). Consequently, this shortfall in digital preparedness among students demands attention to bridge the gap and empower them to thrive in an increasingly digital-centric academic world (Gkrimpizi & Peristeras, 2022). Furthermore, resistance to change within the HEI ecosystem can impede the successful integration of 4.0 digital technologies. The faculty, administrative staff, and even students may resist embracing new technologies and innovative approaches to teaching and learning. Overcoming this resistance is crucial in fostering a culture of openness and innovation, where stakeholders feel empowered to explore and embrace the potential of 4.0 digital technologies to enhance their educational experience (Gkrimpizi & Peristeras, 2022).

3.4.1.4 Pedagogical and Cultural Factors

The successful integration of 4.0 digital technologies in HEIs requires careful consideration of pedagogical and cultural factors (Bonfield et al., 2020). Furthermore, they stated that one such factor is pedagogical adaptation, which entails significant adjustments to existing teaching and learning methods. These changes may involve the redesign of curricula, revision of instructional strategies, and redefinition of assessment methods to align with new technological landscapes (Bonfield et al., 2020). Embracing these changes is crucial to fully capitalise on the transformative potential of 4.0 digital technologies in the educational realm.

Addressing the adoption of 4.0 digital technologies in HEIs requires a comprehensive approach considering organisational culture. The prevailing academic culture, characterised by entrenched hierarchical structures and resistance to innovation, can pose significant barriers to the effective integration of these technologies (Lašáková, Bajzíková & Dedze, 2017). For instance, consider a hypothetical scenario in which a traditional university is reluctant to embrace online learning platforms because of faculty members' resistance to change. This resistance hinders the institution from

tapping into the full potential of digital advancements to enhance its EE excellence (Qurotul- Aini et al., 2020).

HEIs must cultivate a transformative cultural change that embraces openness and innovation (García-Morales, Garrido-Moreno & Martín-Rojas, 2021). An illustration of this is that a progressive university actively fosters interdisciplinary collaboration between faculty members and students. This approach dismantles the silo mentality and fosters the free exchange of ideas (Keller, 2023), successfully integrating virtual reality tools across diverse fields. By nurturing an open environment, HEIs are exemplars for others seeking to harness digital technologies effectively. The following section delves into digital technologies related to Industry 4.0, exploring potential ways to facilitate adopting and seamlessly incorporating these emerging technologies into EE practices.

3.4.2 Driving forces to the adoption of 4.0 digital technologies in HEIs

3.4.2.1 Technological Advancements in HE

Owing to recent technological advancements, HEIs are significantly shifting towards more technology-enabled teaching and learning environments (García-Peñalvo, 2021). This paradigm shift, driven by AI, IoT AR, and significant data analytics developments, has changed student experience across disciplines. However, integrating these advanced technologies within EE presents both opportunities and challenges.

In today's volatile and rapidly evolving entrepreneurial landscape, students must build robust and advanced technological competencies to thrive in digital economies. This urgency highlights the need for EE to transition towards more digitally led pedagogical approaches that align with the digital era (Bonfield et al.,2020). This could suggest a cybergogy paradigm in HE. For instance, faculty members can incorporate simulations, digital collaboration tools, and VR to create immersive learning experiences that prepare students to launch technology-savvy ventures.

Volatile and disruptive technological advancements have marked the rapidly evolving 21st-century landscape. Rather than resisting these advancements, HEIs must

proactively embrace the digital landscape within an HE environment to benefit both students and faculty members. This recognition underscores the urgent necessity to shape and align current entrepreneurial skills with the future digital technological advancements of Industry 4.0. It becomes increasingly evident that the revolutionary technological breakthroughs driven by Industry 4.0 have permeated HEIs, compelling institutions to confront the imperative of digital transformation across all sectors (Benavides, Tamayo-Arias, Arango-Serna, Branch-Bedoya & Burgos, 2020).

In this context, advanced technologies have become a significant reform that HEIs must undertake to optimise the transition of technology changes and seize the associated opportunities pragmatically and responsibly (Gobble, 2018). This digital transformation encompasses comprehensive changes in HEIs and organisations, including procedures, competencies, and models, all aimed at capitalising on the technology mix and its accelerated impact on society. After establishing the importance of technological advancements in HEIs, delving into specific high-demand skills to effectively navigate this technological shift becomes crucial.

3.4.2.2 Skills Demand

The digital transformation and advancements by industry 4.0 have given rise to a pressing need for a new generation of students with distinct competencies, innovation, and technological savviness (Manda & Backhouse, 2017). This paradigm shift has driven faculty members and leadership to embrace Industry 4.0 digital technologies and emphasise developing the so-called “future skills” required for success in the 21st century's modern economy. The concept of future skills encompasses a range of abilities that enable individuals to navigate and excel in the evolving landscape of industry 4.0 (Ehlers & Kellermann, 2019). These skills include but are not limited to technological proficiency, critical thinking, creativity, adaptability, collaboration and entrepreneurial acumen (Howells, 2018). By nurturing these skills, academic institutions strive to empower students with the capacity to thrive amidst rapid technological advancements, automation, and AI integration.

The World Economic Forum (WEF) highlights the increasing significance of anticipating and preparing future skills requirements for businesses, governments, and

individuals (WEF, 2016). In an era in which technological disruption continuously reshapes job roles, proactive measures are essential to fully seize the opportunities presented by these trends while mitigating any potential undesirable outcomes. Academic institutions have taken concrete steps to illustrate their commitment to developing future skills. For example, the Technical University of Munich in Germany offers interdisciplinary programs integrating engineering, technology, and entrepreneurship, enabling students to gain practical experience and develop entrepreneurial mindsets. Similarly, the University of California, Berkeley, has established programs such as the Sutardja Centre for Entrepreneurship and Technology, which provide students with resources and mentorship to cultivate their innovation and entrepreneurial skills (Bodolica & Spraggon, 2021).

Industry 4.0 has ignited extensive discussions among practitioners and academics concerning the demand for specific skill sets. Despite the increasing attention devoted to this matter, empirical evidence from an African perspective remains scarce. Scholars and practitioners agree that the skills and academic qualifications currently produced by most African HEIs do not align with the demands of present and future work opportunities (Reddy, Bhorat, Powell, Visser, & Arends, 2016). Consequently, a substantial disparity exists in the era of Industry 4.0, underscoring the need for initiatives to bridge this skill mismatch within the African workforce (Anyanwu, 2013). This study sought to identify the pivotal skills and competencies that hold significance in African Industry 4.0.

According to Xing and Marwala (2017), Industry 4.0, propelled by AI, is set to reshape workplaces by shifting from task-based attributes to human-centric perspectives. While AI enhances work efficiency and presents avenues for human growth, it also introduces challenges, including job displacement, alterations in job practices, and skewed labour force dynamics (Hu & Chang, 2019; Frey & Osborne, 2017). Consequently, specific skills may no longer suffice for contemporary job requisites due to technological advancements in the 21st century, possibly leading to an upsurge in unemployment unless individuals undergo comprehensive reskilling (Kamaruzaman, Hamid, Mutalib & Rasul, 2019). Hence, governments, HEIs, and the private sector must collaborate to cultivate the essential skills to meet future demand.

In the swiftly evolving current landscape, which is marked by technological and cultural disruptions, a society's ability to learn and adapt is a critical factor for its overall well-being. For actors in entrepreneurship, mere technical know-how falls short; proficiency in problem-solving, critical thinking, effective communication (both written and oral), teamwork, and the commercialisation of technology becomes imperative (Olumuyiwa, Kimanzi & Modise, 2023). However, HEIs grapple with substantial challenges when transitioning their educational models to align with the demands of the 21st century (Monroy García, Llamas-Salguero, Fernández-Sánchez & Carrión del Campo, 2020). Addressing this deficit necessitates the integration of digital technologies, playing a pivotal role in advancing the skills and aptitudes requisite for the modern age (Liesa-Orús, Latorre-Cosculluela, Vázquez-Toledo & Sierra-Sánchez, 2020). In SA, the DHET Research Colloquium (2019) identified a deficiency in entrepreneurial skills, particularly within the context of Industry 4.0, thereby intensifying the pressure on HEIs to equip students with the necessary proficiency and exposure (Motala & Padayachee, 2018).

Given industry 4.0's strategic significance within the broader economy, integrating digital technology into EE emerges as a critical element in nurturing sustainable and responsible technological development (González, Guerrero, Navarro, González & Collazos, 2022). Marwala (2017) and McKinsey Global Institute (2017) advocate cultivating critical thinking, problem-solving acumen, emotional intelligence, judgment, negotiation skills, cognitive flexibility, knowledge production, and management within Industry 4.0. Policy experimentation through localised and national innovation, facilitated by citizen involvement and collective actions enabled by digital technologies, has the potential to unlock these critical skills (Pellini, Weyrauch, Malho & Carden, 2019). Thus, adopting a multi-stakeholder approach, encompassing all participants within the entrepreneurship ecosystem is imperative to promote skill development, including reskilling, ensuring that stakeholders within HEIs are well prepared during Industry 4.0, and fostering a culture that harnesses emerging technologies thoughtfully and responsibly (Nambisan, 2017).

Addressing the skills gap in the era of Industry 4.0 from an African perspective assumes paramount importance. As technology reshapes the employment landscape, HEIs must adapt and equip students with indispensable proficiencies for success in

the swiftly evolving job market. Collaboration among stakeholders, the infusion of digital technologies into HE, and cultivating an innovative culture are pivotal measures for preparing the African workforce to address the challenges and opportunities of Industry 4.0. To bridge the skills mismatch necessitates a collective endeavour; through such concerted efforts, Africa can thrive in the age of Industry 4.0 (Reddy et al., 2016; Anyanwu, 2013).

In conclusion, the digital transformation of Industry 4.0 necessitates a comprehensive focus on future skills within HEIs. By equipping students with competence, innovation, and technological savviness, these institutions prepare them to thrive in the rapidly changing entrepreneurial landscape of the digital economy. Recognising the importance of future skills by businesses, governments, and academic institutions underscores the need for proactive measures to anticipate and prepare for evolving skill requirements, ensuring that individuals can fully embrace opportunities and mitigate the challenges of Industry 4.0.

Given the significance of developing future skills and the proactive steps HEIs take to prepare students for industry 4.0, it is crucial to identify and analyse the obstacles preventing the effective integration of 4.0 digital technologies within EE. Although many widely acknowledge the transformative nature of these 4.0 digital technologies, EE faces challenges requiring solutions to exploit their potential fully.

3.5 Efficacy in Entrepreneurship Education

Assessing the effectiveness of EE poses significant challenges, primarily because of the inherent vagueness of its objectives and the absence of consensus on a standardised definition of entrepreneurship (Pittaway, 2021). The lack of clarity surrounding EE goals makes it difficult to establish clear evaluation criteria and accurately measure the impact of such programs. For instance, different entrepreneurship programs may have diverse objectives and purposes, emphasising various aspects of entrepreneurial skills and knowledge (Price, 2018). Therefore, a thorough assessment of EE's multifaceted nature is required. Such an assessment could consider various factors, including entrepreneurial competencies, business creation and sustainability, innovative thinking, and adaptability to the evolving

business landscape (Lose & Cheteni, 2024). By recognising the complexities and nuances of EE, HEIs can strive for more comprehensive evaluations to provide meaningful insights into their efficacy (Lackéus, 2015).

When formulating EE programs, HEIs must grapple with the key queries raised by Fayolle and Gailly (2008): the “Why” (targets and objectives), the “Who” (intended audience), the “for what results” (examinations, assessments), the “What” (content), and the “How” (pedagogical approaches). The effectiveness of EE programs relies on the coherence of the responses to these questions, forming a foundation for impactful educational experiences. Inconsistent or unclear responses can impede program efficacy and affect the desired outcomes. Amid the dynamic digital 21st-century milieu, global HEIs face challenges due to rapid technological evolution, changing market demands, and entrepreneurial shifts. This necessitates an adaptable, innovative EE program design that considers context, embraces flexible pedagogy, and cultivates digital entrepreneurial skills (George, 2023). Acknowledging these challenges enables HEIs to craft EE programs to prepare students for modern entrepreneurial complexities.

To assess EE’s effectiveness in the digital age, thoroughly exploring the interaction between 4.0 digital technologies and entrepreneurship is imperative. The distinct characteristics and components of 4.0 digital technology necessitate a comprehensive understanding of how they intersect with entrepreneurial practices (Elia, Margherita & Passiante, 2020). While researchers have extensively investigated the benefits of EE, a significant knowledge gap persists in understanding how 4.0 digital technologies contribute to realising these benefits. This gap impedes the complete harnessing of the potential offered by 4.0 digital technologies to augment EE outcomes. A crucial step towards bridging this gap involves comprehensively exploring the influence exerted on EE by 4.0 technological advancements. By gaining deeper insight into the synergies between entrepreneurship and 4.0 digital technologies, faculty members and HEIs can design and implement EE programs that effectively prepare students for the challenges and opportunities of the digital era. Particularly, it is imperative to provide a more formal description of the entrepreneurship ecosystem aspect to comprehensively understand how 4.0 digital technologies can potentially impact the nature and interactions among various entrepreneurship actors.

Entrepreneurship research has partially ignored the 4.0 technological advancements' impact and the role that actors play in digital entrepreneurship (Elia et al., 2020).

Digital technologies have significantly contributed to the emergence of innovative business ventures and digital start-ups, where the integration of novel technology plays a crucial role in their business models and operations. Consequently, it can be argued that digital technologies serve as catalysts for entrepreneurial activity (von Briel et al., 2018). Thus, integrating 4.0 digital technology such as VR into EE enables students to gain hands on experience and learn from successes and failures in a supportive and controlled environment. For example, VR simulations, business incubators, and digital platforms can create immersive learning experiences that simulate entrepreneurial scenarios and foster the development of critical entrepreneurial skills. These technologies allow students to actively engage in realistic situations, preparing them for real-world entrepreneurial challenges (Ahmad, Hussain, Ekiz, & Tang, 2020). Additionally, incorporating real-time data analysis tools and market research resources can enhance students' ability to identify trends, assess market demands, and make informed business decisions. By leveraging data analytics platforms, social media listening tools, and customer survey instruments, students can gain valuable insights and develop the skills necessary for effective decision-making in the entrepreneurial landscape (Obschonka, Lee, Rodríguez-Pose, Eichstaedt & Ebert, 2020). This integration of 4.0 digital technology equips students with practical skills and knowledge that extend beyond theoretical concepts, empowering them to succeed in their entrepreneurial endeavours. Therefore, experiential learning theory provides a valuable foundation for developing an entrepreneurial pedagogical framework to guide technological integration.

3.5.1 Entrepreneurial Pedagogical Framework

Educational practices within EE have conventionally emphasised a pedagogical framework characterised by lecturer-centric and instructor-guided instructional methodologies. In this approach, the lecturer assumes the role of the authoritative figure, the "sage on the stage," with exclusive control over all aspects of the learning-teaching process (Livingstone, 2019). Consequently, the lecturer solely determines the educational content and delivery method decisions. Moreover, face-to-face (F2F) instruction is the primary modality for all instructional endeavours within this context

(Livingstone, 2019). However, such approaches have failed to address student-learning diversity. In response to the growing demand for EE in the 21st century, the field has witnessed the emergence of various teaching approaches. These approaches encompass a broad spectrum, ranging from traditional courses that impart knowledge about entrepreneurship to process-oriented courses that concentrate on the development of business plans and even more action-oriented courses that introduce concepts such as effectual entrepreneurship, lean startup, or design-based learning (Garbuio, Dong, Lin, Tschang, & Lovallo, 2018).

While some proponents strongly advocate for an actionable orientation in EE, emphasising practical application and implementation, others propose a more processual approach that encompasses learning about, for, and through entrepreneurship (Lynch, Kamovich, Longva & Steinert, 2021). These perspectives are not mutually exclusive; they can coexist as complementary pedagogies within the same educational context (Thrane, Blenker, Korsgaard & Neergaard, 2016).

On the other hand, researchers have found that traditional face-to-face faculty support has limited influence on enhancing pedagogic practices and attitudes among faculty members in the Industry 4.0 era (Sugar & van Tryon, 2014). Although the digital era is gradually rendering face-to-face (F2F) teaching outdated, it is crucial not to discard or disregard it, as its effectiveness relies on how educators conduct it (Livingstone, 2019). Such conventional methods emphasise a behaviourist paradigm grounded on transmitting and reproducing knowledge, encouraging passivity in student learning (Nabi, Linan, Fayolle, Krueger, & Walmsley, 2017). However, due to digital disruptions in the prevailing environment, a transition away from passive pedagogies is recognised in most HEIs. This could be indicated by the heightened recognition that students value learning through digital tools, particularly in the 21st Century.

More hands-on technology-enhanced learning gained prominence in the 2000s, as educators began to recognise the significance of real-world opportunities and practical experience as a compelling teaching approach (Hägg & Gabrielsson, 2020). However, these approaches have failed to address the impact of 4.0 digital technologies on EE. Thus, the digital transformation of EE represents a new approach and fundamental challenge in HE. It aims to prepare students to face digital disruptions and thrive in an

increasingly technology-driven world. Many scholars agree that EE must have an experiential learning perspective and interactive pedagogy to enhance learning and innovative capacity (Ollila & Williams-Middleton, 2011). Commenting on integrating digital technologies into entrepreneurship, Nambisan (2017) argues that technologies such as AI, big data, cloud computing, and IoT have transformed entrepreneurial processes.

In light of the changing global landscape and evolving practices of HE, there is a need for a paradigm shift in pedagogical approaches. Traditional teacher-centred methods must give way to contemporary student-centred approaches. Integrating digital technologies into HE is crucial for pedagogical reform (Raturi & Boulton-Lewis, 2014). However, it is essential to note that using digital technologies as add-ons to traditional teaching practices does not necessarily transform pedagogical approaches (Mohamed-Hashim, Tlemsani & Matthews, 2021).

Although the integration of digital technologies into HE has led to new learning opportunities and the availability of novel teaching resources beyond the confines of traditional classrooms (Cooper, Higgins & Beckmann, 2017), there is a tendency to sustain conventional pedagogical practices rather than to leverage the potential of these technologies fully. It is crucial to emphasise that technology alone cannot enhance learning and teaching; the efficacy of EE experiences depends on how technology tools and resources are employed (Brush, Neck, & Greene, 2015).

Scholars highlight the importance of experimentation in the learning process, allowing students to test assumptions and learn from the results of these experiments (Brush, Neck, & Greene, 2015). Consequently, students become increasingly active, engaging in hands-on digitally enhanced approaches and learning by doing, while faculty members shift towards a facilitator role in the learning process (Neck & Corbett, 2018). This involvement with diverse digital technologies, particularly those associated with the 4.0 era, enables students to explore new possibilities.

HE landscapes worldwide are transforming due to 4.0 digital technologies. However, the role of great faculty members remains crucial as technology in their hands can be transformative (Dabbagh, 2018). To fully capitalise on these advancements, faculty

members should adopt a student-centred entrepreneurial pedagogy, leveraging the potential of 4.0 digital technologies. It is important to note that EE should be cross-disciplinary and extend beyond business and economics. However, technology-induced EE is still in its early stages in South Africa, generating both interest and ambiguity among stakeholders (Lackéus, 2015).

The efficacy of EE is hindered by the excessive emphasis on traditional teaching methods (Mbeteh & Pellegrini, 2022). Students' ability to apply entrepreneurship in real-world settings is impeded by the overreliance on theoretical learning without practical engagement (Weng, Chiu & Tsang, 2022). Limited transformative learning outcomes result from technology integration without a clear pedagogical rationale (Ng'ambi et al., 2013). The absence of pedagogical methods that are digitally transformed in EE is emphasised by Shambare (2013). One strategy to tackle this challenge is developing a curriculum incorporating students' digital literacy (Bozalek & Ng'ambi, 2015). Therefore, HEIs must create a context-specific EE curriculum that harnesses the potential of 4.0 digital technologies.

3.5.2 Curriculum Construct

Today, HEIs are challenged to prepare students for a rapidly evolving global economy predominantly driven by digital technology and knowledge. The notion of "curriculum" encompasses the entirety of HEI's instructional and learning approach, aimed at nurturing graduates who are well-equipped to thrive in this new economic landscape. In this context, the curriculum encompasses various institutional inputs, transactions, and outputs designed to cultivate students with the necessary skills and knowledge for maximum productivity and success in the global knowledge economy (Kpolovie & Lale, 2017). Given this backdrop, EE must adapt and revitalise its curricula to effectively respond to an increasingly interconnected digital world. This research examines the current trends in the global economy and contends that EE finds itself at a crucial juncture, necessitating deliberate curricular reforms that emphasise novel technical and social learning methods. The objective is to produce graduates ready to identify opportunities and establish undertakings in a technologically complex and volatile future. Consequently, the HE sector must realign its entrepreneurship curriculum offerings to equip students with the necessary skills to learn and thrive in the digital era (European Commission, 2016; Wang, 2021). Incorporating digital

technology tools and resources in HEIs has gained significant traction in EE and is supported by research. For instance, a study by Tóth-Pajor, Bedő & Csapi (2023) explored the impact of integrating digitalisation into EE. The findings demonstrated that students who engaged with interactive online platforms, virtual business simulations, and entrepreneurial networking tools experienced improvements in their entrepreneurial capacity-building. These results suggest that integrating digital technologies into HEIs' entrepreneurship curricula enhances learning outcomes and fosters an enriched learning experience and increased student engagement.

Curriculum reform has been an ongoing process since the 1950s, driven by recognising its impact on pedagogy. Traditional curricula have often been criticised for being teacher-centred and failing to address learners' diverse needs and interests (Mpho, 2018). Developing a learner-centred curriculum has become essential, emphasising the importance of learner activity and personalised approaches (Falkner, Vivian & Falkner, 2014: Sosibo, 2019.).

3.5.3 Curriculum in the 21st Century

As technology advances, it is reasonable to expect that industry 4.0 technologies transform curricula (Menon & Castrillón, 2019). Updating the curriculum to align with the demands of Industry 4.0, focusing on emerging technologies and the competencies required for future jobs is crucial (WEF, 2018). However, it is equally important to consider how curriculum content is delivered. Scholars argue that effective teaching strategies must facilitate learning (Cilliers & Pylman, 2019).

One methodology that aligns with both curriculum reform and the needs of Industry 4.0 is experiential learning. This approach emphasises learning by doing and provides students with real-world experiences to foster creativity and adaptability (Olawale & Mutongoza, 2021). Faculty members can engage in practical situations by integrating experiential learning into their curriculum, thereby enhancing students understanding and skill development (Lackéus, 2020). This understanding of the importance of experiential learning is crucial in the context of Industry 4.0, where digital technologies have become an integral part of human life. By embracing experiential learning and leveraging technology effectively, curriculum reform ensures students have the competencies to thrive in a rapidly evolving digital landscape (Torreon, Amante, Mabanag & Angtud, 2024).

Industry 4.0 technologies present significant opportunities to transform EE curricula, but realising this potential requires overcoming challenges. Advocates have argued that these technologies can extend teaching and learning capabilities. For example, simulations, digital platforms, and VR may enable more experiential learning, amplifying global student collaboration and networks (Menon & Castrillón, 2019). However, research on EE implementation remains limited. Curriculum transformation requires more than technology integration, and appropriate pedagogical strategies are equally crucial (Luke & Uzoigwe, 2022).

A core priority should be to evolve EE curricula to align with the skills needed for future careers, as qualifications firmly shape graduates' capabilities. The proposed approaches emphasise student-centred learning and constructivist principles, where students actively create knowledge (Aldianto, Anggadwita & Umbara,2018). Specific strategies include project-based learning, collaborative problem-solving, and hands-on digital activities. However, lecture-based instruction still predominates in many HEIs, requiring a paradigm shift (Moorthy & Arulsamy, 2014). Overcoming institutional resistance and training faculty present challenges. Equally important, disparities in student technology access must be addressed to equitably and effectively address curriculum reforms.

Developing economies face significant challenges in designing effective technology-enhanced entrepreneurial curricula for HEIs (Ng'ambi, Brown, Bozalek, Gachago, & Wood, 2016). Lackeus (2015) proposed that these challenges include identifying the target group, defining and measuring entrepreneurship or entrepreneurial traits, deciding on a suitable pedagogy, and determining curriculum content. These obstacles have hindered the development of EE in developing economies (Lackeus, 2015).

Conventional approaches to EE are gradually becoming outdated because they fail to accommodate students' diverse learning styles and preferences (Livingstone, 2019). Consequently, HEIs are shifting towards more modern approaches to teaching and learning, aligning with the rapid changes occurring in HE landscapes. However, to effectively capture students' interests and address the diverse nature of entrepreneurship, the entrepreneurial curriculum's content needs to be comprehensive (Alkhalaileh, 2021).

The content of the entrepreneurial curriculum plays a crucial role in determining the teaching methods employed (Neergaard, Robinson & Jones, 2021). Therefore, the curriculum should encompass a wide range of topics that facilitate the development of students' entrepreneurial skills, attitudes, and behaviours. This includes fostering digital literacy, which is critical for today's technologically driven world. Integrating digital literacy into curriculum construction would empower students to navigate the digital landscape and leverage technology for entrepreneurial success (Wei, 2023). In the subsequent section, discussing the predominant digital technologies that have gained significance within South African HEIs is crucial.

3.6 Prominent digital technologies used in higher education in SA

The increased adoption of online and mobile technologies has facilitated the widespread use of e-learning (e-technology) platforms in HEIs. Consequently, these platforms have evolved to foster greater student collaboration and interaction, as shown by Venter, van Rensburg, and Davis (2012). Learning management systems (LMS) have become essential tools for providing highly interactive and accessible learning solutions, especially in the context of open and distance learning (ODL) institutions worldwide (Netanda, 2020). Therefore, faculty members and learning solution developers must better understand how students perceive and engage in technology-enabled learning and teaching.

HEIs are increasingly adopting 4.0 digital technologies to enhance their teaching and learning. As access to these technologies grows, there is greater emphasis on faculty members leveraging them to improve their educational experience (New Media Consortium, 2017). Moreover, emerging 4.0 digital technologies, such as LMS, collaboration tools, and audio/video resources, have raised students' expectations for enriched learning experiences (Turnbull, Chugh & Luck, 2020). However, it is essential to note that Davis and Venter's (2010) findings that students at a South African university place a high value on face-to-face classes may no longer hold in the rapidly evolving digital era (Clark & Post, 2019). For this reason, the exponential growth of technologies necessitates a reassessment of these findings to determine their current applicability. Therefore, more recent research is needed to investigate how students perceive and respond to technology-enabled learning environments to inform pedagogical practices in EE.

3.6.1 Learning Management Systems

HEIs have been utilising Learning Management Systems (LMS) for more than a decade. As stated by Al-Mamary (2022), the LMS serves as an online tool that aids educational institutions in the creation, implementation, and evaluation of learning systems. Universally, universities employ LMS to establish a comprehensive digital structure within their educational systems. Likewise, Maphalala and Adigun (2021) define an LMS as a software application or web-based technology that facilitates the planning, implementation, and assessment of a particular learning process. Prominent examples of LMS include Blackboard, Moodle, WebCT, Canvas, and Desire2Learn, which are web-based software utilized for managing course delivery via the internet (Bervell, Umar, Masood, Kumar, Armah & Somuah, 2022).

However, implementing and maintaining LMS in sub-Saharan African institutions has raised concerns due to the substantial allocation of limited resources (Mtebe & Raisamo, 2014). Scholars, such as Mtebe (2015), have raised questions about whether these institutions fully realise the potential of LMS. Despite the challenges mentioned, the LMS remains a crucial advancement in HE, especially considering the rapid expansion of information and communication technology (ICTs). HEIs implement LMS to support their course curriculum, offering a wide range of tools such as discussion boards, forums, chat features, online grade posting, online exams, file sharing, assignment management, syllabi, schedules, announcements, and course plans (Findik-Coskuncay & Ozkan, 2013). As a result, LMS has become an essential tool for HEIs, facilitating the dissemination of resources and materials, submission and grading of assignments, and collaboration among students (Dahlstrom, Brooks, & Bischel, 2014).

It is important to note that the presence of LMS in HEIs does not replace traditional teaching methods but serves as a supportive platform. Hence, LMS allow for technology integration while preserving the established pedagogical approaches. As a result, the critical implication is that LMSs do not disrupt conventional teaching practices but enhance and supplement them.

3.6.2 Collaboration tools

Collaboration tools have become essential for HE, facilitating interactive and collaborative learning environments. These tools include Google programs, wikis, discussion forums, and shared spaces, all of which have gained prominence. Students prefer cloud computing alternatives like Google Drive and Dropbox over traditional LMS due to their user-friendly interfaces (Stantchev, Colomo-Palacios, Soto-Acosta, & Misra, 2014; Sharma, 2022).

The utilisation of social media platforms such as Facebook, Twitter, and professional networking sites in HE remains limited despite their growing prevalence. Hamadi, El-Den, Azam, and Sriratanaviriyakul (2022) note that social media is not widely used as a pedagogical tool in HE. Overcoming barriers such as cultural resistance and digital literacy issues is necessary to leverage social media's potential for enhancing student engagement and knowledge sharing in HE (Perez, Manca, Fernández-Pascual & Mc Guckin, 2023).

Online meeting platforms such as Microsoft Teams and Zoom have emerged as valuable tools for enhancing collaboration in HE. Factors such as institutional resource availability and improved social presence drive the adoption of these platforms (Stecuła & Wolniak, 2022).

3.6.3 Audio/video tools

Owusu (2020) highlighted the increased use of audio and video recording tools in HE courses. Screen-casting has gained popularity as a means of creating video content. Screencasts refer to digitally recorded content that typically encompasses audio and video components, as Bahula and Kay (2021) described. Research focusing on screencasts has revealed that online faculty members have reported significant benefits in employing this medium to communicate content with their students (Penn & Brown, 2022). This positive reception further highlights the value of screencasts in enhancing instructional delivery and facilitating students' comprehension.

South African HEIs have recently experienced a surge in adopting 4.0 digital technologies (Lubinga, Maramura & Masiya, 2023). The following section describes

the synthesis and evaluation of the factors driving the adoption of these advanced technologies.

Several compelling factors drive the adoption of Industry 4.0 digital technologies in HEIs. Since its emergence in 2010, Industry 4.0 has exerted a profound influence on the socio-economic and digital landscape (Vuksanović-Herceg, Kuč, Mijušković & Herceg, 2020). This transformative era has witnessed a widespread integration of 4.0 digital technologies into our daily lives, resulting in significant shifts in knowledge distribution, construction, and reconstruction (Lim & Wang, 2016). Consequently, these developments have engendered a pervasive trend towards 4.0 digital technology adoption in HEIs, fueled by several pivotal driving forces.

The foremost among these forces is digital technology's rapid and exponential advancement. As new technologies evolve and improve, HEIs must adapt and embrace these innovations to remain competitive in the global digital economy (Bonfield, Salter, Longmuir, Benson & Adachi, 2020). This shows that technological advancements are crucial in accelerating the uptake of digital tools in HEIs, and their catalytic influence in enabling adoption cannot be overstated. Therefore, these technologies offer unprecedented possibilities for transformative learning experiences, innovative research endeavours, seamless collaboration, and enhanced engagement, thereby enriching the educational landscape for students and faculty members (Bonfield et al., 2020).

Furthermore, the imperative to cultivate agents of change who can positively impact the world is another driving force behind adopting industry 4.0 technologies in HEIs (Kpolovie & Lale, 2017). HEIs are responsible for equipping students and faculty members with the requisite skills and knowledge to navigate the intricate digital landscape proficiently. By strategically integrating digital technologies into their curricula, HEIs empower stakeholders to think critically, communicate effectively, and participate meaningfully in an increasingly globalised society (Esteve-Mon, Postigo-Fuentes & Castañeda, 2023). Hence, aligning institutional activities with the technological landscape enables EE to provide students and faculty members with a

comprehensive worldwide perspective, thus nurturing their development as informed and culturally aware global citizens.

Moreover, the imperatives of remaining competitive in an ever-evolving digital environment represent a compelling impetus for adopting 4.0 technologies in EE (Diaz, Halkias & Thurman, 2022). To attract and retain students, faculty, and funding, HEIs must demonstrate their unwavering commitment to leveraging 4.0 digital technologies for enhanced teaching methodologies, groundbreaking research initiatives, and innovative approaches to problem-solving. By actively embracing technologies in Industry 4.0, HEIs position themselves as forward-thinking institutions at the vanguard of EE transformation, well-equipped to address the dynamic challenges and capitalise on the abundant opportunities the digital age presents.

In conclusion, the driving forces discussed in the previous paragraphs, namely, the rapid advancement of digital technologies, the imperative to cultivate agents of change, and the need for HEIs to remain competitive in the digital world, all converge on the pivotal role of technological advancements. These advancements are the bedrock for adopting Industry 4.0 digital technologies in EE. Through a comprehensive understanding of technological advancements, EE can effectively navigate the evolving digital landscape and leverage cutting-edge tools and innovations to propel entrepreneurial educational offerings to new heights. The following subheading, “Technological Advancements,” delves deeper into the specific advancements that have been instrumental in shaping the digital landscape within HEIs and explores their impact on teaching, research, and student engagement.

3.7 Industry 4.0 digital technologies

The emergence of Industry 4.0 has revolutionised global economies and reshaped societies by integrating transformative digital technologies. This epochal shift began around 2010 and encompasses cutting-edge innovations like AI, Cloud Computing, VR, and big data analytics. These technological advancements have transcended conventional boundaries, converging the physical, digital, and biological realms to create a seamless and interconnected ecosystem (Schwab, 2017). Scholarly focus is on studying digital technologies in Industry 4.0, as scholars and researchers recognise their profound implications for diverse industries and disciplines. In this context, this

study aims to comprehensively examine the core elements of Industry 4.0, particularly its digital technologies. By analysing their impact on HE and entrepreneurship, this study endeavours to unravel the complexities and potentials of these 4.0 digital technologies, contribute valuable insights to academic discourse, and facilitate an informed understanding of their future implications.

As technological advancements continue to drive radical changes, entrepreneurial activities have flourished, leading to the emergence of innovative products and services (Christensen, 2002). Thus, transformative 4.0 digital technologies, such as AI, IoT, VR, big data, and cloud computing, have been among the key drivers of this entrepreneurial revolution, propelling unprecedented global changes (Christensen, Raynor, & McDonald, 2013). These technologies have significantly impacted diverse entrepreneurial endeavours, reshaped business practices, and revolutionised markets worldwide. Consequently, the continuous convergence between entrepreneurship and 4.0 digital technologies is resulting in the emergence of a novel type of entrepreneurs who utilise digital technologies and the internet to carry out the majority of the processes necessary for initiating a new venture (Giones & Brem, 2017).

By understanding the implications of these digital disruptions, EE can prepare future entrepreneurs to embrace opportunities and overcome challenges, ensuring their success in the fast-paced and competitive world of Industry 4.0.

The advent of numerous developments in digital technologies in recent years has been the driving force behind the upsurge in entrepreneurship activities (Modgil, Dwivedi, Rana, Gupta & Kamble, 2022). Tipping points have led to the prevalence of industry 4.0 technologies, transforming the entrepreneurial landscape and scope (Nambisan, 2017; Davidsson, Recker & Von Briel, 2020). Additionally, HEIs must consider entrepreneurship students' exposure to 4.0 digital technologies to design relevant EE models that respond to market trends (Nhleko & van der Westhuizen, 2022). It is essential to acknowledge that the pace at which industry 4.0 technologies develop is not gradual, as experienced in previous technological trends, but rather exponential (Schwab, 2016; Bongomin et al., 2020). However, this exponential growth rate varies from country to country based on economic, social, and cultural factors and readiness to change and adapt (Schwab, 2016).

When launching a new venture, students must fully understand novel technological affordances and various creative, cognitive, and physical processes (Obschonka & Audretsch, 2020; Townsend & Hunt, 2019). This study focused on five critical technologies within Industry 4.0: AI, Big Data, IoT, VR, and Cloud Computing. Although AI is presumed to be the fulcrum of Industry 4.0, it also holds a prominent position among these emerging technologies (Schwab, 2017). Thus, investigating these specific 4.0 digital technologies sheds light on their influence on entrepreneurship and HE, contributing to a deeper understanding of their future implications.

The transformative digital technologies of industry 4.0 have profoundly impacted entrepreneurship and HE, ushering in a new era of opportunities and challenges. By thoroughly examining the core elements of Industry 4.0, including AI, Big Data, IoT, VR, and Cloud Computing, this study aims to provide valuable insights into the evolving landscape of entrepreneurial activities and EE. Understanding the implications of these digital disruptions enables HEIs and faculty members to equip students better, thereby ensuring their adaptability and success in the dynamic world of Industry 4.0. Having established the profound impact of industry 4.0 digital technologies on entrepreneurship and HE, the discussion now delves deeper into one of the pivotal components: AI.

3.7.1 Artificial Intelligence (AI)

AI is a scientific domain that pursues the objective of granting machines the capacity to carry out various operations, including but not limited to logic, reasoning, planning, learning, and perception (Andreu-Perez, Deligianni, Ravi & Yang, 2018). Thus, computer software with human-like characteristics holds substantial potential across various domains, including industry, innovation, and corporate governance. However, their impact on EE has received limited attention.

Understanding the significance of AI requires a clear understanding of its capabilities and potential applications in EE. AI can revolutionise the operations of entrepreneurial initiatives and transform the methodologies employed by entrepreneurship scholars (The Economist, 2018). Moreover, its integration into HE opens new avenues for learning and teaching approaches, potentially yielding insights into students' learning processes and prompting changes in traditional educational settings.

However, this shift towards AI-powered education poses challenges for HEIs. Adopting AI could lead to more productive instruction and personalised student learning experiences. Nevertheless, this raises concerns about the potential loss of human agency and decision-making capabilities (Tuomi, 2018). As AI plays a more significant role in education, faculty members and HEIs must carefully navigate ethical implications to ensure responsible implementation.

In EE, embracing AI technologies presents both opportunities and responsibilities. By integrating AI into entrepreneurship curricula, students can gain exposure to cutting-edge tools and develop skills relevant to Industry 4.0. (Tuomi, 2022). However, balancing AI-driven efficiency and maintaining the human-centric aspects of entrepreneurship require careful consideration. Understanding the history and current state of AI development is essential to envision future possibilities. As the influence of AI on EE continues to evolve, educators, policymakers, and researchers must collaborate to harness the potential benefits while addressing the ethical and practical challenges that AI introduces to the HE landscapes.

3.7.1.1 Origin and Applications of AI

AI, the field of science aimed at providing machines with human-like capabilities, traces its roots back to the mid-20th century. While Srivastava (2018) is frequently associated with coining the term “AI” in 1956, Andresen (2002) emphasises that John McCarthy introduced this term during a working group meeting at Dartmouth College in the summer of 1956. This pivotal moment marked the beginning of an era that aimed to understand and model human thought using computer systems (Brock, 2018). The foundational work of Marvin Minsky, John McCarthy, Herbert Simon, and Allen Newell earned them the status of pioneers in the field of AI (McCarthy, Minsky, Rochester & Shannon, 2006). AI has witnessed an unprecedented surge in research and applications across diverse domains in recent years. For instance, AI-driven data analytics have enabled entrepreneurs to make data-informed decisions, identify market trends, and forecast consumer demand more accurately. Through AI algorithms, entrepreneurs can process vast amounts of data from diverse sources, leading to valuable insights that help optimise marketing strategies and product offerings (Holmes & Tuomi, 2022).

Moreover, AI has played a pivotal role in enhancing customer support by implementing AI-powered chatbots and virtual assistants. These intelligent virtual assistants offer personalised assistance, address customer queries, and guide potential buyers along the sales funnel. These AI-driven tools deliver tailored recommendations by analysing customer interactions, preferences, and behaviour, improving overall customer satisfaction (Alqahtani, 2023).

The transformative potential of AI applications continues to expand, shaping industries and societal dynamics. As AI increasingly integrates into various sectors, its implications for EE, economy, and governance warrant thoughtful consideration and collaborative exploration among researchers, policymakers, and practitioners alike. In the following section, this study delves deeper into how AI is revolutionising the entrepreneurial landscape, offering valuable insights into how EE can leverage AI's transformative capabilities to thrive in the fast-paced world of Industry 4.0.

3.7.1.2 AI and Entrepreneurship

AI has emerged as a rapidly advancing technology with immense promise for enhancing convenience and efficiency in daily life (Chalmers, MacKenzie & Carter, 2021). Although its benefits are evident in numerous domains, the implications of AI for EE remain speculative (Xu, Kim & David, 2018). This uncertainty calls for an in-depth examination of AI's potential relevance and effectiveness within the context of AI in entrepreneurial learning. As Tuomi (2018) aptly argues, a continuous and critical discussion of the subject is essential. AI, defined as technologies enabling machines to exhibit human-like intelligence and behaviour (Brynjolfsson, 2022), opens the possibility of machines undertaking tasks that were once exclusive to humans, such as sensing, understanding, and acting. Such transformative capabilities of AI suggest its potential to revolutionise entrepreneurship by driving automation and innovation. However, to harness AI's full potential in EE, there is a pressing need for targeted research to assess its current capabilities and applicability in enhancing entrepreneurial teaching, learning, and practice. This introductory exploration aims to shed light on the existing knowledge and research gaps surrounding AI's impact on EE, contributing to a better understanding of its role in reshaping the future of entrepreneurial endeavours.

HEIs have been increasingly recognised as fertile ground for AI ecosystems, providing opportunities for leading researchers to explore innovative ideas (Crompton & Burke, 2023). Notably, universities in the United Kingdom (UK), the United States (US) and France have been instrumental in seeding several successful start-ups (Pillay, 2017). In addition, these academic institutions serve as important forums for debating and evaluating the impact of AI, offering valuable insights for policymakers (Xing & Marwala, 2017). Nevertheless, while the idea of HEIs as AI incubators is appealing, it is essential to consider this perspective's potential challenges and limitations. For instance, the successful seeding of start-ups in the UK, the US, and France does not guarantee the widespread applicability of this model across various HEIs. Cultural, financial, and regulatory differences among regions may affect the establishment and growth of AI ecosystems in academic settings.

The rapid emergence of new technologies, particularly AI, has profoundly affected the landscape of entrepreneurship. Some experts even go as far as to consider AI as the fulcrum of Industry 4.0 (Schwab, 2017). One of AI's remarkable strengths is its ability to process large amounts of unstructured data using complex algorithms, which has significant implications for entrepreneurial activities (Choudhury, Starr & Agarwal, 2018). For instance, AI-driven automation can streamline routine tasks, freeing entrepreneurs to concentrate on their ventures' strategic and creative aspects.

In this dynamic context, EE is pivotal for fostering entrepreneurship and innovation, which are vital elements of economic growth (Bunz, 2017). It is imperative to equip aspiring entrepreneurs with a solid understanding of AI, its potential applications, and the skills necessary to thrive in the ever-evolving technological landscape. As AI technologies continue to advance, they have the potential to spur massive innovation, leading to elevated living standards and an economy driven by constant advancements. However, harnessing AI's potential requires addressing specific challenges, such as data privacy, security concerns, and the potential biases embedded in algorithms.

In considering the influence of AI on enterprise formation, processes, and outcomes, EE must examine both potential benefits and drawbacks. Chalmers, MacKenzie, and Carter (2020) proposed that AI can significantly impact the antecedents of enterprise

formation. However, exploring the specific mechanisms through which AI affects the various stages of entrepreneurial activities is necessary to understand its true impact. According to Cockburn, Henderson, and Stern (2019), AI introduces a new 'innovation playbook' that relies on vast datasets and learning algorithms to predict phenomena reliably. This development suggests that individuals can harness these datasets and algorithms to recognise and exploit entrepreneurial opportunities. AI possesses the unique ability to uncover trends and insights in data that may go unnoticed by human entrepreneurs (Chalmers, MacKenzie & Carter, 2021). This offers promising prospects for augmenting traditional entrepreneurial approaches.

A significant advantage of AI-augmented approaches is their ability to identify needs or market failures on a significant scale. Thus, AI can provide novel insights that drive business development by connecting disparate pieces of information (Microsoft, 2018). This capability allows entrepreneurs to make more informed decisions, increasing efficiency and the potential for higher rewards.

Despite the potential benefits of integrating AI into entrepreneurial processes, it is equally important to acknowledge the challenges and limitations of technological advancement. Overreliance on AI to make business decisions raises ethical concerns and has the potential to diminish human creativity and intuition, which have traditionally been crucial drivers of entrepreneurship. Considering these potential drawbacks, it is imperative to integrate AI into the entrepreneurial landscape. In doing so, it is essential to strike a balance that optimises the advantages of AI while preserving the unique strengths of human entrepreneurs. This balance paves the way for exploring the many entrepreneurship opportunities that AI can unlock.

3.7.1.3 AI and Entrepreneurial Opportunities

In today's dynamic world, the fusion of AI and innovation has triggered a revolution in entrepreneurship. By harnessing massive datasets and powerful machine learning algorithms, AI offers a novel approach to predicting occurrences and unlocking untapped opportunities (Corkburn et al., 2018). This intriguing synergy between AI and entrepreneurship promises to transform traditional business practices and drive remarkable growth (Obschonka & Fisch, 2022).

As AI penetrates deeper into the entrepreneurial domain, its ability to discern patterns and insights beyond human comprehension opens new avenues for identifying market gaps and customer needs at an unprecedented scale (Nambisan, Wright & Feldman, 2019). The enthralling potential of AI-augmented approaches lies in their ability to connect seemingly unrelated pieces of information, generate innovative ideas that fuel entrepreneurial ventures, and foster business development (Nambisan, Siegel & Kenney, 2018). However, amid the excitement surrounding AI's impact on entrepreneurship, it is vital to critically assess the boundaries of AI's influence and appreciate the continued significance of human ingenuity in recognising novel opportunities.

Beyond entrepreneurship, AI's transformative impact extends into HE, where digital technology and big data analytics revolutionise teaching and learning practices (Chalmers et al., 2021). Therefore, integrating AI-driven tools into EE settings opens exciting possibilities for personalised learning experiences and improved student outcomes. However, this rapid advancement also prompts crucial deliberation on ethical considerations and potential biases arising from the ever-increasing reliance on AI in educational decision-making (Mei & Symaco, 2022).

As the integration of AI and entrepreneurship paves the way for remarkable growth and innovative business practices, it ushers in a new era of leveraging big data in this dynamic landscape. By harnessing massive datasets and employing powerful machine learning algorithms, AI not only predicts occurrences and identifies market gaps in entrepreneurship but also unlocks the potential of big data to drive transformative insights (Lévesque, Obschonka & Nambisan, 2022).

3.7.2 Big Data

Integrating digital systems in teaching and learning within HE has led to an unprecedented surge in data generation, marked by an exponential growth in data volume, velocity, variety, scope, resolution, flexibility, and scalability (Singh & Madaan, 2022). This technological revolution has fostered the accumulation of vast amounts of educational data from diverse sources and formats within entrepreneurial ecosystems. Consequently, HEIs now face the imperative of adopting data mining practices to gain valuable insights into student performance, enabling customised learning experiences

that align with entrepreneurial demands and individual student needs (Abu Saa, Al-Emran & Shaalan, 2019).

Nonetheless, while data-driven practices offer immense opportunities for growth and development within the educational ecosystem, they also present significant challenges and raise pertinent questions (Benita, Virupaksha, Wilhelm & Tunçer, 2021). The foremost challenge lies in the effective management and interpretation of this vast volume of data, necessitating the extraction of meaningful information that can genuinely impact student outcomes and inform institutional practice.

One can find a pertinent illustration of data-driven practices in HE by utilising data mining techniques to analyse students' learning patterns and performance (Romero & Ventura, 2020). Through such an analysis, faculty members can discern areas where students may struggle or excel, enabling the tailoring of teaching methods to suit students' needs. Furthermore, leveraging data analytics to monitor industry trends empowers HEIs to update their curricula, offering courses that equip students with high-demand skills.

However, integrating digital systems and data-driven approaches also elicits concerns regarding data privacy, security, and potential biases in the analysis (Daniel, 2019). Ethical practices are imperative to safeguard individuals' rights and uphold the trust placed in HEIs when collecting, storing, and utilising student data.

The concept of "big data", introduced by McKinsey and Company in 2011, has become increasingly relevant in the 21st century. This refers to large datasets that surpass the capabilities of traditional data analysis techniques (Ali & Novikov, 2020). Scholars such as Daniel (2019) and Hussain and Cambria (2018) define big data as high-magnitude datasets generated through users' continuous actions and interactions in digital environments. Big data processing often requires advanced technologies, including AI-infused methods, as they come in various sizes and types ranging from megabytes to petabytes, depending on the domain (Obschonka & Audretsch, 2020). Thus, EE must assess its capability to handle big data effectively. By harnessing statistical data on student performance, attitudes, progress, and engagement within classrooms and online Massive Open Online Courses (MOOCs) platforms, EE stand to gain profound

insights into enhancing processes and procedures through data-driven decision-making (Ashaari, Singh, Abbasi, Amran & Liebana-Cabanillas, 2021).

3.7.2.1 Big Data and Entrepreneurship Education

In HEIs, educational data, often generated from students' interactions with LMS platforms, encompass a range of administrative, educational, and quality assurance information (Schumacher & Ifenthaler, 2018). Despite this vast data pool, the true potential of big educational data remains untapped, necessitating unique techniques to uncover hidden insights (Gibson & Ifenthaler, 2017). This critical issue becomes even more pronounced within EE, where analysing large datasets through data analytics can offer valuable insights into student preferences within the entrepreneurial ecosystem. Consequently, adopting big data analytics has become increasingly recognised worldwide as a crucial component of data-driven decision-making in EE (Seele, 2017). This process of datafication has gained significant importance in the realm of enhancing innovation, analysing entrepreneurship, predicting trends, and aiding decision-making for entrepreneurs. Consequently, the utilisation of big data has become an immediate requirement for entrepreneurship (Nie, 2020).

The application of big data analytics in EE holds immense potential for revolutionising pedagogical approaches and empowering students. Through data analytics, correlations, trends, and other relevant information can be unearthed, enabling faculty members to tailor their teaching to the needs and aspirations of students. Moreover, big data analytics can play a vital role in fault prediction by minimising error probabilities when identifying opportunities (Ji & Wang, 2017). By harnessing predictive algorithms driven by big data, potential harm can be mitigated, fostering a proactive learning environment.

Recognising the limitations of traditional data processing applications in managing large datasets, HEIs are adopting big data technologies to handle massive amounts of data generated by student records (Picciano, 2012; Ang, Ge & Seng, 2020). From this transformation emerges learning analytics (LA), a concept derived from data mining. LA encompasses a range of techniques and procedures to extract meaningful insights from the vast data reported by educational platforms (Liang, Yang, Wu, Li & Zheng, 2016). By implementing LA systems to analyse patterns in student learning,

HEIs can better understand individual learning needs (Menon, Gaglani, Haynes & Tackett, 2017). These insights enable personalised support and interventions to improve academic outcomes. Thus, LA represents a significant facet of the digital transformation of HEIs.

3.7.2.2 Learning Analytics

Recently, EE has witnessed significant advancements in the integration of LA. Hence, LA's insights have proven invaluable to faculty members and students (Neumeyer, 2021). By leveraging LA to analyse student behaviours, track progress, and identify learning patterns, entrepreneurship faculty members can enhance their pedagogical approaches and optimise the delivery of entrepreneurship programs (Ciampi, Demi, Magrini, Marzi & Papa, 2021). This digital transformation allows them to understand better how students learn and make data-driven decisions that ultimately improve outcomes for students and faculty members (Tsai, Poquet, Gašević, Dawson & Pardo, 2019). Integrating LA into EE is a crucial step towards achieving excellence in teaching practices.

LA can be crucial in customising EE according to individual student's needs and learning styles. By employing data mining techniques, faculty members can extract meaningful information from the vast data generated by students' online activities (Banihashem, Farrokhnia, Badali & Noroozi, 2022). This approach enables the creation of personalised learning paths and tailored support, allowing students to develop their entrepreneurial skills and knowledge more effectively. However, it is crucial to consider the potential risk of over-reliance on data-driven decision-making. While LA can provide valuable information, there is concern that it might lead to a reductionist approach in EE. Relying solely on data and algorithms can neglect the importance of fostering creativity, intuition, and critical thinking, essential for successful entrepreneurship (Nishant, Schneckenberg & Ravishankar, 2023). Striking a balance between data-driven insights, nurturing individuality, and innovative thinking is crucial.

Entrepreneurship faculty members can also leverage LA to optimise the design of entrepreneurship courses and curricula. They can use predictive analysis to anticipate students' needs and challenges, allowing them to design courses that better address

these aspects (Sedkaoui, 2018). Moreover, LA can help to identify the most effective instructional strategies and resources, guiding faculty members in selecting the most suitable materials and activities to foster entrepreneurial competencies. Despite the benefits of predictive analysis (PA) in designing entrepreneurship courses, it is essential to recognise the limitations of historical data. Entrepreneurship is a dynamic field that constantly evolves with market trends and technological advancements (Ramírez, Cañizare & García, 2017). Therefore, past data may not always accurately predict future demands or challenges, and an overreliance on historical patterns could hinder the adaptability of entrepreneurship programs (Garcia et al., 2021).

While the implementation of LA in EE offers significant advantages, it is essential to consider the ethical and privacy implications (Tsai & Gasevic, 2017). Institutions must address data privacy concerns to safeguard students' personal information throughout the analytical process. The responsible use of data and transparent practices are crucial for earning students' trust and maintaining the integrity of the educational environment (Jones et al., 2020).

As HEIs navigate the complexities of leveraging LA, another essential aspect to consider is the role of social network analysis (SNA) in enhancing student engagement and success. By examining social connections and relationships within their academic communities, faculty members can gain valuable insights into how students interact, collaborate, and learn from one another. Faculty members can then use this knowledge to inform strategies to foster more effective collaboration, build robust support networks, and ultimately improve student outcomes. Though distinct in their approaches, LA and SNA are complementary lenses offering a comprehensive perspective on the complex fabric of the students' experience.

3.7.2.3 Social Network Analytics

Social Network Analytics (SNA) has become a crucial area of exploration in EE owing to the widespread adoption of social media platforms. Hence, social media platforms have transformed communication patterns and interactions within entrepreneurial ecosystems (Ansari & Khan, 2020). Consequently, SNA has emerged as a valuable tool for examining relationships, interactions, and communication dynamics among students and faculty members (Sobaih, Hasanein & Abu Elnasr, 2020).

In the context of EE, social constructivists view learning as an active construction of knowledge that occurs through social interactions and dialogue among students (Alismaiel, Cifuentes-Faura & Al-Rahmi, 2022). Consequently, they are inclined to adopt SNA to understand better how aspiring entrepreneurs connect and collaborate (Saqr & Alamro, 2019). Research using SNA has revealed that the degree of social network connections among students positively correlates with their overall learning outcomes (Saqr, Nouri, Vartiainen & Malmberg, 2020). Therefore, to comprehensively understand collaboration in EE, future studies should focus on exploring correlations between students and faculty members. Examining how aspiring students interact and engage with faculty members on social media platforms could provide valuable insight into the effectiveness of such interactions.

3.7.3 Internet of Things (IoT)

The Internet of Things (IoT) has emerged as a transformative force with profound implications across various sectors. In this literature review, the researcher examines the potential impact of the IoT on EE, which has garnered significant attention in the era of Industry 4.0, as it promises to reshape academic approaches and institutional operations (Sun, 2021; Madakam & Lake, 2015). By interconnecting everyday objects through smart sensors, IoT revolutionises the learning experience, enabling wireless communication and internet-based interaction (Madakam & Lake, 2015).

The integration of IoT into EE unlocks unprecedented opportunities for personalisation and tailored learning experiences. By leveraging IoT technology, EE can cater to individual student needs and preferences (Jing, 2022). Thus, interactive IoT devices seamlessly facilitate experiential learning, provide resources and stakeholders, foster collaboration, and effectively monitor student progress to enhance EE efficacy and support entrepreneurship initiatives.

IoT provides HEIs with a means to tackle a significant drawback in traditional EE approaches to inclusivity. By harnessing customisation capabilities, EE has the opportunity to craft programs that align with a wide range of student demographics, disciplines, and industries. This approach fosters the growth of a more diverse student body, encompassing individuals who might have otherwise been marginalised by conventional educational offerings (Zikria, Ali, Afzal & Kim, 2021). However, along with

the undeniable potential, a critical analysis must consider the challenges and limitations associated with IoT adoption. Among these concerns are privacy and security (Alenizi & Al-Karawi, 2022). As IoT devices collect and exchange vast amounts of data, ensuring data protection and confidentiality has become paramount. Therefore, EE must implement robust cybersecurity measures and comply with data-protection regulations to mitigate potential risks.

Furthermore, IoT fosters an interconnected entrepreneurial ecosystem that transcends classroom boundaries. By seamlessly integrating various stakeholders, including financial institutions, government programs, angel investors, venture capitalists, and crowdfunding platforms, EE enriches students' exposure to real-world entrepreneurship and facilitates a holistic learning experience that aligns with market demand (Hardie, Highfield & Lee, 2020). However, challenges related to technological barriers and financial constraints in implementing IoT infrastructure require innovative funding models and collaborative partnerships, particularly for smaller institutions (Costan et al., 2021).

Beyond data collection, IoT assists faculty members in identifying and addressing shortcomings in curriculum design, resulting in increased curriculum efficiency and effectiveness (Bayani-Abbasy, Corrales-Ureña, León-Brenes & Loaiza-Berrocal, 2019). Additionally, IoT implementation fosters improved program coordination and student monitoring (Supriadi, Iqbal, Pratista, Sriyono & Buanasari, 2023). For instance, IoT enables the live streaming of smart classrooms worldwide, expanding students' exposure to diverse entrepreneurial perspectives. Furthermore, IoT can revolutionise distance learning scenarios, allowing students to access recorded lectures through virtual learning spaces or attend live lectures outside traditional classrooms (Sun, 2021).

In the era of EE, Virtual Reality (VR) is another groundbreaking technology poised to redefine the entrepreneurial learning landscape. As HEIs continue to unlock the extraordinary potential of IoT, VR adds a new dimension, revolutionising the way students learn. By immersing students in captivating virtual environments, VR enhances and complements the existing benefits of the IoT, forging transformative and unparalleled educational experiences.

3.7.4 Virtual Reality

In 1966, the US Air Force initially employed VR as a training course, marking the inception of its extensive educational application in history (Rashid, Khattak, Ashiq, Ur-Rehman & Rashid-Rasool, 2021). Over the years, VR has undergone various stages of acceptance and rejection in educational settings (Kavanagh, Luxton-Reilly, Wuensche & Plimmer, 2017). However, recent developments have seen VR gaining traction as a powerful tool in teaching and fostering innovative business mindsets (Lai, Wong, Yu & Kang, 2020).

As entrepreneurship faculty members and students embark on this dynamic journey, the significance of VR in reshaping pedagogical practices for EE has become apparent. Scholars have documented positive outcomes, including enhanced student engagement, heightened motivation, enriched learning experiences, and improved knowledge retention (Putz, Hofbauer & Treiblmaier, 2020). By providing interactive and multisensory learning environments, VR fosters an immersive context in which aspiring students can actively participate, leading to a deeper understanding of business concepts and improved entrepreneurial skills (Huang & Liaw 2018).

However, when it comes to the specific impact of VR on EE especially in a developing nation context, there is a paucity of studies as some students have limited access to computers and the Internet (Asad, Naz, Churi & Tahanzadeh, 2021). Although VR's potential benefits of VR in general education settings have been well documented, its application and effectiveness in EE remain relatively unexplored (Mystakidis, Berki & Valtanen, 2021). Few studies have thoroughly investigated how VR can enhance student engagement and motivation in HE. This research gap presents an exciting opportunity for entrepreneurship scholars and educators to delve deeper into the pedagogical implications of VR and its potential to revolutionise EE.

At the HE level, VR tools have applications for diverse educational purposes, including immersive business simulations, entrepreneurial pitching scenarios, and cross-border collaboration with international startups (Moolman, Corkery, Walsh & Morrissey-Tucker, 2022). These applications have the potential to not only engage aspiring entrepreneurs in real-life business challenges but also offer unique experiential learning opportunities. By immersing students in entrepreneurial scenarios, VR can

prepare them to navigate the complexities of the business world, cultivate creative problem-solving skills, and foster a spirit of innovation (Grivokostopoulou, Kovas & Perikos, 2019).

Despite its promising potential, the effective integration of VR in entrepreneurship curricula requires a well-founded theoretical basis and pedagogical framework (Kavanagh et al., 2017). Integrating constructivist learning approaches and entrepreneurship theories into VR experiences can be pivotal for harnessing the full potential of this technology in HE (Huang & Liaw, 2018). As VR continues to evolve and expand its applications in various domains, including medical, engineering and EE (Mori, Ikeda, Takeshita, Teramura & Ito, 2022; Dagobert & Helfer, 2022; Lai, Wong, Yu & Kang, 2020), the need for comprehensive guidelines and best practices specific to EE becomes even more apparent.

In conclusion, VR holds great promise for EE applications. Its positive impact in general educational settings is encouraging, but its potential to revolutionise EE remains largely untapped. Therefore, the scarcity of research on VR's impact in this context calls for further exploration and collaboration among entrepreneurship scholars, educators, and policymakers. By bridging this research gap and embracing VR's transformative power, EE can embark on a more immersive and innovative path toward shaping the future entrepreneurs of the world. Having discussed the potential of VR in EE and the need for further research, the researcher delves into another groundbreaking technology that has reshaped the entrepreneurship landscape: cloud computing.

3.7.5 Cloud Computing

Cloud computing has become a transformative technology in HEIs, offering numerous benefits to academics and students. This section discusses the educational usage of cloud technologies and their significant impact on virtual services within HE. This study draws upon a comprehensive literature review and analysis of current cloud computing provisions and applications in HEIs to evaluate the opportunities and challenges associated with adopting cloud services in the HE sector. The study aimed to equip faculty members with a deeper understanding of the concept and influence of cloud technology on teaching and learning.

3.7.5.1 Historical Context and Conceptual Framework

The concept of cloud computing is rooted in John McCarty's visionary thinking in the 1960s. He conceived of a future where computing would function as a public utility, much like electricity or water (Ishaq, Abid, Farooq, Farooq & Ijaz, 2019). Since then, this idea has become a reality and has evolved into an everyday practice where data and applications are stored and accessed over the internet instead of on individual hard drives (Wada,2018). One of the key reasons behind the widespread adoption of cloud computing is its remarkable flexibility and adaptability (Partsafas, 2023). This technology has attracted millions of people by allowing them to store their data securely in remote servers for extended periods while still being able to access it whenever needed (Mariani, Styven & Teulon, 2021). Ultimately, cloud computing revolutionises digital resource management by providing convenient storage solutions accessible from anywhere with an internet connection. The scalability and convenience offered by this technology have empowered individuals and businesses alike to harness their potential to improve productivity.

3.7.5.2 Cloud Computing Adoption in HEIs

The adoption of cloud technologies in HEIs has ushered in a new era, rendering traditional, expensive and inaccessible technologies obsolete. Cloud computing has garnered proponents who argue for its cost-effectiveness (Gupta, Mazumdar, Mishra, Shinde, Srivastava & Deepak, 2023). Although cloud solutions allow institutions to avoid upfront infrastructure costs, it is essential to consider the ongoing operational expenses associated with cloud service providers (Kishor, 2023). These expenses encompass monthly subscription fees, data storage charges, and potential average fees if the usage surpasses specific limits. Critics also highlight security risks and dependency issues introduced by relying on third-party vendors for critical IT operations (Pallathadka et al., 2022). The lack of control over data residing in external servers compromises sensitive information or results in downtime during vendor outages. As HEIs deliberate on embracing cloud computing, it is imperative to thoroughly evaluate the benefits and challenges of making informed decisions (Attaran, Attaran & Celik, 2017).

The rapid and widespread adoption of cloud computing has emerged as a pivotal element in the era of Industry 4.0, with promising transformative advancements for HEIs (Kurni & Srinivasa, 2021). Cloud computing enhances efficiency and flexibility by catalysing collaborative learning approaches, primarily through robust storage capabilities. This enables HEIs to facilitate teamwork among students and faculty members seamlessly facilitate teamwork among students and faculty members, transcend geographical constraints, and enrich the EE. Moreover, cloud-based solutions empower HEIs to optimise their software and hardware infrastructure expenditure, ultimately reducing costs and potentially improving financial outcomes (Aldahdouh, Nokelainen & Korhonen, 2020). Technology-driven learning has been pivotal in shifting from traditional physical platforms to e-learning and virtual environments facilitated by cloud technologies (Olasile & Emrah, 2020). Consequently, it has eliminated geographical barriers in HE, broadening student participation opportunities across diverse locations (Kravariti et al., 2018).

However, as HEIs embrace these advantages, it is imperative to recognise and address the associated challenges. Data security and privacy considerations emerge prominently in this context, urging HEIs to implement stringent measures to safeguard sensitive information (Almaiah & Al-Khasawneh, 2020). Furthermore, while the allure of reduced costs is enticing, a comprehensive cost-benefit analysis is warranted to gauge the long-term economic implications of cloud adoption. Integrating complexities with existing systems and the need for staff training also represent vital aspects that require careful attention.

Moreover, integrating cloud services with the mass adoption of mobile devices has facilitated access to valuable educational materials, benefiting students and faculty members alike (Almaiah & Al-Khasawneh, 2020). This seamless access to diverse resources, research applications, and educational tools further strengthens the strategic value of cloud computing in HE.

3.7.5.3 Challenges and Security Concerns

Successful migration from traditional systems to cloud-based architectures in HE requires meticulous planning, well-defined strategies, and robust frameworks (Hiran & Henten, 2020). Although cloud computing adoption in HEIs has gained momentum

globally, lingering concerns over the sub-optimal performance of specific cloud services persist primarily because of their third-party nature (Ali, Wood-Harper & Ramlogan, 2020). For example, heavy reliance on cloud service providers raises concerns about service reliability during critical academic activities such as examinations.

Security is a paramount concern for faculty members and management, considering the internet's vulnerabilities that hackers can exploit to compromise data privacy and institutional details (Malhi, Iqbal, Nabi & Malhi, 2020). The lack of data control in the cloud further exacerbates these security challenges (Qasem et al., 2020). Although cloud security remains complex, ongoing research has been dedicated to developing holistic solutions safeguarding data and upholding user privacy.

In conclusion, cloud computing has emerged as a powerful enabler in the HE landscape, revolutionising virtual services and education delivery. The benefits of cloud adoption, such as cost-effectiveness, enhanced accessibility, and increased institutional efficiency, underscore its significance for HEIs. Nevertheless, addressing security concerns remains crucial for ensuring cloud-based education solutions' continued growth and prosperity. By leveraging cloud technology prudently and implementing robust security measures, HEIs can fully harness their potential to create innovative and inclusive learning environments for students and faculty members. Future advancements in cloud security offer the hope for safer and more reliable cloud-based education.

Understanding how faculty members perceive and utilise these technological advancements provides valuable insight into their integration and effectiveness in the academic sphere. Faculty members' involvement and engagement with digital technologies are crucial in shaping the overall learning experience and maximising the benefits that technologies offer students and institutions. Therefore, examining their perspectives and practices is vital to comprehending the holistic impact of 4.0 digital technologies on EE.

3.8. Faculty members' perspective and practices on digital technologies

To adequately respond to the requirements of the contemporary era, it is imperative that EE expeditiously emphasises augmenting its faculty members' adeptness in utilising 4.0 digital technologies and integrating novel pedagogical approaches (Sherouk & Raad, 2020). Integrating digital tools and modern pedagogical strategies has become increasingly crucial for imparting "digital wisdom" to students (Ali, 2019). Considering this imperative, attempting to teach the digital generation of students without a comprehensive understanding of their learning processes can be likened to embarking on an endless voyage (Ali, 2019). Such an approach undermines the underlying advantages presented by 4.0 digital technologies, which possess the potential to enhance both the learning experience and pedagogical methods. Pedagogy-centric emphasis inadvertently raises questions regarding whether it marginalises the inherent benefits of these technologies.

Some faculty members continue to adhere to conventional teaching methods, acknowledge, and appreciate the significant role digital technologies play in HE (Amhag, Hellström & Stigmar, 2019). Building on this notion, Garzón et al., (2020) contend that the dynamic nature of technological advancements continually reshapes pedagogical methodologies and learning environments, further emphasising the need to embrace digital advancements in the academic sphere. This perspective is reinforced by Falloon (2020) in his exploration of technology integration among university faculty, revealing a pivotal connection between effective teaching and adept technology utilisation in HE.

However, despite the great potential of digital technologies, their anticipated impact of 4.0 digital technologies in the EE context has not been satisfactorily fulfilled (Karamti, 2016). Faculty members' attitudinal responses toward integrating these technologies into their practice have contributed to this deficiency (Cubeles & Riu, 2018). While several studies indicate that faculty members view digital technologies positively, recognising them as tools that facilitate active, motivational, and interactive learning while respecting students' rhythms (Gamage, 2018), others highlight limitations, such as lack of technological knowledge, traditional training, and required economic investment (Spante, Hashemi, Lundim & Algers, 2018). Consequently, there is a pressing need to develop digital competencies and literacy among faculty members.

König, Jäger-Biela and Glutsch (2020) highlighted the concept of instructor ability, which pertains to faculties' beliefs or perceptions of their teaching competence concerning instructional strategies and effectiveness. Examining faculty attitudes towards the significance of various exponential technologies in HE is crucial. Researchers have found that positive faculty attitudes towards digital technologies and online course delivery positively impacts students' learning outcomes (Mercader & Gairín, 2020). However, as underscored by Lucas, Bem-Haja, Siddiq, Moreira, and Redecker (2021), the successful integration of technology in teaching is contingent not solely on the availability of technology but also on how both faculty members and students embrace and employ it. Having explored the perspectives and practices of faculty members, it is imperative to delve into students' viewpoints and practices regarding digital technologies.

3.9 Students' perspective and practices on digital technologies

Globally, HE students have developed a natural inclination towards dependence on technology in every aspect of their lives (Bennett & Corrin, 2019). However, effectively utilising the potential of digital technologies in an EE setting continues to pose a challenge. Li and Ranieri (2010) argued that mere access to these technologies does not guarantee their practical application, highlighting the importance of taking students' perspectives into account regarding their integration into HE.

Kusumo, Subali and Sunarto (2022) emphasise the importance of incorporating digital technologies into teaching and learning. Such integration provides greater flexibility in educational processes and empowers students to develop autonomy and adeptness in managing their learning endeavours. Therefore, understanding students' self-perception of digital competence in utilising these technologies is crucial (Colás-Bravo, Conde-Jiménez & Reyes-de-Cózar, 2021).

One key implication of these studies is that students' perspectives and digital competencies play a pivotal role in successfully adopting digital technologies. Nonetheless, Gallardo-Echenique and Anchapuri (2019) introduced a different perspective, contending that the use of digital technologies for learning among university students is influenced by various factors, such as subject speciality, which may hold a more significant sway than individual characteristics. Disparities in

technology access and expertise have also come into play. Therefore, it is imperative to consider students' technological concerns and priorities, especially in developing countries that strive to achieve quality education with limited resources (Dube & Scott, 2017).

Consequently, a holistic approach is required when digital technology is introduced to the educational landscape. Simply focusing on adoption without implementing a proper operating model or framework can lead to failure and deprive learning institutions of anticipated returns (Naveh & Shelef, 2021). For a comprehensive understanding of the subject, Gallardo-Echenique and Anchapuri (2019) thoroughly investigated the use of new digital technologies in teaching and learning in HE, providing valuable insights.

In conclusion, contemporary HE students can effectively utilise technology and rely heavily on it daily. However, the mere availability of technologies does not guarantee their effective utilisation for educational purposes. Although students possess a certain level of familiarity with technology, this does not always translate into the necessary digital competencies required for productive entrepreneurial learning. Moreover, students' attitudes towards technology integration vary; some readily embrace it while others may not. To fully harness the potential of 4.0 digital technologies, faculty members must carefully consider students' mindsets, skills, and unique needs through meticulous planning and scaffolding to ensure that technologies enhance rather than hinder student learning. When implemented with great attention to detail and a comprehensive understanding of students' digital literacy and abilities, technology integration can provide invaluable opportunities to engage students, promote collaboration and empower student agencies. By adequately implementing technology, guided by students' perspectives, HEIs can effectively utilise the vast potential of emerging technologies to enhance learning outcomes and equip students for future success.

In HE, digital technologies have become integral to students' lives, instilling confidence in their literacy. However, this confidence may be somewhat exaggerated, as it often stems from their familiarity with a limited set of technologies that they use daily, such as mobile smart devices (Mosco, 2017). A prevailing misconception suggests that today's HE students are inherently equipped with the computer skills necessary for

academic success, making computer application courses seemingly unnecessary (Buzzetto-Hollywood, Elobeid & Elobaid, 2018). Nevertheless, it is crucial to recognise that contemporary students differ from previous generations in the way they learn, interact with digital technology, and engage with one another.

Prensky (2001;2009) introduces the notion of “digital immigrants” and “digital natives” to capture this generational distinction. “Digital immigrants” are individuals born before 1980, who, despite adopting new technologies, retain strong connections to the pre-digital era, potentially limiting their understanding of “digital natives,” those born after 2000 who have grown up surrounded by and adeptly interacting with digital technologies. Wright, White, Hirst, and Cann (2014) introduced the notion of “digital residents” as a means to delineate individuals who are adept at utilising digital technologies in a fluent, continuous, and highly interactive manner within social contexts. For these individuals, digital environments are an inherent component of their existence, transcending the mere role of utilitarian instruments that can be activated or deactivated at will. Recognising these distinctions is crucial for HEIs to address the diverse digital readiness levels among students.

The literature review reveals a disconnect between students’ affinity for technology and its integration into HE. While today’s students highly value digital technologies, their adoption in educational practices remains limited (Dube & Scott, 2017). This lagging integration frustrates students, who feel traditional teaching methods fail to leverage the potential of technology. Moreover, students in developing nations may feel particularly disadvantaged by the lack of technology integration, hampering their technological abilities compared to peers in developed countries. These disparities signify that HEIs locally have yet to create environments that fully enable students to harness digital technologies for learning (Dube & Scott, 2017). Despite students’ receptiveness to technology, its meaningful integration in HE remains sparse. Thus, HE must prioritise fostering digital literacy skills and cultivating learning ecosystems that empower students to use technology to its full potential as a tool for academic and professional growth.

With the understanding that user perception and complexity significantly affect technology adoption, the focus has now shifted to how HEIs can effectively enhance

digital integration. By fostering a deeper understanding of students' digital needs and preferences, HEIs can pave the way for seamless and compelling integration of digital technologies into the learning journey. This strategic approach aligns with the imperative of equipping students with the essential 21st-century skills and competencies demanded by the dynamic landscape of Industry 4.0.

3.10 Digital Literacy and Competence

HEIs strive to nurture higher order thinking skills in students, positioning them for success in the upcoming digitally disruptive entrepreneurial landscape. Achieving this goal necessitates robust collaboration between these institutions and the entrepreneurship ecosystem–a symbiotic relationship crucial for sustaining the digital entrepreneurship process. Paradoxically, despite students' inherent digital fluency, studies have indicated that the integration of digital tools into academic pursuits often falls short and fails to align with the expected level of academic literacy (Guzmán-Simón, García-Jiménez, & López-Cobo, 2017). Thus, elevating students' digital skills is imperative to facilitate meaningful and effective incorporation of digital technology for educational purposes. These actions involve fostering digital interactions for learning, adeptly navigating digital information and skillfully retrieving pertinent data from daily life and training programs (Gallardo-Echenique, Bullen, Zottmann & Anchapuri, 2019).

The advent of the digital age has fundamentally transformed the student landscape. Contemporary students, colloquially known as digital natives, are deeply entrenched in digital technologies. Smartphones, tablets, televisions and the internet are woven into their daily lives, shaping their cognitive and learning approaches (Prensky, 2001). While awareness of this shift exists among faculty members, a substantial portion still operates under the assumption that traditional pedagogical methods apply universally. This disconnect underscores a dichotomy between faculty members, often dubbed "digital immigrants," and students, who epitomise the "digital native" phenomenon. However, this binary categorisation oversimplifies a complex reality and potentially hinders the exploration of hybrid traits (Teo, 2013). Given the incongruity between established educational paradigms and the digital-native generation, it is imperative to examine these terms critically.

In the contemporary landscape, digital literacy reigns as a pivotal skill, a prerequisite for navigating the intricate web of the digital world. Its scope encompasses the adept utilisation of digital tools, seamless access to and management of digital resources, synthesis of novel knowledge, and meaningful engagement with peers (Martin, 2005). Beyond convenience, digital literacy is indispensable for participating in the digital economy, fostering innovation, and achieving societal inclusion (Reddy, Sharma & Chaudhary, 2020). Therefore, faculty members must discern students' technological inclinations to tailor their learning experiences, allowing the distinctive traits of digital natives to flourish.

3.11 Conclusions

The evolution of EE stands at a critical crossroads, necessitating the seamless infusion of Industry 4.0's transformative digital technologies into its core fabric. Despite the immense promise of disruptive technologies such as AI, big data, IoT, VR, and cloud computing, their integration within African HEIs remains hampered by financial constraints, infrastructural limitations, skill gaps, pedagogical challenges, and cultural considerations. By embracing a collaborative and innovative approach, leveraging the power of the Industry 4.0 technologies, and noting student and faculty members' insights, EE can embark on a profound reimagining journey that nurtures students equipped for the future. However, this venture hinges on overcoming digital disparities, fostering robust digital literacy, revitalising curricula, and assessments, and fostering a culture of adaptability. The upfront terrain is multifaceted; however, through the conscientious harnessing of 4.0 technologies, EE can unleash human creativity and substantively contribute to a sustainable era of economic prosperity. By actively addressing challenges, ethically navigating technological integration, and continually refining strategies, this transformative journey stands poised to shape a thriving ecosystem of future entrepreneurs and innovators, transcending borders and propelling societies toward holistic growth.

CHAPTER 4: THEORETICAL FRAMEWORK

4.1 Introduction

In the preceding section, the researcher presented a comprehensive discussion that encompasses the theoretical foundations and empirical studies relevant to technology integration and its impact on HE. This chapter delves into the theoretical framework of the study. The theoretical framework of this study is built upon the complementary foundations of the Technology Pedagogical Content Knowledge (TPACK) and the Technology Acceptance Model (TAM). While TPACK, initially conceived for educators, offers a lens to examine how faculty members integrate technology into their pedagogical approaches and content delivery in EE, TAM provides insights into the factors influencing students' acceptance and adoption of technology-enhanced learning environments. By synthesising these two theories, the theoretical framework presents a holistic and multidimensional perspective, illuminating the intricate interplay between technology, pedagogy, content knowledge, and user acceptance, thereby offering a comprehensive understanding of technology's role in enhancing entrepreneurship teaching and learning experiences for both educators and students.

4.2 TPACK

Technological Pedagogical Content Knowledge (TPACK) is a conceptual framework that outlines the essential cognitive components that educators need to navigate technologically advanced learning environments. Developed as an extension of Shulman's concept of pedagogical content knowledge (PCK), TPACK recognises the complex and multifaceted nature of educators which is influenced by the specific context in which they work (Mishra & Koehler, 2009). Mishra and Koehler's established three key fundamental categories of knowledge that form the foundation of the TPACK framework: Technology Knowledge (TK), Content Knowledge (CK), and Pedagogical Knowledge (PK) (Mishra & Koehler, 2009). The framework acknowledges that effective integration of technology into teaching requires a nuanced understanding of the interconnectedness among these knowledge domains, enabling educators to leverage technology to enhance the quality of learning experiences.

4.2.1 Rationale for Adopting TPACK Framework for this Study

As clarified by Mishra and Koehler (2009), the TPACK framework holds utmost significance in the understanding and progression of technology-enhanced instruction for faculty members. Building upon Shulman's Pedagogical Content Knowledge (PCK), Mishra and Koehler expanded the framework to encompass Technology Knowledge (TK), thereby establishing the comprehensive TPACK model. This model explains the interrelated domains of technology, pedagogy, and content knowledge, serving as the bedrock for efficacious educational practices (Mishra & Koehler, 2009).

Lye (2013) emphasised the interdependent relationships among these three knowledge elements and their function in successful technology integration in education. This interconnectedness is particularly pertinent in the context of EE. By utilising the TPACK framework in this South African case study, the researcher acquired valuable insights into the TPACK-related knowledge of faculty members in the EE domain. The model facilitates the comprehension of how technological expertise, subject matter knowledge, and pedagogical methods collaborate to promote effective learning within the distinctive EE landscape (Lye, 2013; Mishra & Koehler, 2008).

The significance of TPACK has become particularly evident in tackling the challenges related to technology integration in EE. The emphasis on the methodology of integrating technology, as highlighted by Lye (2013), is of utmost importance for faculty members engaged in EE. This understanding is particularly relevant in SA, where the impact of advanced digital technologies on EE has been thoroughly examined.

Recognising the significance of TPACK, its development by faculty members becomes a theoretical construct and a crucial aspect for the practical and effective implementation of technology in teaching and learning within EE (Niess, Lee, & Kajder, 2008). In SA, integrating 4.0 digital technologies into EE is dynamic, and the TPACK framework offers a structured approach to unravel the complexities associated with this integration.

By investigating the TPACK-related understanding of faculty members in EE, this study aimed to understand and bridge the gap between theoretical frameworks and real-world applications. The TPACK model highlights the interaction between technology, pedagogy, and content knowledge, which aligns well with the complexities

of 4.0 digital technologies in South African EE. The results have important implications for faculty training programs, curriculum development, and teaching methods to maintain the relevance and effectiveness of EE in today's digital era.

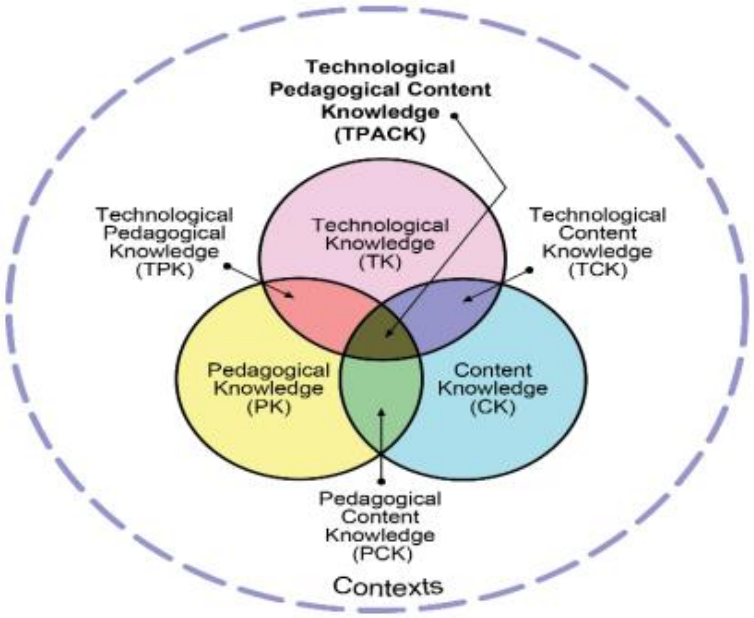
4.2.2 Discussion of the TPACK Framework

The modern era demands that students excel in a digital economy of complex and transformative technologies. The International Society for Technology in Education emphasizes the importance of preparing students to thrive in a sophisticated and information-rich environment, aligning with the TPACK model's focus on addressing educators' challenges in integrating digital technologies into education.

Harris and Hofer (2011) conducted a critical examination of the current approaches to technology integration in teaching. They observed that many existing methods tend to place excessive emphasis on technology, thereby disregarding the intricate connections between content, technology, pedagogy, and context. As a remedy, the researcher puts forth the TPACK model as a comprehensive framework for facilitating effective technology integration. This model acknowledges the interdependent nature of technology, pedagogy and context, highlighting their significance in teachers' knowledge essential for effectively instructing content-based curricula with the aid of educational technologies.

TPACK, a model for educator knowledge, depicts the intricate interplay between three knowledge domains: Content Knowledge (CK), Technology Knowledge (TK), and Pedagogical Knowledge (PK). This interaction is best illustrated in the TPACK framework, as shown in the figure below.

Figure 4.1: The TPACK Model and its Knowledge Components



(Adapted from Koehler & Mishra, 2008:3)

Nevertheless, the approach and dialogue presented in this context surpass mere consideration of content, pedagogy, and technology as distinct components of teaching and learning activities. Rather, it encompasses intricate connections and dynamic interactions among these three fundamental elements: content, pedagogy, and technology. Significantly, this perspective underscores the significance of perceiving these elements synergistically. This underscores the necessity of a comprehensive comprehension of the interplay between content, pedagogy, and technology to effectively integrate technology into educational practice.

In addition to the core elements of content, pedagogy, and technology, the model extends its scope to encompass three crucial knowledge domains: Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Pedagogical Content Knowledge (PCK). These interconnected knowledge areas are fundamental for understanding the intricate relationships between technology, pedagogy, and content (Akram, Yingxiu, Al-Adwan & Alkhalifah, 2021). A detailed exploration of these knowledge areas is as follows.

4.2.2.1 Technological Pedagogical Knowledge

The fusion of technological proficiency and pedagogical insight leads to Technological Pedagogical Knowledge (TPK), which plays a crucial role in HE. TPK encompasses a detailed comprehension of how different technologies interact with educational methods, emphasizing their elements, potential, and incorporation into educational settings. Acquiring this understanding involves identifying the tools suitable for particular purposes, such as promoting collaboration and determining instructional approaches that maximise technology usage. This knowledge is essential for educators as it enables them to effectively integrate technology into their teaching practices and enhance student learning outcomes (Koehler, Mishra & Yahya, 2007).

At its core, the TPK requires educators to grasp general pedagogical strategies tailored to extract the utmost from technology in education (Margerum-Leys & Marx, 2002). This requirement implies comprehending the pedagogical potential and limitations of diverse technological tools and resources, aligning them with appropriate pedagogical designs and strategies, and considering the disciplinary and developmental contexts. The pivotal implication drawn from the TPK concept is that a profound understanding of it is indispensable in educational environments. This understanding elucidates the potential benefits and constraints of specific technologies in various learning activities and educational settings.

Educational practitioners, including faculty members, are thus required to possess the knowledge and skills that empower them to harness technology for pedagogical purposes. For instance, they might leverage Microsoft Excel to facilitate data organisation and analysis among students or employ podcasts as a medium to share synthesised knowledge (Koehler & Mishra, 2009). Hence, TPK transcends mere technical know-how; it embraces a forward-looking, creative, and open-minded exploration of technological applications. This exploration, however, is not an end but rather a means to advance student learning and comprehension.

In conclusion, the symbiotic relationship between technology and pedagogy birth TPK is a cornerstone for effective modern HE. Its comprehension resonates strongly within EE contexts, urging faculty members to orchestrate a harmonious symphony between technology's potential and pedagogical excellence. As the educational landscape evolves, educators must be equipped with technical adeptness and artistry to integrate technology seamlessly into the tapestry of learning.

4.2.2.2 Technological Content Knowledge

Similarly, combining technical and content knowledge yields technological content knowledge (TCK), which is crucial for successful teaching and learning outcomes. TCK entails grasping the dynamic interplay between technology and subject matter and understanding how they mutually shape each other. Educators must delve beyond their expertise in the content they teach and comprehend how technology transforms the nature of the content (Koehler et al., 2007).

TCK's significance lies in its ability to empower educators to envision seamless technological integration within their teaching methods (Margerum-Leys & Marx, 2002). Moreover, TCK involves an intricate comprehension of how a technology's potential and constraints influence the contours of content delivery. This awareness is vital in instructional planning, where content and technology are frequently treated as distinct entities. However, the assumption that content development is solely within the purview of content experts, such as EE faculty members, should be nuanced by recognising the transformative role of technology.

Faculty members can bridge the divide between technology and content by harnessing TCK and sculpting a holistic and effective pedagogical landscape. This recognition reshapes teaching methodologies and underscores the symbiotic relationship between technology and subject matter, heralding a new era in integrated education.

4.3 Technology Adoption Models

The exploration of the impact of 4.0 digital technologies on EE within HEIs, particularly in SA, is anchored in the theoretical foundations of the TAM. These frameworks were employed to comprehensively understand how 4.0 digital technologies are integrated into EE by students. The TAM is a widely accepted and empirically validated model for understanding user acceptance and usage behavior of information technology systems (Davis, 1989). Despite its initial development in a Western context, the TAM has been successfully applied and validated across various cultural contexts, including developing countries (Vogelsang, Steinhüser & Hoppe, 2013; Tarhini, Arachchilage & Abbasi, 2015). South Africa represents a unique and diverse cultural context, with a mix of traditional and modern values, as well as varying levels of technology exposure and adoption (Janks, 2014). The TAM can provide a robust theoretical framework for investigating the factors influencing technology acceptance among South African

students, who are an important user group in the context of educational technology adoption.

Several studies have successfully utilised the TAM to understand technology acceptance among students in South Africa, across different educational levels and technology domains (Erasmus et al., 2015; Jaiyeoba & Ilorin, 2019; Mtebe & Raisamo, 2014). These studies have demonstrated the applicability and explanatory power of the TAM in the South African context, providing empirical support for its use in the proposed research.

In the era of Industry 4.0, the infusion of technology has prompted a significant examination of user acceptance, attitudes, and behaviour towards novel technologies (Porto, 2020). User acceptance is now a crucial consideration for maintaining the use and progress of technology, and it also plays an integral role in implementing new technologies (Al-Nuaimi & Al-Emran, 2021). The domain of technology acceptance has emerged as a focal point for investigation in the 21st century, giving rise to various pertinent theories and models, including TAM (Marangunić & Granić, 2015). Therefore, the TAM and other frameworks explain why users adopt or reject specific technologies, drawing insights from IT, IS, psychology, and sociology.

Among the theories and models, TAM has emerged as the most extensively utilised framework within IT and IS (Mugo, Njagi, Chemwei & Motanya, 2017). Its prominence is rooted in addressing a deficiency identified in the IT domain, specifically, the lack of robust measures to predict user acceptance, its interplay with system usage, and its associations with the system itself (Veiga, Floyd & Dechant, 2001). TAM introduced a fitting scale for forecasting user acceptance and technology usage grounded in perceived usefulness and ease of use. The primary objective of the TAM is to dissect the reasons underlying user decisions to embrace technology, considering the influence of system attributes and seeking avenues to enhance user acceptance (Silva, 2015). Notably, Davis and Venkatesh highlight TAM's indispensability in foreseeing user acceptance, intentions, and effective technology tool utilisation.

The focus on TAM became especially relevant for students in the South African case study, where the participants included students (Ndebele & Mbodila, 2022). The TAM model, introduced by Davis (1989), offers a framework for comprehending technology acceptance and utilisation. Concerning perceived usefulness and perceived ease of

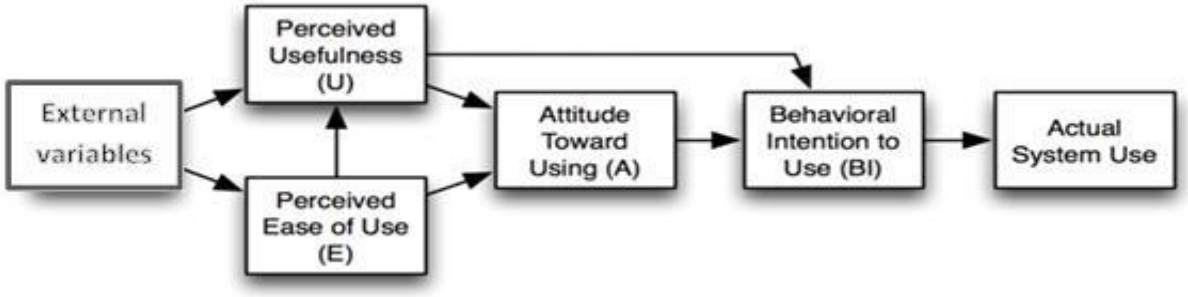
use as primary determinants, The TAM has emerged as a pivotal theoretical framework for investigating students' attitudes and behavioural intentions associated with the adoption and utilisation of Industry 4.0 digital technologies within the educational environment (Granić & Marangunić, 2019). Its evolution over time, culminating in placing perceived usefulness and perceived ease of use at its core, aligns with the logical trajectory of technology adoption and user behaviour, making it a valuable tool for understanding and enhancing the integration of 4.0 digital technologies within EE for students in SA.

4.3.1 Development of TAM

TAM, developed in 1986, has evolved through multiple modifications since its inception, enhancing its explanatory power and applicability. One significant adaptation occurred in 1989 when Davis, Bagozzi, and Warshaw introduced behavioural intention as an integral component of the original TAM framework. Their rationale stemmed from the premise that users' intentions to adopt technology are influenced by their attitudes and beliefs regarding the tool's utility. This addition aimed to capture the nuanced interplay between users' beliefs and their subsequent intention to utilise technology. Moreover, these modifications extend beyond the internal dynamics of user beliefs and attitudes. The TAM underwent further refinement by incorporating external variables acknowledged to impact users' perceptions and intentions. These variables, often contextual factors, expand the model's scope by acknowledging the broader influences that could shape users' technology adoption behaviour.

This revised version of TAM, now referred to as TAM1 (denoting its first significant modification), introduced a more comprehensive framework for understanding technology adoption. In contrast to the original model's focus on internal beliefs and attitudes, TAM1 highlights the interconnection between users' intentions, external variables, and their inherent beliefs and attitudes. This enriched model, as depicted in Figure 4.2, symbolises the evolution of the TAM from its initial iteration to a more encompassing depiction of users' technology acceptance processes.

Figure 4.2: TAM1, the first modified version of the TAM Model



Source: (Davis, Bagozzi & Warshaw, 1989)

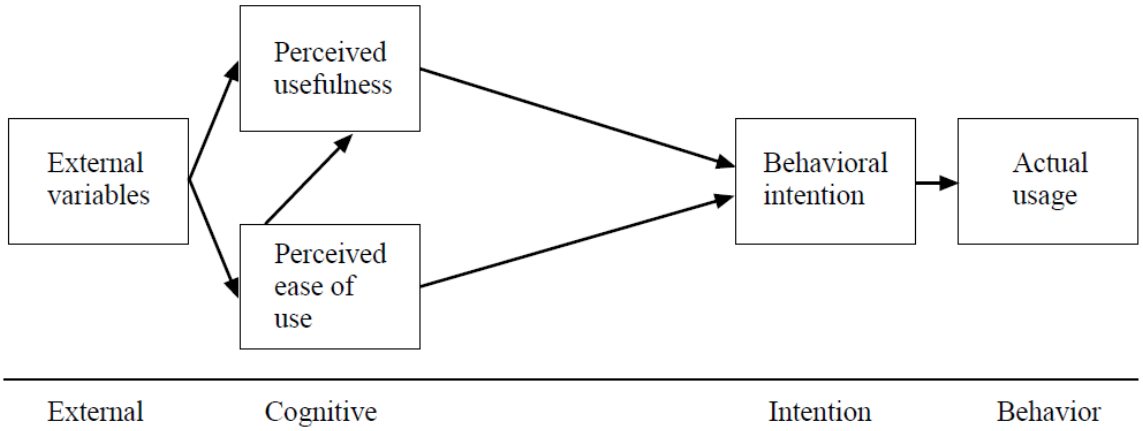
In 1996, Davis and Venkatesh introduced significant refinements to the Technology Acceptance Model (TAM), building upon empirical evidence from Davis, Bagozzi, and Warshaw's 1989 study. This adjustment occurred because of the discovery that perceived ease of use and perceived usefulness directly influenced behavioural intention. Their investigation led to a pivotal observation that users may adopt technology without favourable attitudes. Consequently, Davis and Venkatesh postulated that attitudes did not entirely mediate the impact of perceived usefulness on behavioural intention. This shift in perspective led to the exclusion of attitudes from the revised TAM. This adjustment stemmed from the realisation that attitudes were constrained by performance and effort expectancies, as Venkatesh et al. (2003) highlighted. By excluding attitudes and focusing on the direct effects of perceived ease of use and perceived usefulness, Davis and Venkatesh aimed to create a more refined model that captured the dynamic interplay between these variables and users' behavioural intentions.

Note that Figure 4.3 represents the final form of the revised TAM Model. This visual representation encapsulates the culmination of these adjustments, signifying a pivotal step in the evolution of TAM, where the interplay of ease of use, usefulness, and behavioural intention took centre stage. This progression, driven by empirical insights and theoretical refinement, redefined the framework's understanding of technological acceptance behaviour.

Davis and Venkatesh's 1996 adjustments to the TAM model mark a crucial milestone that deepened the model's explanatory power and reshaped the landscape of technology acceptance research. The exclusion of attitudes favouring direct influences and the consequent emphasis on ease of use and usefulness set the stage for a more

comprehensive exploration of users' decision-making processes in adopting technology.

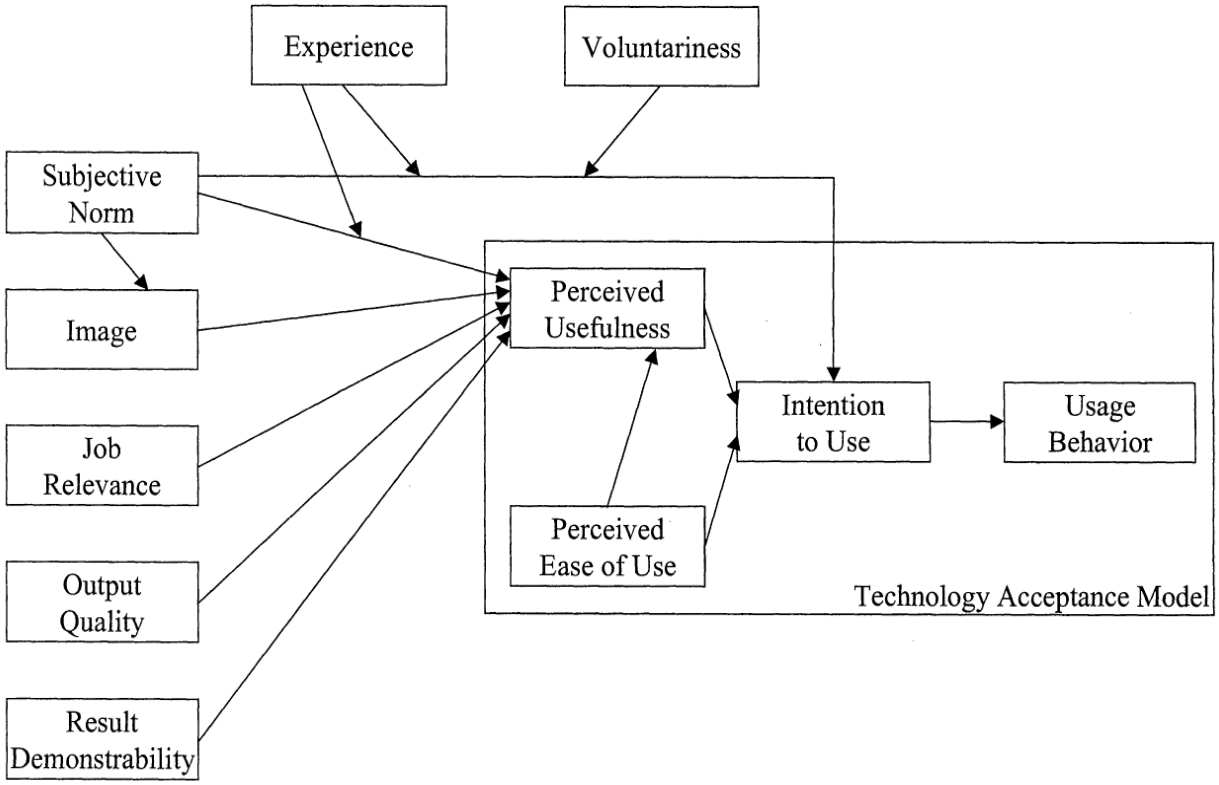
Figure 4.3: Final version of TAM1



Source: (Davis & Venkatesh, 1996)

In 2000, Venkatesh and Davis proposed a theoretical expansion of the Technology Acceptance Model (TAM), known as TAM2. The main objective of TAM2 was to address the limitations of TAM1 in explaining why individuals perceive a particular system as valuable. To achieve this, Venkatesh and Davis included specific variables as antecedents to clarify the perceived usefulness and usage intentions from both social and cognitive perspectives. This advancement incorporated cognitive processes such as job relevance, output quality, result demonstrability, and perceived ease of use. On the other hand, the researchers combined social influence processes such as subjective norms, voluntariness, and image. An important observation from Figure 4.5 indicates that all the aforementioned factors are directly and exclusively associated with perceived usefulness, without any relationship between these factors and perceived ease of use.

Figure 4.4: Technology Acceptance Model 2



Source: (Venkatesh and Davis, 2000)

Aligned with social psychology, recognising attitudes as potent predictors of behaviour, TAM provides a robust criterion to gauge students' acceptance (Fishbein & Ajzen, 1975). Numerous studies have underscored the impact of attitudes on behavioural intentions, establishing a notable correlation between students' attitudes and intentions regarding technology usage. This insight is paramount, as it enhances future technology adoption and its effects and aids in designing compelling digital learning landscapes (Liaw, 2008).

In alignment with the study's objective of investigating the impact of digital technology on students and faculty members in an ODL setting at a South African University, adopting the TAM1 version, including attitudes, is crucial. This strategic choice ensures a comprehensive examination of technology acceptance in an EE context. Importantly, this adoption does not mark a departure from the original TAM Model; rather, it signifies the intention to maintain the model's integrity while preserving its fundamental components and relationship pathways. By embracing TAM1, the researcher aligns the scope of the study with the intricate dynamics of technology acceptance while respecting the model's foundational framework. TAM is arguably the

first model to include psychological variables influencing technology acceptance and knowledge that link psychological and other factors (van Raaij & Schepers, 2008).

4.3.2 The Main TAM1 Model Components and the Relationships

The TAM has been acknowledged as the inaugural framework to encompass a psychological element that influences the acceptance of technology (van Raaij & Schepers, 2008). Additionally, an appreciation of the interplay between psychological factors and other variables is integral to comprehending this relationship. TAM1 predominantly comprises two fundamental convictions or perspectives, namely the perception of ease of use and the perception of the utility of technology. Davis (1989) provides a scholarly definition of perceived usefulness as the "degree to which an individual believes that the utilisation of a specific system would enhance their job performance." Conversely, perceived ease of use is defined as the "degree to which an individual believes that utilising a particular system would require minimal effort." These fundamental perceptions have a direct influence on users' attitudes towards a specific technology and can significantly shape their overall attitudes.

Similarly, these perceptions are crucial in determining users' acceptance of and attitudes towards adopting technology. On the other hand, the TAM2 Model was not utilised in the current study, primarily since TAM2 incorporates certain factors that are not relevant to the study objectives in this particular context. This study aimed to identify the driving forces and barriers to adopting Industry 4.0 and digital technologies in EE. This study also explores faculty members' and students' perspectives and practices related to digital technologies in the era of Industry 4.0.

Furthermore, the primary objective of this study is to examine the impact of particular factors on the attitudes of both students and faculty members, primarily focusing on the perceived ease of use and usefulness of digital technologies. Ultimately, the TAM was chosen as the most suitable model for this research.

4.3.3 The Significance of attitudes in technology adoption

Attitude is ubiquitous in psychology, extending its influence across domains such as sociology and education. It is a pivotal factor in deciphering and construing individual behaviour, thus commanding substantial attention from researchers in theoretical and practical realms (Kai-ming Au & Enderwick, 2000). According to Fishbein and Ajzen (1975), attitudes are an individual's positive or negative sentiment toward engaging in a particular behaviour, such as utilising a system. Davis (1993) refines this by defining

attitudes towards use as the level of evaluative impact an individual associates with employing a target system within their professional sphere.

Halloran (1970) contends that attitudes are not inherent traits but are acquired and developed through direct personal encounters and social contexts. Adding to this perspective, Baker (1992) underscores the significance of attitudes as markers of an individual's thoughts, convictions, inclinations, and aspirations. Beyond their significance, attitudes also play a pivotal role in elucidating and grasping the intricacies of social processes. This facet empowers understanding of the trajectory and persistence of individual actions and even facilitates anticipation behaviour (Crano & Prislin, 2006).

In this regard, identifying attitudes equips individuals to emotionally connect, form realisations, and adopt specific viewpoints regarding diverse subjects encountered and experienced in their journey. This dynamic interaction with attitudes contributes to the intricate fabric of students' behaviour, enriching the comprehension of how students perceive and respond to the technological changes around them.

4.3.4 Behavioural Intention

Fishbein and Ajzen (1975) define behavioural intention as an individual's perceived likelihood of participating in a specific behaviour. The Theory of Reasoned Action (TRA) explains that behaviour emerges from these intentions, influencing an individual's attitude towards behaviour and pertinent subjective norms. The theory of planned behaviour delineates a progression of associations linking beliefs, attitudes, and behaviour. Within the scope of the present study, behavioural intention pertains to the decisions made by students and faculty members concerning incorporating digital technologies for educational purposes in EE.

Fishbein and Ajzen (1975) illustrate that a favourable attitude prompts positive behaviour, while a negative attitude is associated with unfavourable behaviour. In e-learning, Parker (2003) underscores that those with positive attitudes toward technology tend to adapt successfully and consistently utilise digital tools. Behavioural intentions emerge as immediate predictors of behaviour (Ajzen, 1991) and rely on identifying attitudes through underlying beliefs.

In TAM1, Davis (1989) posited that attitudes significantly influence users' intent to adopt new technology. Attitudes, often shaped by personal experience, influence

feelings and thinking patterns that subsequently impact behaviour. As mediators between beliefs and intentions, attitudes substantially influence individual behaviour and daily life. Awareness of an individual's attitude towards a particular subject enables predicting achievement levels. Additionally, precise identification of attitudes reveals the reasons behind task performance successes or failures and exposes the underpinnings of disagreements within individuals or groups (Hassan, Shiu & Shaw, 2016).

4.4 Limitations of the TAM Model

TAM is a significant framework for understanding user attitudes and technology adoption. Although the core concepts of perceived usefulness and ease of use in TAM have gained recognition for influencing user thoughts and attitudes, they still fall short of providing a complete explanation for these attitudes. These concepts provide a general overview of user sentiments about a system but lack the depth to elucidate how these beliefs are formulated and impact user acceptance and usage (Mathieson, 1991).

Goodhue's critique (2007) identifies a blind spot in the TAM approach by primarily addressing "what causes users to adopt technology". This emphasis on adoption overlooks the valid reasons for a system's perceived usefulness, leaving important aspects unexplored (Gupta, Abbas & Srivastava, 2022). Furthermore, the intricate nature of perceived usefulness and ease of use is likened to a "black box", which challenges understanding their mechanisms (Mathieson, 1991).

Another dimension of criticism, highlighted by Salovaara and Tamminen (2009), underscores TAM's failure to consider temporal dynamics in accepting technology. The model lacks provisions for scenarios where users might initially accept a technology but later reject it or vice versa. Bagozzi (2007) echoes this concern and raises doubts about the theoretical relationships within the model, especially those between behavioural intention and actual usage. The time between intention and usage elapses external factors that influence users' perceptions of technology acceptability, potentially affecting the model's predictive capacity.

In response to these critiques, researchers (Venkatesh & Davis, 2000; Venkatesh & Bala, 2008) have substantially revised the original TAM. These adjustments aim to expand the model's explanatory scope and adapt it to evolving information technology

landscapes (Benbasat & Barki, 2007). However, this evolution has resulted in the proliferation of TAM iterations, leading to confusion regarding the authoritative version (Benbasat & Barki, 2007).

Despite these criticisms, TAM maintains significance in explaining and predicting technology acceptance. Numerous meta-analyses, such as the review of 26 empirical studies by Ma and Liu (2004), confirm the validity of the original TAM1 model. Numerous meta-analyses, such as the review of 26 empirical studies by Ma and Liu (2004), confirm the validity of the original TAM1 model. Notably, the dominance of perceived usefulness in influencing technology adoption was affirmed, even over perceived ease of use.

Researchers have incorporated additional factors into the TAM to respond to criticism and enhance its applicability, resulting in the evolution of TAM3. This ongoing process underscores the commitment to refining the model's explanatory and predictive capabilities, reflecting the dynamic nature of technology acceptance research. In conclusion, given its strengths and weaknesses, TAM remains a foundational framework for studying user behaviour and technology adoption.

4.5 Technology Acceptance Model 3

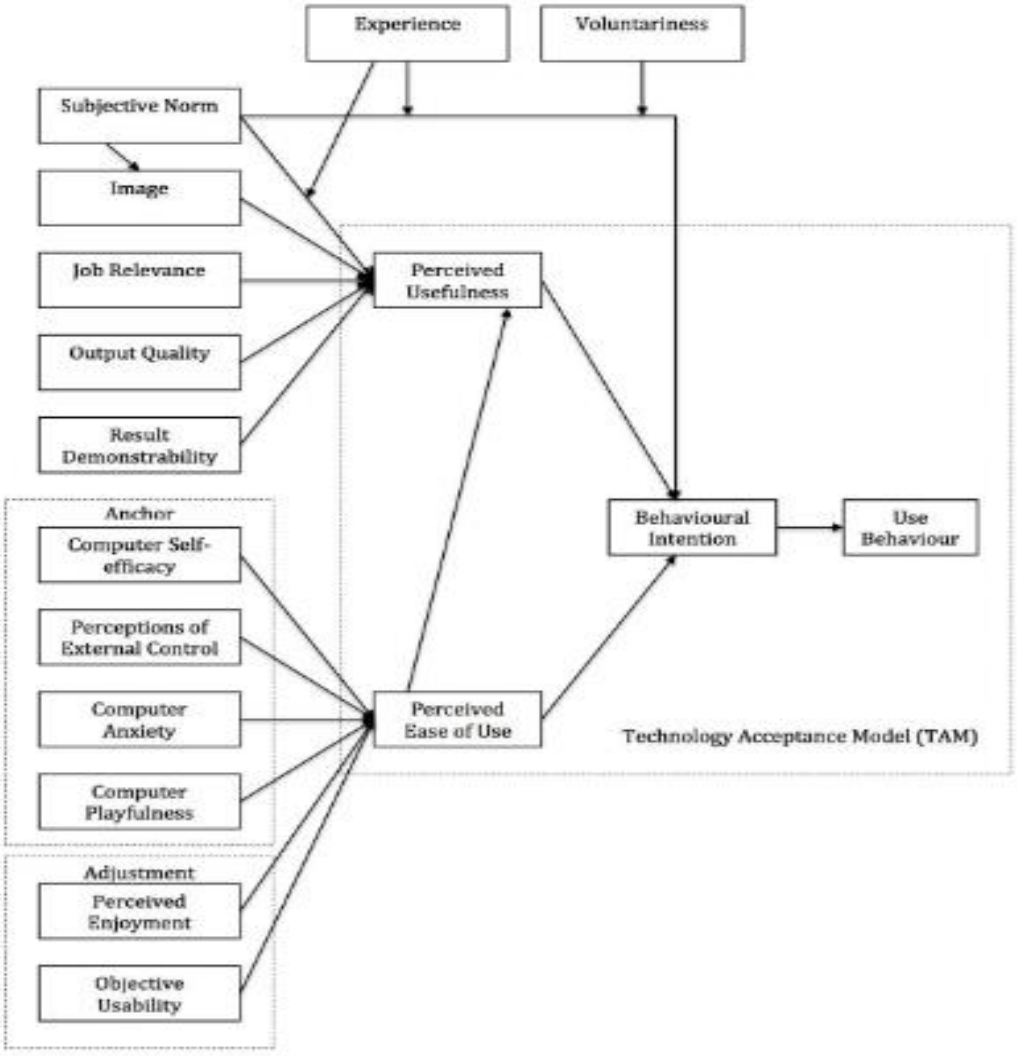
Several factors, expressed through the constructs of TAM 3, can help us understand faculty members' and students' behavioural intentions and the resulting use behaviour (Venkatesh & Bala, 2008). TAM 3 focuses on the determinants influencing an innovation's Perceived Usefulness and Ease of Use.

Venkatesh and Bala (2008) proposed modifications to the TAM by introducing TAM 3. Their focus was to enhance the factors that impact the perceived usefulness and ease of use of innovation, ultimately leading to positive outcomes. The theory states that behavioural intention is the determining factor for actual behaviour. Perceived usefulness is influenced by subjective norms, image, job relevance, output quality, and demonstrability. Therefore, perceived ease of use is influenced by anchor variables such as computer self-efficacy, perceptions of external control, computer anxiety, and computer playfulness, as well as adjustment variables like perceived enjoyment and objective usability. Additionally, the level of experience and the voluntariness of the user play a role in modifying behavioural intentions.

Based on the aforementioned discussion, it is evident that TAMs have been extensively employed in the realm of e-learning to examine the factors that influence the acceptance of technology. Numerous studies have successfully confirmed assumptions and elucidated the interplay between the constituent elements of the TAM. The substantial body of research in this domain has significantly contributed to the status and validity of the TAM, thereby establishing its significance within this research field. To be more precise, the Technology Acceptance Model (TAM) can be considered as one of the most successful models in comprehending the acceptance of technology among users, focusing on two key factors: perceived ease of use and perceived usefulness. Numerous studies have consistently affirmed the influential role of prior beliefs in shaping students' acceptance of e-learning.

On the other hand, there is a variance between the studies regarding attitudes, where several studies exclude attitudes from their models. In addition, these studies also indicate variance in the relationship between perceived usefulness and behavioural intention and the relationship between students’ attitudes and behavioural intention.

Figure 4.5: Technology Acceptance Model 3



Source: (Venkatesh & Bala, 2008)

TAM3 considers a broader range of variables, hence TAM 3 provides a more comprehensive understanding of the factors influencing technology acceptance and use behaviour. This makes it a more suitable choice for this study as it aims to capture the complexities and nuances involved in the adoption and utilisation of 4.0 digital technologies within the context of EE.

4.6 Conclusion

Theoretical frameworks of TAM and TPACK provided a robust foundation for this study, exploring the integration of Industry 4.0, digital technologies, and EE.

In its original form, incorporating attitudes, the TAM model offered valuable insights into students' acceptance and usage of digital technologies based on the critical determinants of perceived usefulness, perceived ease of use, and attitudes. This elucidates the factors shaping students' behavioural intentions and technology adoption decisions.

For faculty members, the TPACK framework allowed a systematic examination of the knowledge components that needed to be developed for effective technology integration in EE. A particular focus is enhancing technological pedagogical knowledge, technological content knowledge, and the overall TPACK capacity.

Together, TAM and TPACK enabled a comprehensive investigation into the opportunities and challenges associated with leveraging Industry 4.0 technologies to transform teaching and learning practices in EE. These research findings have important implications for theory, policy, and practice related to technology integration and adoption in the specific context of EE.

This concluding chapter summarises the key facets of TAM and TPACK and their suitability as theoretical lenses for this study. The next chapter delineates the research methodology and data collection methods utilised based on the grounding provided by these theories. There is tremendous potential for research undertaken through the TAM and TPACK perspectives to expand knowledge and inform strategies for preparing faculty and students to thrive in today's digital era within EE.

CHAPTER 5: RESEARCH DESIGN AND METHODOLOGY

This chapter is concerned with the methodological aspects of the current study, beginning with an overview of the research philosophies, approaches, research design, strategies, and data collection methods adopted.

5.1 Research Philosophies

5.1.1 Interpretivism/Constructivism

Interpretivist philosophy delves into the intricate process of how individuals construct and reconstruct meaning through their daily interactions. This perspective draws attention to the unique patterns of interaction and interpretive mechanisms that individuals employ to attribute significance to events and situations (Leavy, 2017). Essentially, researchers within this framework seek to unravel the subjective and socially contingent meanings attributed to the phenomenon under investigation. This notion resonates with social constructionism, which underscores the idea that meanings are inseparable from human cognition, a result of people's interpretations of the world around them (Creswell & Creswell,2018).

These subjective meanings, often directed at specific objects or concepts, are products of social negotiation and historical contexts (Saunders, Lewis, & Thornhill, 2016). Rather than imprinting upon individuals, these meanings emerge through interactions with others (thus embodying social constructivism) and the historical and cultural norms that shape their lives (Creswell & Creswell, 2018). Given their reliance on social interpretation, qualitative research data exhibit more ambiguity, elasticity, and complexity than quantitative data (Saunders et al., 2016).

Several prominent theoretical schools of thought are found within the interpretive paradigm, namely symbolic interactionism, ethnomethodology, dramaturgy, and phenomenology.

Symbolic interactionists - Symbolic Interactionism, a sociological perspective, was originated by George Herbert Mead (1934/1967) and Herbert Blumer (1969). This theoretical framework examines how individuals and small groups utilise shared symbols, such as language and gestures, during their interactions to communicate meaning (Hesse-Biber & Leavy, 2010). From this perspective, symbolic interactionists

argue that the meanings attributed to interactions, individuals, or objects are not inherent but rather emerge from the dynamics of “ongoing social interactions” (Hesse-Biber & Leavy, 2010).

The crux of symbolic interactionism lies in the belief that these shared meanings play a pivotal role in guiding appropriate behaviour (Hesse-Biber & Leavy, 2010). This shared understanding provides individuals a framework for navigating their social worlds and engaging in effective interactions. Consequently, the diversity of meanings attributed to various things, events, and objects contributes to variations in people’s behaviours and responses.

Ethnomethodology - Ethnomethodology, spearheaded by Harold Garfinkel (1967), is a distinctive field that employs elements of phenomenology to investigate how individuals derive meaning from their lives by interacting with others and engaging in the negotiation of meanings. Ethnomethodologists engage in the comprehensive examination of the intricate mechanisms by which social life is formed and reconstructed, grounded on the “micro-level comprehension that individuals employ in their daily social encounters” (Hesse-Biber & Leavy, 2011). This approach highlights the often unnoticed and unspoken rules that govern our social interactions, revealing the complex web of meanings underlying even the most routine actions.

A notable aspect of ethnomethodology is its connection to philosophical belief systems and methodological choices. Ethnomethodologists frequently employ ethnographic and interview methods to demonstrate the interplay between their philosophical stance and research approach. This aligns with the broader notion that researchers’ underlying beliefs fundamentally shape their selection of methods. Ethnomethodology’s focus on uncovering the implicit norms and shared understandings that guide social interactions makes it a valuable tool for unveiling the often-taken-for-granted dynamics of human behaviour within the intricate fabric of social life.

Dramaturgy - Dramaturgy, pioneered by Erving Goffman in 1959, is a compelling theoretical framework that employs the metaphor of theatre to unveil the dynamics of social life. Drawing parallels between human interactions and the world of acting can

provide valuable insights into the art form of dramaturgy. Dramaturgy suggests that social interactions, such as theatrical performances, comprise a ‘front stage’ and a backstage. On the ‘front stage’, individuals present their public roles and faces, engaging in interactions that are visible to others and subject to judgment. This is a space in which people conform to social norms and expectations. In contrast, the ‘backstage’ is where individuals can express themselves more authentically, as they are unbound by the need to maintain a public image (Karabulut & Celikoglu, 2019).

In summary, dramaturgy provides a unique lens through which researchers can understand the intricacies of human interactions. This perspective illustrates the performative aspects of social life and how individuals manage their impressions to align themselves with social norms. This concept aligns well with interpretivist philosophy, often associated with qualitative research approaches (Denzin & Lincoln, 2008). Investigating the connections between research questions and associated methodologies is crucial for evaluating the thoroughness and importance of current scholarly endeavours. The subsequent section examines the research design employed in the study.

Phenomenology - Phenomenology, an influential philosophical approach, was developed by prominent thinkers such as Edmund Husserl (1913/1963), Martin Heidegger (1927/1982), Maurice Merleau-Ponty (1945/1996), and Alfred Schutz (1967). This framework delves into the realm of human consciousness to decipher social reality, specifically focusing on how individuals ‘think’ about their experiences—an exploration of how consciousness is perceived (Hesse-Biber & Leavy, 2011). At its core, phenomenology shares a common objective across its various approaches: a deep exploration of how human beings comprehend and translate their experiences into consciousness, both at an individual level and as shared meanings (Patton, 2015). This entails meticulously capturing and describing the nuances of how individuals perceive, describe, feel, judge, remember, and discuss particular phenomena. This methodological undertaking involves conducting in-depth or semi-structured interviews with individuals who possess direct, first-hand experiences of the phenomenon in question—a concept often referred to as ‘lived experience’ instead of second-hand information.

To gather such intricate data, phenomenological researchers must understand the unique lens through which individuals interpret and engage in their experiences. This approach sheds light on an individual's perspective and offers insights into the broader significance of these experiences within a shared social context. For the current study, phenomenology was selected as the primary paradigm. This decision aligns with the researcher's pursuit of understanding the essence of lived experiences and the profound meanings that individuals attribute to those experiences.

5.2 Research design

Research design is the framework used to address the questions posed by the researcher throughout the study and to mitigate potential hurdles that may arise throughout the research process (Creswell & Poth, 2018). A qualitative case study was deemed the most suitable research design for this particular investigation, given its exploratory nature, as advocated by Myers (2013). An exploratory case study was more appropriate in this study as the study sought to determine what was happening and get clarity to establish why it happened. Qualitative methods rooted in ontological and epistemological constructivism/interpretivism seek to comprehend the social world from the participants' perspective (Bryman, 2016). This approach allows researchers to immerse themselves in participants' viewpoints as closely as possible, facilitating an understanding of internal dynamics (Bryman, 2016).

While quantitative methods primarily describe causal relationships, qualitative research focuses on social enquiry that produces rich, comprehensive data that reveal complex interaction patterns. Clur (2015) and Creswell (2017) concur that qualitative research is an exploration of the understanding people attach to human challenges. Hence, this study adopted a qualitative approach to unearthing the subjective significance that students and faculty members attach to their experiences of the impact of 4.0 digital technologies on EE. This approach proved invaluable in uncovering these stakeholders' underlying motivations, perspectives, and intentions.

The qualitative methodology enabled a more profound comprehension of the reasons behind actions, a spectrum of opinions, and the driving intentions of both students and faculty members. By immersing in their subjective realities, the researcher gained insights into how 4.0 digital technologies impact their EE activities and subsequently

shape their decisions and intentions. This study sought to contribute to a broader understanding of the evolving landscape of EE in the digital age.

In this vein, acknowledging the pivotal role of research design and delving into the nuances of qualitative methodologies, this study aimed to illuminate the intricate interplay between 4.0 digital technologies and EE, as seen through the eyes of those directly involved. By tapping into the interpretive paradigm, the researcher aimed to offer insights beyond surface-level understanding, often associated with quantitative analysis.

5.3 Research Approach

This study adopted an inductive approach as it is inherently compatible with the principles of interpretivism. The foundational belief of interpretivism, is that reality is socially constructed and shaped by individual experiences in a natural setting (Junjie & Yingxin, 2022). Hence this aligns well with the emphasis of the inductive method on deriving conclusions from observed patterns, similarities, and regularities. Given that individuals perceptions, aspirations, and expectations are not inherently objective or universally representative of truth, employing an inductive method with an interpretive approach was regarded as the most suitable option for achieving this study's objectives.

The inductive logic is used to interpret specific experiences and the meanings that arise (Pill, 2015). Thus, an inductive focuses on theory generation/building (Nickerson, 2022). The lack of predefined premises at the study's commencement underscores the appropriateness of an inductive strategy as it encourages the researcher to be open to developing insights and new perspectives.

An important characteristic that demonstrates the innate flexibility of the inductive approach is that it allows researchers to freely modify the research trajectory based on the unfolding narratives of the data (Kennedy & Thornberg, 2018). Moreover, this flexibility facilitates a more profound exploration of aspects that may have remained undiscovered within a rigid deductive framework. Consequently, this enhanced the study's potential to uncover nuanced findings.

The strategic alignment of an inductive research approach with interpretivism was a deliberate choice to navigate the uncharted terrain of 4.0 digital technology on EE. By embracing the inherent adaptability and depth of the inductive method, this study aimed to unearth insights that transcend mere generalisations, capturing the essence of participants' experiences and perceptions in a rapidly evolving digital landscape.

5.4 Research Strategy

The interaction between the study's philosophical foundations and its effectiveness in addressing the research objectives are fundamental in the selection of an appropriate research strategy (Cuthbertson, Robb & Blair, 2020). Consequently, it is important to note that no single strategy inherently outweighs another. The research strategy selection process follows the research purpose, methodological approach, alignment with research philosophy, time constraints, and available resources (Saunders & Townsend, 2018).

The case study was considered to viable as a research strategy as it affords the researcher to study the phenomenon in its natural setting to understand the nature and complexity of the processes taking place (Yin, 2014). This enabled an in-depth exploration of the impact of 4.0 digital technologies on EE. A case study approach delves into a specific research topic within its context or across multiple real-life contexts. Therefore, the researcher chose this approach because of its ability to yield a nuanced understanding of the research context and the intricate processes unfolding within it (Eisenhardt, Graebner, & Sonenshein, 2016).

The case study strategy has the distinct advantage of addressing questions that delve into a phenomenon's "why," "what," and "how" aspects. However, the perspectives of the case studies vary. Some view it as a strategy that employs a blend of methods to investigate a case (Oancea & Punch, 2014; Creswell & Poth, 2018), whereas others consider it to be an approach (Creswell, 2013) or methodology within a qualitative research design (Creswell & Creswell, 2017). However, this research regarded a case study as a distinct research method in line with Yin (2014) and Johnson and Christensen (2019).

When making the decision on whether to utilise the case study approach, there exist multiple factors that must be taken into account. In situations where the focus necessitates an examination of contemporary events or phenomena in a natural environment, it becomes evident that employing the case study method proves advantageous. Conversely, if the priority lies in the requirement for control or manipulation of variables, the case study approach would be deemed inappropriate unsuitable (Yin, 2014). It is crucial to establish that the necessity should be linked to the nature of the problem rather than the researchers' capability or incapability to conduct research using a specific methodology. Preliminary investigations are generally better suited to single cases, in other words, cases lacking any previous theoretical framework (Yin, 2014). However, it is important to acknowledge the significant drawback of the case study approach, particularly its demanding and time-consuming nature.

The adoption of a case study method has undoubtedly enriched the research by providing an extensive exploration of the subject matter. Despite the imperative nature of acknowledging the time investment necessary, this method was selected meticulously because of its inherent potential for uncovering profound insights and fostering a comprehensive understanding of the intricate dynamics that underscore the influence of Industry 4.0 digital technologies on EE. In transitioning to the next subtopic, it is worth considering the population under study as a critical factor in shaping the trajectory of research outcomes.

5.5 Population

The term "population" refers to the individuals or objects targeted for study. In this case, the focus was on HEIs in South Africa. SA has 26 public HEIs and 125 private institutions (Department of Higher Education, 2021). Given these institutions' extensive numbers and complexity, conducting in-depth interviews with all faculty members and students in the entrepreneurship department across all HEIs in SA was not feasible. Rather than including the whole population, a more feasible approach was to narrow the focus to a subset that was both technically viable and accessible. In doing so, it enabled the study to maintain rigour and gather more complex

information by focusing on a smaller population. Hence this approach enabled the researcher to yield more accurate conclusions.

Focusing only on the entrepreneurship department should not result in the presumption that this department represents all other departments within the designated institution. It is not suggested that the observations made within this division can be broadly applied. Instead, the emphasis lies in the notion of “relatability,” which asserts that findings from one department may provide valuable insights to other departments across various HEIs (Biggam, 2018).

All variables pertinent to the research problem were considered when constructing the sample population (Mishra & Alok, 2022). Analysing the sample population allows the researcher to extend outcomes and formulate generalisations about the broader population. This process assumes that the chosen sample sufficiently represents a larger context, thus facilitating the extraction of meaningful insights.

5.6 Sampling

It was not feasible to include the whole population due to the time constraints, logistical restrictions, and associated costs. Therefore, the researcher had to select the University of South Africa (UNISA), a specific open distance learning university in Pretoria for its suitability. This institution stands out because it offers an EE program at the undergraduate level (Bachelor of Commerce). Significantly, it is noteworthy that this institution is the largest open-distance learning establishment in Africa, attracting over 370 000 of South African students. As a result, it holds the distinction of being the most comprehensive university system in the country. Furthermore, as stated on its website, the university’s commitment to harnessing information and communication technology (ICT) as part of its digital future provides a compelling backdrop for investigating the impact of 4.0 digital technologies on EE delivery within such a sizable educational setting. South Africa has 26 public universities that offer a variety of EE programs at undergraduate and postgraduate levels. Some of the major HEIs with notable EE offerings include:

- University of Cape Town: Bachelor of Business Science in Entrepreneurship
- University of Pretoria: Bachelor of Commerce in Entrepreneurship

- University of Johannesburg: Diploma and BTech in Entrepreneurship
- Nelson Mandela University: Advanced Diploma in Entrepreneurship
- University of the Western Cape: Postgraduate Diploma in Entrepreneurship

However, UNISA stands out as the largest single provider of EE through its distance learning model serving students across SA and other African countries. Its scale, online delivery approach embracing digital technologies and accessibility to a wide student population made it an insightful single case to deeply investigate the research questions around technology integration in entrepreneurship teaching and learning. The open distance learning context at UNISA also allows examining potential challenges like enabling interactive learning experiences and creating immersive virtual environments for skills development when students are geographically dispersed. These implications for leveraging educational technologies align well with the study's focus.

Permission from relevant authorities within the selected institution was secured to facilitate access to participants, even though obtaining students' contact details proved challenging. The researcher chose to conduct virtual interviews through MS Teams as the mode of interaction. This approach not only curtailed logistical expenses and time constraints but also ensured accessibility for students residing outside Pretoria.

Notably, the insights gathered from qualitative studies are closely tied to data richness rather than the study's scope (Staller, 2021). In qualitative research, sample size is not the determining factor; instead, data saturation is more significant. Data saturation guided the study by determining when the data collection reached a saturation point, thus informing the appropriate sample size (Fusch & Ness, 2015).

This study exclusively focused on UNISA as its single case. The researcher intentionally aimed at faculty members and students within the entrepreneurship department, as they are key actors in EE and play a critical role in integrating 4.0 digital technologies in the teaching and learning process. This choice was made because of the department's direct involvement in EE, which ensured the overall representativeness of the study. The participant selection process covered a diverse range, including professors, associate professors, senior lecturers, junior lecturers,

and final-year undergraduate students from the entrepreneurship department. Precise criteria were established for this selection process, considering the participants' knowledge, experience, engagement with EE, job roles, and relevance to the study's objectives.

Taking into account all pertinent factors, such as the research objectives, the nature of the study, and the researcher's data access, it can be concluded that non-probability purposive sampling has emerged as the most suitable option for this particular study. In contrast, probability sampling methods are inappropriate for this study's goals as it demands a larger participant pool. Hence, purposive sampling was deemed appropriate because of existing contacts within the institution, facilitating the deliberate participant selection. This method gathers comprehensive and pertinent data from information rich sources.

Purposive sampling, the chosen approach, hinges on identifying participants who can contribute to the information necessary to answer the research questions effectively. Patton (2015) asserts that this strategy seeks out "information-rich cases" that aptly address the research's purpose and inquiries. In alignment with these considerations, the researcher embraced the interpretivist paradigm. This paradigm acknowledges that people construct and reconstruct meanings through daily interactions, negating the concept of universal truth within a specific context (Patton, 2005). A purposive sampling method was employed to ensure accurate participant selection.

Purposive sampling in this study met the following selection criteria:

- The participants worked in the entrepreneurship department.
- Final-year students enrolled for entrepreneurship qualification at the undergraduate level.
- Entrepreneurship faculty members with three or more years of lecture/ research experience.
- Participants must at least understand the fundamental concepts of entrepreneurship and the basic knowledge of Industry 4.0 technologies.

5.7 Data collection

The choice of data collection method is determined by the nature of the data required to address the research questions and research problem. In this particular study, data was gathered via semi-structured interviews. Semi-structured interviews were appropriate in gathering insights from faculty members and students regarding how 4.0 digital technologies impacted their activities within their faculty. Furthermore, they allowed the participants to spontaneously respond to questions based on their personal experiences with technology within the faculty rather than being guided solely by the existing literature (Kakilla, 2021). This stimulated a more comprehensive understanding of their experiences. Hence, the research questions were purposely designed with a extensive scope to allow participants to provide unique insights into the discussion during the interviews (Bryman & Bell, 2015). This approach facilitated rich, meaningful conversations aligned with the study's exploratory nature.

The interviews were audio recorded with the intention of capturing an exact representation of the interviews, while also preventing any potential data loss that may occur as it is not feasible to write down every detail during the interviews. The questions utilised during the interviews were carefully designed to align with specific themes that were identified during the pilot study. The semi-structured nature of the interviews served the purpose of gathering perspectives and facilitating a deeper understanding of the experiences and practices exhibited by both faculty members and students. Data collection relied primarily on data saturation. Data saturation occurs when there is a sufficient amount of information to reproduce the study and when further coding becomes unfeasible (Guest et al., 2006). Similarly, Saunders et al. (2016), defines saturation as a point when participants contribute no new information and emerging themes cease to develop. Adhering to this principle ensures that a comprehensive understanding is achieved.

Saunders et al. (2016) recommended a minimum sample size for a non-probability sample, as Table 5-1 outlined, which could provide valuable guidance in this context. Therefore, although qualitative research does not rigidly prescribe sample size, thoughtful consideration of these factors remains crucial for ensuring the credibility and richness of the collected data.

Table 5. 1 Minimum sample size for non-probability sampling (Adapted from Saunders et al., 2016)

Nature of the study	Minimum sample size
Semi-structured/in-depth interviews	5–25
Ethnographic	35–36
Grounded theory	20–35
Homogeneous population	4–12
Heterogeneous population	12–30

Therefore, the saturation point was determined by referencing Table 5-1, which provides the minimum sample size for non-probability interview sampling. Consequently, a total of 17 semi-structured interviews were conducted with faculty members and students in order to achieve the study's aims and objectives. The saturation point was reached after the fifteenth interview, however, two additional interviews were conducted to minimise any potential bias in the results and reduce the margin of error. Prior to the main data collection phase, a preliminary pilot study was carried out to refine the research methodology and ensure the effectiveness of the interview process.

5.7.1 Pilot Study

A pilot study was undertaken to examine the interview guide and make corrections as necessary. The pilot study encompassed conducting two interviews with individuals who resembled those identified in the primary investigation. The objective of the pilot study was to evaluate the interview process and detect any biases on the part of the researcher that might have been evident. Adjustments to the process were implemented based on the discoveries of the preliminary investigation (Marshall & Rossman, 2011; Andrade, 2020).

During this preliminary evaluation, two semi-structured interviews were conducted with knowledgeable participants from the HE sector, one with over five years of academic expertise and one was entrepreneurship graduate student. The semi-structured format facilitated a thorough investigation of diverse topics and allowed further exploration when necessary. The purpose of this undertaking was to authenticate and corroborate

the interview queries before incorporating them into the investigation. Furthermore, the investigator also solicited feedback from the participants in order to ascertain any uncertainties and challenging queries, as proposed by Chenail (2011).

An observation that emerged from the initial study revealed certain terms that required clarification or simplification, while other questions were ambiguous. Consequently, the feedback obtained from the pilot study aided the researcher in refining and rephrasing certain questions to enhance understanding. Therefore, the pilot study facilitated the refinement of the data collection strategy (Yin, 2016). Consequently, augmenting the knowledge and confidence of the researcher through informal virtual discussions. These discussions proved instrumental in dispelling doubts, especially regarding primary data collection methods.

Insights from the pilot study and informal discussions informed the researcher of the research approach. This enabled the exploration of participants' perspectives through open-ended conversations, aligning with the exploratory nature of this research. Moreover, the semi-structured interview format ensured a balance between focused questioning and the flexibility to delve into topics in greater detail. Thus, the chosen approach flowed logically from the pilot study findings to support an effective qualitative investigation. As a result, it led to increased researcher's confidence and refined interview questions paving the way for a more intricate investigation of the impact of 4.0 digital technologies on EE. By embracing a semi-structured format, the study aimed to capture the predefined aspects established in the pilot study and allow participants to elaborate on their unique perspectives and experiences. This transition to a semi-structured interview approach clarifies how the research methodology evolved to accommodate a richer understanding of the subject matter.

5.7.2 The Semi-structured Interview

The semi-structured interviews are a widely employed method for collecting data in qualitative studies (Creswell & Creswell, 2017). Semi-structured interviews assist the interviewer in making sense of the perceptions and experiences of interviewees. Furthermore,they permit interviewers to guide the conversation while allowing participants to share insights, resulting in a rich exchange of information (Adedoyin,

2020). This technique entails the utilisation of an interview guide, which is a comprehensive catalogue of predetermined questions formulated in a way that allows for the inclusion of flexibility and fluidity during the questioning process (Kvale & Brinkmann, 2015; Husband, 2020). However, there is no prescribed number of questions to be included in the interview guide. Nevertheless, it is recommended that the guide encompasses descriptive, structural, comparative, and evaluative questions (Rubin & Rubin, 2015). Therefore, the primary questions are augmented with further probing to ensure a thorough understanding, encouraging participants to elaborate further on their responses (Ruslin, Mashuri, Rasak, Alhabsyi & Syam, 2022).

The selection of semi-structured interviews as the main data collection instrument was justified by its inherent flexibility, enabling an interactive dynamic between the interviewer and interviewees (Saunders et al., 2016). This flexibility encourages participants to engage actively, leading to more comprehensive information exchange. Thus, participants have the capability to respond to questions according to their own individual approach, thus enhancing the collected data's diversity, accuracy, and objectivity. This approach enhances the validity of qualitative findings (Saunders et al., 2016).

Data collection preparation requires researchers to create interview guides ranging from general topics to specific open-ended questions (Weiss, 1995). For novice researchers, developing detailed guidelines that provide a structured foundation is recommended (Roulston & Choi, 2018). However, experienced interviewers could deviate from the guide as needed during the interview. For this reason, semi-structured interviews allow flexibility in covering the key points and questions required to meet the research objectives. Thus, a 'funnel' approach, suggests starting with broader questions and progressively moving to specific ones (Roller & Lavrakas, 2015). In doing so, it fosters participant comfort and rapport building while facilitating the collection of valuable insights. Effective interview research relies on the cultivation of rapport by means of active listening, which plays a crucial role in successful communication. The demonstration of interest through gestures and eye contact effectively stimulates participants to divulge more information. The act of probing, whether through follow-up questions or non-verbal cues, signifies active engagement

in the process of listening and elicits more in-depth and detailed responses (Saunders et al., 2016).

5.7.3 Conducting the interviews

Prior to commencing the research process, ethical considerations took priority. Interested participants were first contacted through an email and provided with the informed consent form and the participant information sheet. This was done to introduce the participants to the research project and its scope. The 17 semi-structured interviews were scheduled from October 2022 to January 2023, allowing participants the flexibility to select dates and times that suited them. While the original plan was to conduct interviews via Microsoft Teams, a few student participants preferred the Zoom platform because of its familiarity with it.

Before commencing each interview, the researcher restated the study's details to address any lingering concerns among the participants to ensure that the researcher and the participants were aligned. The researcher conveyed ethical codes through an informed consent form and delineated the intentions of the study. The informed consent process also functioned as a preparatory mechanism, providing participants with insights into the interview structure and expectations. Central to the informed consent process ensured participants' confidentiality and privacy throughout the study. Thus, the informed consent form assured participants that their identities would remain concealed and interview data would be securely stored on an encrypted, password-protected laptop to safeguard their personal details and interview recordings.

The interview process embraced dynamic engagement with 17 participants lasting approximately 25 minutes each on average. Some interviews extended to over 35 minutes while others were shorter at around 20 minutes. The interviews began with a fundamental question regarding participants' familiarity with 4.0 digital technologies in the era of Industry 4.0, subsequently branching into distinct conversational practices based on the research questions. The researcher completed the data collection process in approximately three months upon achieving data saturation. This determination was made because of the absence of new themes in the concluding interviews, signalling that the researcher had satisfactorily collected sufficient data.

This marked the climax of the data collection phase, paving the way for the subsequent task of transcribing the interview recordings.

5.7.4 Transcription of the Interviews

The ethical foundation of conducting interviews requires participants' informed consent. In parallel with audio recordings, handwritten notes were taken during and immediately after each interview. By so doing, these notes played a key role in enhancing the subsequent analysis. The primary step in the analysis involved the transcription of the audio recordings. This undertaking demanded substantial time and effort, requiring 2 to 3 hours to transcribe a single interview. The labourious nature of transcription mandates allocating ample time within the research design (Leavy, 2017). Thus the researcher was committed to acquiring transcription skills to address this challenge, encompassing mastering punctuation to capture pauses and intonations authentically. While there was an option to utilise AI transcription tools such as Otter, the researcher opted to manually transcribe the audio recordings. This decision was made in the light of unreliability and ineffectiveness exhibited by some of the AI tools. Hence, the researcher desired to fully engage with the data. Manual transcription aimed to generate comprehensible transcriptions suitable for reading, extracting quotes, and conducting data analysis later.

The average length of a single interview transcript spanned between 1000 and 1500 words. Consequently, the total duration of the interview transcripts was approximately 22,000 words. This indicator provided a sense of the data volume subject to transcription. After transcribing the fourth interview, the researcher gained proficiency leading to an increased pace of subsequent transcriptions. Throughout transcription process, ongoing communication with supervisors was crucial to ensure alignment with research objectives and fostering discussions around emerging intriguing discoveries.

After the conclusion of the transcription phase, the transcripts were colour-coded. This categorisation, informed by interview handwritten notes, contributed to a more refined understanding of the content and facilitated the drafting of data analysis sections. This approach aided in identifying recurring themes and patterns within the transcribed

material. The subsequent colour-coding of transcripts showcased a strategic effort to enhance data analysis and identify significant insights.

5.8 Validity of the study

The concept of validity is concerned with the alignment of study findings with predetermined research objectives (Kumar, 2018). Therefore, the researcher evaluates the accuracy of the findings by utilising specific methodologies (Creswell, 2009). This study utilised member checking to validate the accuracy of the findings and interpretations. Themes were extracted after the analysis of the transcripts, preliminary findings were sent to a sub-sample of participants to check whether they accurately reflected their experiences and perceptions (Erdmann & Potthoff, 2023). The sub-sample of participants were requested to review the theme summaries and provide feedback on the plausibility of the researcher's interpretations. The areas of grey and overlapping areas were discussed, and sub-sample participants' perspectives were incorporated into the final analysis. This member-checking process served to validate that the essence of the participants' experiences was captured and interpreted appropriately by the researcher. Hence, member checking was a valuable technique for ensuring the credibility and trustworthiness of the findings of the study. As a result of the participants' involvement in the research process, the researcher ensured that the findings were grounded in the experiences and perspectives of those most impacted by the research topic (Creswell & Poth, 2018).

Moreover, to validate the study, a pilot study was undertaken involving one faculty member from a distinct non-participating HEI and a recently graduated student to corroborate the research tools further. Consequently, a preliminary investigation was conducted to confirm the rationality of the research tool components, guidelines, and arrangement (Cohen et al., 2007). Concurrently, it aimed to alleviate any ambiguities or vagueness in the phrasing of interview questions and assessed the interview guide's level of readability for the intended participants.

To ensure dependability, the researcher outlined the research methods, data collection procedures, and decision-making processes used in the study. This encompasses a thorough explanation of the research plan, criteria for selecting

participants, data collection procedures (such as interviews) and data collection methods for analysing data.

The researcher also upheld an audit trail by maintaining detailed records of all research activities, such as interview transcripts, field notes, analytical memos and documentation of the data analysis process. This audit trail enables an external auditor to review the research process and verify if the data supports the findings, interpretations and conclusions.

Although qualitative research does not prioritise generalisability, (Lewis, Ritchie, Ormston & Morrell, 2003), the researcher provides in-depth information about the research setting which encompasses thorough profiles of the participants such as demographic details, backgrounds and their experiences tied to the research area). Through offering comprehensive, detailed descriptions and utilising deliberate sampling techniques, the researcher's goal has been to improve the transferability of the findings enabling readers to gain a clearer grasp of the study's range and limitations and evaluate how the findings could be relevant to their own circumstances or settings.

By addressing dependability, generalisability and confirmability through these strategies, the researcher aimed to enhance the trustworthiness and rigour of the study by providing readers with a clear understanding of the research process and the credibility of the findings.

5.9 Limitations of the study

Despite the valuable insights provided by this research, it is important to acknowledge certain limitations inherent in the study. These limitations serve as boundaries within which the findings should be interpreted and applied. Recognising these constraints allows for a more nuanced understanding of the findings and informs future research endeavours aimed at addressing the identified limitations. This sets the stage for discussing the specific limitations of the study. It highlights the importance of acknowledging limitations to provide proper context for interpreting the findings and to guide future research efforts. The table 1.1 below indicates the limitations and the solutions of the study.

Table 5. 2 Limitations and Solutions

Limitation	Solution
Unavailability of participants for interviews	The researcher offered flexible scheduling options: Provided participants with flexible scheduling options to accommodate their availability. This included offering different time slots for interviews, including evenings or weekends, to accommodate participants with work or other commitments during regular business hours. This provided multiple options for scheduling and increased the likelihood of finding mutually convenient interview times.
Time constraints	Information gathered from the pilot study indicated an estimate of how much each interview would take on average, which resulted in the researcher trimming down unimportant interview questions to fit in the allocated time as per the participant agreement.
Internet connectivity issues	Backed-up communication channels: The researcher established backup communication channels to mitigate potential internet connectivity issues during virtual interviews. These included offering participants alternative contact methods, such as phone numbers or email addresses, to use if necessary to switch to another channel or reschedule the interview.

5.10 Summary of chapter

This chapter detailed the research design and methodology used in the study. The study utilised an interpretive/constructivist philosophy and an inductive qualitative method within a case study framework. The study concentrated on one specific instance, UNISA, examining faculty members and fourth-year undergraduate students in the entrepreneurship division. Participants were chosen using purposive sampling techniques. Semi-structured interviews were utilised as the main method for collecting data. An initial study was done to improve the interview guide and procedure. 17 virtual

semi-structured interviews were conducted with participants until data saturation was achieved. The researcher manually transcribed the interviews. Member checking was employed to validate the results through participants reviewing and giving feedback on the researcher's interpretations. Measures were implemented to guarantee the accuracy, reliability, and applicability of the findings. Participant availability, time constraints, and potential internet connectivity issues for virtual interviews are important limitations that have been addressed. Tactics such as adjusting schedules, reducing questions, and having alternate forms of communication were employed to address these constraints. In general, the chapter presented a thorough summary of the philosophical underpinnings, structure, sampling, data collection and measures to guarantee the reliability and credibility of the results in this qualitative, interpretive case study research.

CHAPTER 6. DATA ANALYSIS & FINDINGS

Chapter 5 presented a comprehensive account of the research methodology used in this study. It provided the methodological choices made in the study, offered the rationale for selecting each approach and demonstrating their alignment with the research framework while also addressing the research aim, objectives, and questions. Subsequently, the data collection process is explained alongside an examination of the study's validity.

This chapter provides a comprehensive explanation of the qualitative data analysis methodology utilised to examine the data collected through the semi-structured interviews. The use of Atlas ti, a widely recognised software for qualitative data analysis played a fundamental role in the coding and interpretation process. Initially, it facilitated the in identification of emerging themes from the data. Subsequently, traditional coding techniques were applied to further develop and elaborate on these themes thereby enhancing the validity of the data analysis. Thematic analysis (TA) was selected as the exploratory qualitative data analysis method due to its robustness, accessibility, and theoretical flexibility approach to analysing qualitative data, providing a rich, detailed, yet complex account of data (Braun & Clarke, 2006). Guest et al. (2012) described TA as a method that focuses on identifying, analysing, and reporting patterns as well as describing implicit and explicit ideas within the data, that is, themes.

A theme encompasses a crucial component of the data pertaining to the research query and represents a structured reaction or significance within the dataset (Braun & Clarke, 2006). The importance of a theme is not contingent on quantifiable metrics, but rather on its ability to capture something relevant concerning the overarching research question (Braun & Clarke, 2006; Guest et al., 2006). Organising, arranging, and attributing significance to the extensive assortment of gathered data can be conceptualised as qualitative data analysis (Marshall & Rossman, 2014). Similarly, Miles, Huberman, and Saldaña (2018) define qualitative data analysis as a process that involves dealing with data in the form of words or based on written accounts, unstructured and non-numerical. Using this methodology, researchers can generate "comprehensible narratives" based on information obtained through semi-structured interviews (Wolcott, 1994). This approach involves the comprehensive examination of

large volumes of data which is achieved through the process of raw information reduction, identifying significant patterns, and ultimately deriving meaning insights from the data (Vaismoradi, Jones, Turunen, & Snelgrove, 2016). It is crucial to note that data does not possess the ability to convey its meaning independently. Consequently, researchers must assume the responsibility of interpreting and analysing the data on its behalf (Vogt, Gardner, Haeffele & Vogt, 2014). As a result, it is crucial for the researcher to thoroughly comprehend the data before initiating the process of data analysis. Hence, the immersion process proved to be invaluable in enabling the researcher to fully engage with and comprehend the essence of data (Saldana,2014). Furthermore, the study's observation explains that this immersion allows one to gain deep emotional insight into the social worlds studied and what it means to be a human (Saldana, 2021).

6.1 Rationale for Thematic Analysis (TA)

TA was selected for this study as it facilitated the ability to identify the pivotal and pertinent themes that were in alignment with the research objectives. Therefore, the suitability of TA was reinforced by its capacity to consolidate information, expound, and extract its significance. Given the extensive and voluminous text data, the qualitative study did not utilise all the information. Thus, the researcher refined data irrelevant to the study during the data analysis process. This refinement process, known as winnowing, involves focusing on the selected insightful data while disregarding irrelevant material (Guest, MacQueen, & Namey, 2012). The consequence of this process is the consolidation of data into a concise number of themes, typically ranging from four to seven (Creswell, 2013).

TA involves the identification, analysis and the reporting of patterns within the data to form themes. Hence, TA necessitates searching across the dataset to distinguish repeated patterns of meaning or themes (Braun & Clarke, 2006; Braun & Clarke, 2019). As a result, different meanings, manifestations, and interpretatives are the focus of TA. Thus, the manifestation level reflects directly observable information, such as the explicit content of a participant's words. On the other hand, the interpretative level reflects the researcher's interpretations, for example, what a participant reveals. Given the study's interpretivism position, both observable patterns of meaning and

those influenced by the underlying phenomena were considered. This enabled the generation of themes that concerned both explicit and implicit content (Squires, 2023).

Themes can be generated through either a data-driven (inductive) or theory-led (deductive) approach. Inductive TA aims to organise and describe data without attempting to fit it into a pre-existing coding framework (Braun & Clarke, 2006). As a result, themes that emerge from inductive analysis are based on the data and do not reflect the researcher's theoretical bias. On the other hand, deductive TA involves applying preconceived themes derived from theory or existing knowledge to the data. However, a combined deductive-inductive approach allows researchers to approach the dataset with an understanding of the existing literature while remaining open to new ideas and concepts. Joffe (2012) recommends this approach, as it helps to avoid replicating previous research and enables the generation of new knowledge about the phenomenon being studied. Nevertheless, this study employed an inductive approach.

6.2 Data Analysis

Aligned with the epistemology of social constructionism, the analysis concentrated on the participants' experiences of engaging with 4.0 digital technologies in the context of EE. Two participants were omitted from the analysis due to their inability to respond to the interview questions. The audio recordings of the remaining 17 participants were transcribed in their entirety. Subsequently, the data were examined using Braun and Clarke's (2006) framework for TA, employing the following phases:

Phase 1: Familiarisation with the Data

Familiarisation and data comprehension are pivotal before commencing any systematic data analysis process. Therefore, Hesse-Biber and Leavy (2011) state that data needs to be read, looked at, and thoroughly thought about. This emphasizes the significance for researchers to thoroughly engage with the data to acquaint themselves with its content's extensive and comprehensive nature (Braun & Clarke, 2006). Before commencing the coding process, the researcher had to read and re-listen to the interview audio recordings at least three times to note the potential codes and patterns. The Initial immersion in the data provides three key benefits. Firstly, it allows the researcher to get a deep understanding and familiarity with the data. According to Saldana (2014), this could be "feeling the pulse of the data".

It is common to lose sight of the comprehensive perspective when conducting daily data collection and preparation. In order to reestablish a connection with the essence of the data, one must fully engage with it. Saldaña (2014) elucidates that this immersive approach enables individuals to attain profound emotional understanding of the social environments under scrutiny and the essence of human existence.

Secondly, immersion is crucial for cultivating preliminary concepts (Creswell, 2014). While scrutinising the data, researchers make concise annotations to serve as personal reminders regarding their reflections, conceptions, and arguments (Saldaña, 2014).

Thirdly, it is important to note that when conducting research involving extensive data, it is advantageous for the researcher to engage in preliminary exploration to initiate the process of data reduction (Hesse-Biber & Leavy, 2011). In this particular case, the researcher took the initiative to prioritise the data for analysis based on its relevance in addressing the research purpose and responding to the research questions (Saldaña, 2014).

Phase 2: Generate the initial codes.

The generated data was reduced and classified through the coding process by the researcher. Coding involves assigning a word or phrase to segments of the data (Leavy, 2017). Therefore, the selected code should summarise or capture the essence of the data segment (Saldaña, 2014). Hence, codes identify data features of interest to the researcher (Braun & Clarke (2006). This study utilised a hybrid approach of manual hand coding and computer-assisted qualitative data analysis software (CAQDAS) in ATLAS.ti to analyse the interview transcripts. This combined approach allowed us to leverage the strengths of both human and computerised analysis. Hand coding enabled a close, iterative reading of the data to identify themes and concepts grounded in the participants' perspectives. The inductive, organic nature of manual coding facilitated the discovery of unanticipated meanings and nuances within the data. Therefore, Saldaña (2021) asserts that "manual qualitative coding provides a more intimate experience with the data than relying solely on CAQDAS outputs."

Hand-coding a sizeable qualitative dataset is laborious and introduces the risk of human error or bias. So, Atlas ti was used to supplement and validate the hand coding through computational power like coding retrieval and frequency counts. Atlas ti also provided data management assistance by compiling, organising, and annotating many transcripts. As Woods et al., (2016) noted, CAQDAS does not analyse data but serves as a valuable adjunct to qualitative analysis performed by the researcher. In line with recommendations by Maher, Hadfield, Hutchings, and De Eyto (2018), the inductive, semantic codes from hand-coding were complemented by Atlas ti's capabilities for efficient data storage, visualisation, and confirmation of coding consistency. This mixed approach balanced human insight and critical thinking with the systematic power of software. The strengths of each method were leveraged while counterbalancing some of the inherent limitations.

Individual data extracts were subjected to coding for a wide range of potential themes. The application of in vivo coding was employed, as this approach hinges on the utilisation of participants' precise language to generate codes (Strauss, 1987). The adoption of in vivo coding is preferred by numerous qualitative researchers due to its emphasis on upholding and preserving the participants' language. In the current study, coding was undertaken within the framework of qualitative analysis, specifically in the context of thematic analysis, in order to maintain a steadfast focus on the participants' language and to guarantee the organic development of codes. The coding process employed in this study aimed to identify recurring ideas, concepts, and patterns in the data; these findings were crucial for generating themes. The process was conducted in detail following a systematic approach consisting of several steps.

First, the researcher conducted an initial examination of all transcripts, allowing for the formation of initial impressions and recording of any immediate observations. Second, the transcripts were meticulously scrutinised and analysed line-by-line and word-by-word. This scrutiny allowed for the generation of codes with varying levels of complexity, ranging from simple descriptions to conceptual categories. In this phase, the researcher emphasised pertinent words or sentences and documented any associations or disparities with findings in the existing literature. Moreover, the researcher focused on the topics or ideas the participants mentioned multiple times.

The subsequent phase involved the classification of the codes produced into separate research themes to establish correlations and ascertain overarching patterns.

The researcher used a constant comparison method during the coding process to compare different codes and within individual codes. This approach allowed researchers to identify similarities, differences, and relationships between codes (Lochmiller, 2021). The codes were refined and integrated into coherent categories and themes using an iterative process of constant comparison. As the process continued, a code list was created by identifying the most significant codes and grouping-related codes. This step involved considering the research aim, objectives, and questions to ensure alignment between the emerging themes and objectives of the study.

The researcher conducted the coding process iteratively until theoretical saturation was achieved, indicating the absence of any novel codes arising from the data. This observation signified that the coding procedure successfully encompassed all the concepts presented within the dataset. Through multiple iterations of coding, refinement, and comparison, the researchers formulated a comprehensive collection of codes that effectively captured the intricacy and complexity of the qualitative data. Achieving saturation instilled confidence in the accuracy of the resulting codes, thereby ensuring an authentic depiction of the phenomena being investigated (Braun & Clarke, 2012). Throughout this process, constant consideration was given to the research aims and objectives to ensure that the codes and resulting themes accurately represented the data. Following this systematic coding process, the study aimed to comprehensively analyse the data, establish meaningful connections through categorisation, and generate themes that effectively address the research questions.

Phase 3: Categorising and Theming.

Once the data had been coded by the researcher, it became imperative to examine the data for patterns and connections between codes, a practice commonly referred to as categorisation. Categorisation entails the grouping together of codes that are similar or appear to be related (Saldaña, 2014). Moreover, while working with the coded data, the researcher may also engage in the process of theming. Themes arise during the analysis of codes and categories and can be thought of as comprehensive

expressions or sentences that reveal the underlying significance of a code or group of codes (Saldaña, 2014). Once all the data had been coded and compiled, the analysis advanced to a more comprehensive level of thematic analysis. This entailed categorising various codes into potential themes and sub-themes, and arranging the corresponding coded data excerpts within the identified themes.

Phase 4: Reviewing Themes.

Internal and external homogeneity were evaluated through a systematic analysis of the coded excerpts under the identified themes and sub-themes. This process involved repeated iterations of reading and re-reading to ascertain the emergence of a coherent pattern (Patton, 1990). In cases where needed, the researcher adjusted the definitions of the themes and re-coded the relevant data. Subsequently, the entire dataset was re-evaluated to identify any data that may have been overlooked in the initial stages, resulting in an improved thematic map.

Phase 5: Defining and Naming Themes.

Themes were initially identified and subsequently iteratively developed through a meticulous process of data analysis and organisation. This systematic approach allowed for the creation of comprehensive and internally congruous accounts of the data. To ensure the accuracy and robustness of the identified themes, examples of data extracts and their respective themes were shared with the research supervisor. The researcher then critically evaluated these extracts in terms of their pertinence, lucidity, and significance in defining the themes.

Phase 6: Writing the Report.

The final analysis consisted of writing the report (see Findings section 7). Sufficient evidence of the themes within the data was provided by choosing vivid extracts that capture the essence of the theme.

6.3 Interpretation

6.3.1 Thematic development

After the generation of the codes, a code framework was devised. However, as the code framework alone did not provide an explanation of the insights garnered from the

coding process concerning the views on the subject matter, thematic development was subsequently pursued. While the primary research areas were initially identified to address distinct research questions, a variety of sub-themes emerged within each thematic category because of the coding process. Consequently, as evidenced in Table 6.1-6.5, the outcomes of the coding process were organised into sub-themes. The first theme addresses the entrepreneurial pedagogical framework (Research Question 1); the second explores the drivers and barriers to the adoption of industry 4.0 technologies (Research Question 2); and the third assesses the perspectives and practices of faculty members and students toward industry 4.0 technologies (Research Question 3). Finally, the digital literacy required for Industry 4.0 is discussed (Research Question 4).

Table 6.1: Code framework for shaping the theme '4.0 digital technologies' impact on the development of an entrepreneurial pedagogical framework that fosters an entrepreneurial mindset'. (Illustrated by the author)

Codes		**Categories**
LMS	AI/Big Data/IoT/Cloud computing/VR	Digital Technologies
E-Learning	Ms Teams/Zoom/Skype/Google Classroom	
AI-based software (ChatGPT)	Cloud storage (Google Drive/Dropbox)	
BYOD (Laptops, cellphones, and tablets)	Audio/video conferencing tools	
Web-based learning	e-books (electronic books).	
Online collaboration	Interactive digital books	
Social media platforms (Facebook, Twitter, Linkedin, Research-Gate)	MOOCs	
Real-time feedback	Face-to-face approaches	Pedagogical approaches
Technology-enhanced learning	Conventional pedagogy	
Instructional teaching to student-centred learning	Individualised learning	
Learner centred approaches	Project-based learning	
Appropriate digitally transformed pedagogical methods	Experiential learning/ learning by doing	
Innovative, active, interactive, and collaborative pedagogy	ICT-based didactic–methodological updating	

Student-centred approach	Revolutionise education	
Outdated curriculum	Curriculum transformation	Curriculum development
Learning about technology	Curriculum relevancy	
Crowded garage effect	Theory based curriculum	

Table 6. 2 Code framework for shaping the theme 'driving forces and barriers to the adoption of industry 4.0 digital technologies (illustrated by the author)

Codes		**Categories**
Convenience	On-demand knowledge	Drivers
Collaboration	Customisable	
Demand for flexibility	Personalised/Individualised	
Perception of the usefulness of ICT (perceived usefulness)	Skill & Workforce Development	
Global competitiveness		
Poor broadband/internet connectivity	Legacy ICT infrastructure	Barriers/Constraints
Technophobia	High costs of digital infrastructure	
Educators' unfamiliarity with technology	Financial issues	
Security and privacy issues	Digital divide issue	
Infrastructure incapability	Pedagogical issues	
Leadership lacks digital vision.	Regulatory and Compliance	
Generational differences	Technological complexity	
Lack of exposure	Cultural resistance	

Table 6. 3 Code framework for shaping the theme of 'perspectives and practices of faculty members and students on industry 4.0 digital technologies' (illustrated by the author)

Codes		Sub-themes
Potential job losses	Accessibility issues	Faculty members and students' concerns/perceptions
Technology anxiety	Privacy issues	
Lack of institutional support	Use of ChatGPT	
Student participation	Lack of training	
Change fatigue	Infrastructure upgrades	
Digital savvy	Perception of the usefulness of ICT (perceived usefulness)	
Insufficient technological support	Increased engagement	

Poor ICT infrastructure	Expectation of effort (perceived ease of use)	

Table 6. 4 Code framework for shaping the theme of digital literacy required for industry 4.0 (illustrated by the author)

Codes		Sub-themes
Digital skills	Motivation for self-learning in technology	Digital Literacy
Digital native	Ongoing ICT training	
Digital immigrants	Exposure to digital technologies	
Workforce development program	Digital culture	
Basic computer literacy skills	Generational differences	

Using a similar process, the sub-themes were grouped to create themes for this study. The codes and sub-themes were finally categorised into four different themes, as they were related to the research questions and framework, as shown in Table 6.5.

Table 6. 5 Summary of research themes and sub-themes for the following empirical analysis (illustrated by the author)

Sub-themes	**Addressing question**	**Themes**
Digital reforms	1	E-Pedagogy
Virtual simulations		
Self-regulated learning and curriculum transformation		
Reimagine curriculum		
Collaborative learning		
Digital apps and platforms		
Convenience and flexibility	2	Tech-Embracing Transformation
Cost reduction		
Promote collaboration		
Entrepreneurial university		
Improves productivity		
Financial issues		
Inadequate ICT infrastructure		

Cultural resistance Pedagogical reforms Global competitiveness Digital illiteracy		
Technological unemployment Reshaping the human interaction Exposure to ICT Digital inequality Technologies for a younger generation New forms of entrepreneurial action Ms Teams is used for collaboration. Google Drive for storage of documents Google is the leading search engine. LMS for assignment submissions Use of LMS for disseminating information to students Social Network Applications	3	Perspectives & practices on Digital Transformation
Digital fluency Passive digital footprints Passively consumption of digital technology University-industry-government support Technological exposure	4	Digital Comptencies

6.4. Conclusion of the data analysis section

The comprehensive qualitative data analysis process employed in this study has yielded rich and intricate insights into the multifaceted nature of integrating Industry 4.0 technologies within entrepreneurship education. Through the meticulous application of thematic analysis, pivotal themes have emerged, illuminating the complex interplay between digital pedagogies, adoption drivers and barriers, stakeholder perspectives, and the evolving digital literacy landscape.

This rigorous analytical approach has laid the foundation for a nuanced understanding of the research questions, providing a robust framework for the subsequent interpretation and discussion of findings. The identified themes serve as a springboard for delving deeper into the intricate dynamics that shape the integration of Industry 4.0 technologies, offering a comprehensive lens through which to examine the transformation of entrepreneurial pedagogical approaches.

The findings and discussions that follow represent the culmination of this exhaustive analytical process, weaving together the intricate threads that emerged from the data. By intertwining the empirical evidence with theoretical underpinnings, this section aims to provide a holistic and contextualised understanding of the research phenomena, elucidating the intricate relationships and implications that underpin the adoption and integration of Industry 4.0 technologies within entrepreneurship education. Through a critical examination of the identified themes, this section seeks to unravel the complexities that underpin the transformation of entrepreneurial pedagogical approaches, the adoption drivers and barriers, stakeholder perspectives and the evolving digital literacy landscape. By juxtaposing empirical evidence with theoretical underpinnings, a nuanced and contextualised understanding of the research phenomena emerges, shedding light on the intricate relationships and implications that shape the integration of Industry 4.0 technologies.

6.5 Findings and Discussion

This section presents the findings and discussions, starting with the participants' distribution and description. The researcher then provided an overview of the key identified themes and a detailed discussion of the findings under each theme. Finally, the researcher conducted a critical interpretive discussion of each theme.

6.6 Distribution of Participants

The researcher identified 25 potential participants for interviews. Ultimately, the researcher interviewed only 17 participants, comprising ten final-year entrepreneurship students and seven faculty members, as this was the data saturation level. As shown in Figure 7.1, faculty academic members constituted 41%, while the student sample constituted 59% of the total participants. The participants worked within the Applied Management department, specifically entrepreneurship. The researcher assigned pseudonyms to each participant during sample selection. The participant number was attached to the department, with ES1 denoting Entrepreneurship Student Participant 1 and AM1 denoting Academic Member Participant 1.

Figure 6. 1 Distribution of participants

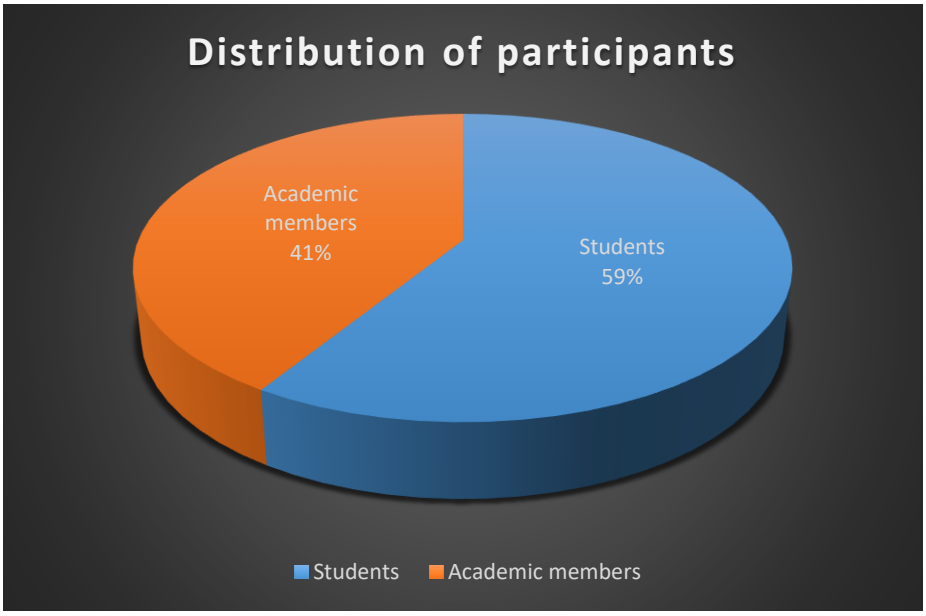


Table 6. 6 Summarised description of the participants' (Source Own)

Participant	Location	Education Level	Age Bracket	Department	Experien
AM1	Pretoria	Masters	35-45	Entrepreneurship	5 Years
AM2	Pretoria	Doctorate	45-55	Entrepreneurship	7 Years
AM3	Pretoria	Honours	25-35	Entrepreneurship	3 Years
AM4	Pretoria	Doctorate	35-45	Entrepreneurship	5 Years
AM5	Pretoria	Masters	35-45	Entrepreneurship	4 Years
AM6	Pretoria	Masters	25-35	Entrepreneurship	3 Years

AM7	Pretoria	Doctorate	45-55	Entrepreneurship	5 Years
ES1	Johannesburg	Undergraduate	25-35	Entrepreneurship	Year 3
ES2	Midrand	Undergraduate	21-25	Entrepreneurship	Year 3
ES3	Polokwane	Undergraduate	25-35	Entrepreneurship	Year 3
ES4	Durban	Undergraduate	21-25	Entrepreneurship	Year 3
ES5	Pretoria	Undergraduate	25-35	Entrepreneurship	Year 3
ES6	Pretoria	Undergraduate	21-25	Entrepreneurship	Year 3
ES7	Nelspruit	Undergraduate	25-35	Entrepreneurship	Year 3
ES8	Johannesburg	Undergraduate	21-25	Entrepreneurship	Year 3
ES9	Johannesburg	Undergraduate	35-45	Entrepreneurship	Year 3
ES10	Cape Town	Undergraduate	21-25	Entrepreneurship	Year 3

The table 6.6 above summarises the study's participants, categorising them into two groups: faculty academic members, labelled AM1-AM7, and entrepreneurship student participants, labelled ES1-ES10. Regarding educational level, the study included bachelor's, master's, honours and doctoral-level participants, with most participants being undergraduates. The faculty academic members were professionals in various positions, including lecturers, senior lecturers, associate professors, and full professors.

Based on this analysis, the researcher concluded that several participants in this study belonged to the young adult demographic group. This information helped to understand the study's participants and their experiences with the impact of 4.0 digital technologies on EE. It is important to note that this descriptive analysis provided no causal or predictive insights.

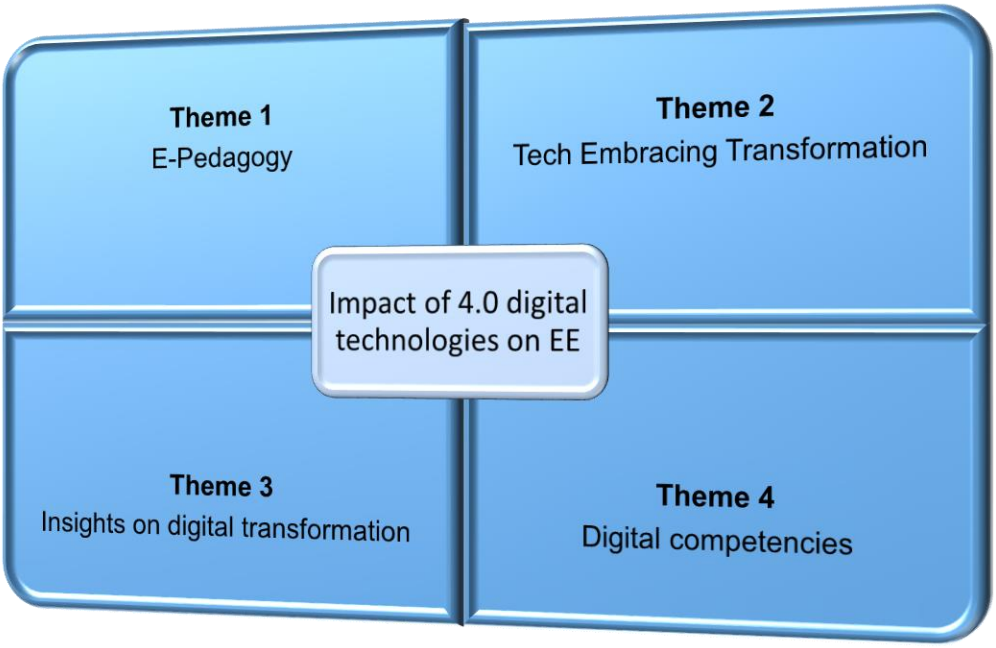
Overall, the information presented in Table 7.1 provides an overview of the demographic and professional characteristics of the study's participants. Moreover, the table presents diverse participants with different understandings and experiences of 4.0 digital technologies in EE. Additionally, it highlights the concentration of participants within the 21-25 and 25-35 age brackets, suggesting the importance of understanding individual experiences, educational background, and exposure to technology. Finally, the table indicates that the study included participants

from various South African cities, bringing diversity to the research sample. Building on this discussion, the researcher explored the key themes of this study.

6.7 Key themes of the study

Figure 7.2 presents an overview of the themes identified in the data analysis, in which the researcher expands on each issue investigated, revealing the themes and then outlining them. Participants' views were confirmed or contrasted with the existing literature, followed by a critical interpretive discussion at the end of each theme.

Figure 6. 2 Overview of the key theme findings (Author's own)



The researcher first derived a comprehensive evaluation of the participants' knowledge regarding 4.0 digital technologies. Participants relevant descriptions and thought-provoking responses are shown in Table 7.2. This step proved indispensable in ensuring that only the most suitable candidates were selected for the interview process, as their extensive knowledge and expertise on this subject matter could significantly contribute to fruitful discussions and enlightening insights during the inquiry phase.

Upon thoroughly analysing the participants' responses regarding their interpretation and definition of 4.0 digital technologies, the researcher attained a comprehensive understanding by identifying five distinct common categories:

I. 4.0 digital technologies are seen predominantly as the latest digital technologies.
II. 4.0 digital technologies are seen as a wave of technological revolution.
III. 4.0 digital technologies are seen as smart and intelligent systems.
IV. 4.0 digital technologies are considered disruptive technologies.
V. 4.0 digital technologies are considered as advanced technologies.

The researcher conducted an in-depth analysis of the faculty members and students' responses to comprehensively understand their insight into the 4.0 digital technologies. Table 7.2 presents the extracts from verbatim quotes as evidence supporting the findings. Upon careful examination, it became evident that most participants defined 4.0 digital technologies as the latest technological advancements with disruptive potential for revolutionary changes in various aspects of daily life and work routines. The descriptors used by participants AM2, AM3, AM4, AM5, AM6, ES4, ES5, ES8, ES9, and ES10 through these verbatim quotes revealed how they acknowledged the disruptive nature of 4.0 digital technologies in entrepreneurial pedagogy. Participants AM1, AM7, ES2, ES3, and ES7 further elaborated that 4.0 digital technologies require curriculum reforms to accommodate experiential learning. Overall, it remains clear from participant feedback that substantial agreement exists upon embracing these cutting-edge 4.0 digital tools to facilitate a shift from conventional teaching practices to technology-enhanced learning.

Table 6. 7 Extracts of participants' responses regarding their understanding of 4.0 technologies

Participant	**Key Extract identified in the definition of 4.0 digital technologies**	**Alignment of quotes with identified. categories** **1 = Latest/innovative technologies** **2 = Technological revolution** **3 = Smart, intelligent systems** **4 = Disruptive technologies**

		5 = Advanced technologies
AM1	*"…they are a new wave of a technological revolution that is changing the way we live and work"*	2
AM2	*"…the latest crop of innovative technology tools and systems that have the potential to revolutionise how we do things."*	1;2
AM3	*"…a technological revolution is transforming almost every aspect of our life."*	2
AM4	*"…these are disruptive technologies driving the Fourth Industrial Revolution".*	4
AM5	*"…the next wave of technological innovation that transforms almost everything in most industries."*	5
AM6	*"…the latest and most advanced smart and interconnected technological systems".*	1
AM7	*"…it is a technological revolution, characterised by the convergence of physical and digital systems that fundamentally changes how industries operate."*	2
ES1	*"…are the latest technological advancements revolutionising almost every aspect of life".*	1;2;5
ES2	*"they are part of the ongoing technological revolution, reshaping almost everything worldwide."*	2
ES3	*"…these disruptive technologies are central to the fourth industrial revolution and have a transformative impact".*	4
ES4	*"…one of the key features of 4.0 tech is that they are smart, intelligent systems, which can learn and adapt to their environment to provide better outcomes."*	3
ES5	*"…they are advanced technologies that comprise the latest technologies and include things like AI, big data, and the Internet of Things."*	1;5
ES6	*"…here we are talking about the latest technologies such as AI, virtual reality (VR), etc. These are technologies found in the 21st century".*	1
ES7	*"…these disruptive technologies are the cutting-edge innovations shaping the future".*	4
ES8	*"All I know is that they are bringing about a new era of innovation and disruption in various aspects of life".*	1;4

ES9	*"…these innovative technologies rely heavily on smart, intelligent systems that allow for automation and the use of data to make informed decisions".*	1;3
ES10	*"… these are at the forefront of the fourth industrial revolution, which is all about using technology to create smarter, more connected systems."*	2;3

Upon carefully analysing the feedback from the participants, the researcher inferred that they comprehend 4.0 digital technologies beyond mere acknowledgement of their existence. Most participants fully understood these cutting-edge technologies and recognised them as pivotal in driving significant changes across various industries. To them, 4.0 digital technologies represent more than advanced technologies but indicate a technological revolution transforming conventional practices into more innovative and highly intelligent methods. Regarding the definitions provided by the participants, it is interesting to note that these align with those found in the existing literature. Schwab (2016), for instance, describes 4.0 digital technologies as a new technological revolution that involves integrating smart and advanced technologies across the physical, digital, and biological domains. Likewise, Erboz (2017) defined such technologies as comprising highly advanced technical systems and network integration through smart and intelligent technology. From these definitions offered in the relevant literature on Industry 4.0, it becomes apparent that "smart" or "advanced/disruptive" technologies play a central role in most explanations given by participants regarding this phenomenon. Thus, the researcher can infer that faculty academic members and students often characterise their understanding of 4.0 digital technology in key terms, including advanced and smart technologies.

While sub-themes 4 (Disruptive technologies) and 5 (Advanced technologies) were not as prominently mentioned by participants as sub-themes 1 (Latest/innovative technologies) and 2 (Technological revolution), the central role of category 3 (Smart, intelligent systems) could provide insight into this deviation from theoretical expectations. One potential interpretation is that participants may view the disruptive and advanced nature of 4.0 digital technologies (category 4 and 5) as consequences or outcomes of the intelligent and adaptive capabilities of these systems (category 3). In other words, the disruption and advancement stem from the ability of these

technologies to learn, process data and make informed decisions, rather than being the defining characteristics themselves. For example, participants may perceive technologies like AI and IoT as disruptive and advanced because of their underlying smart, intelligent systems that enable automation, data analysis and decision-making. The disruption and advancement are by-products of the intelligence and adaptability of these systems.

The strong presence of category 3 in participants' responses suggests that they perceive the intelligence and adaptability of these systems as a core characteristic of 4.0 digital technologies. This aligns with the theoretical framework, which likely positions smart, intelligent systems as a crucial component of these technologies.

Additionally, the prominence of category 1 (Latest/innovative technologies) and 2 (Technological revolution) could be an indication that participants view 4.0 digital technologies as part of a larger technological shift or revolution, with the smart, intelligent systems (category 3) being a key enabler and driver of this transformation. This interpretation aligns with the quote from ES10, which states: "...these are at the forefront of the fourth industrial revolution, which is all about using technology to create smarter, more connected systems." The participant explicitly links the smart, intelligent systems to the broader technological revolution.

Furthermore, the literature may have placed more emphasis on the disruptive and advanced aspects of 4.0 digital technologies, while participants' understanding and perception were more focused on the underlying intelligent systems and their transformative potential.

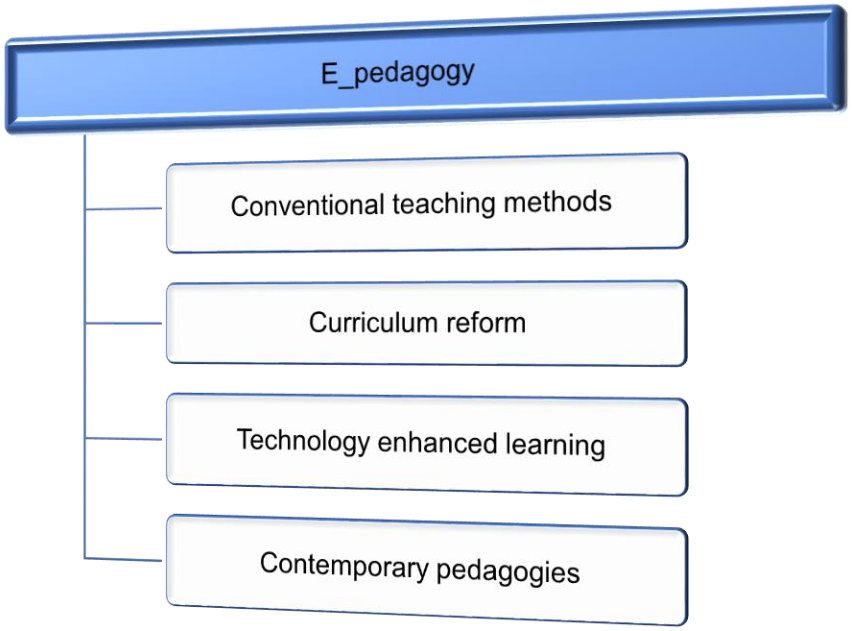
The next section of the study concern's theme one regarding participants' insights into the entrepreneurship pedagogy framework in the 4.0 era.

6.8. Theme one: E- pedagogy

In addressing research objective 1, which is "**the investigation of the effect 4.0 digital technologies in the development of an entrepreneurial pedagogical framework that fosters an entrepreneurial mindset among students**", three broad

themes emerged from the analysis and are indicated in Figure 7.3, which shows the links between the issue being investigated and the theme from the data analysed regarding the impact of 4.0 digital technologies in developing an entrepreneurial pedagogy framework that fosters an entrepreneurial mindset.

Figure 6.3 Summary of research theme and sub-themes for the "entrepreneurship pedagogy framework"



The participants provided insights into the impact of the 4.0 digital technologies on entrepreneurial pedagogy. Moreover, participants expressed their experiences and observations regarding the impact of 4.0 digital technologies on current entrepreneurial pedagogy and their aspirations for future entrepreneurial pedagogies.

Table 6. 8 Interview responses on the Entrepreneurship Pedagogical Framework

Participant	Interview extracts
AM1	*"I have noticed that these digital technologies seem to have accelerated the pace of learning, enabling us to cover more content in less time. We can now provide our students with the latest developments in the entrepreneurship domain, such as new business models and changing market trends in real-time. To add more, we are no longer limited to a single mode of instruction as we can now offer a range of multimedia content, such as videos, podcasts, and*

	interactive games, to make learning more engaging and effective. Personally, I am yet to learn other modes of instruction.
AM2	*"In my view, there is a pressing need to move away from solely learning about technology and instead prioritise the development of practical skills related to working with technology. This shift in pedagogical focus can bring more depth and relevance to our teaching methods. As lecturers, we strive to comprehend these concepts at a granular level to know exactly how they function within various contexts. I believe integrating technological tools into our environments enables us lecturers and nurtures students' creativity while equipping them for future success in an increasingly digital world."*
AM3	*"As much as I am aware of the impact digital technologies have on EE, the transformation of EE is not as easy as people might think…it is a process. However, I admit that we might lag behind as technologies grow exponentially and our teaching strategies grow progressively. Also, I believe the current pedagogical guidelines only scratch the surface of what is possible with digital technologies in EE, leaving us struggling to create effective curricula."*
AM4	*"These technologies have transformed our pedagogy by offering new avenues for learning entrepreneurship beyond traditional classroom methods. We can now use case studies and online resources to give our students a comprehensive understanding of entrepreneurship. I would also like to add that online forums, webinars, and social media platforms have revolutionised how we interact with our students and share knowledge. We can now connect with them regularly, provide them with live feedback, and create a sense of belongingness in the community."*
AM5	*"With 4.0 digital technologies, we can now engage our students in collaborative learning activities, where they can participate in team projects and share their ideas in real-time. This has helped foster a sense of community among our students and promote critical thinking skills. However, with the advent of digital technologies, we face ethical considerations, such as cybersecurity, data privacy, and responsibility towards our students. We must be aware of these critical issues and encourage our students to pursue ethical entrepreneurship practices."*
AM6	*"Digital technologies have transformed the landscape of EE, allowing us to broaden our reach, collaborate with global partners, and create innovative, multi-disciplinary programs. As lecturers, we must adapt to this rapidly changing environment, embrace innovation, and continue improving our teaching practices. Personally, incorporating these 4.0 digital technologies into my daily routine can be challenging, but I use them mostly for my administrative tasks. It makes some of the processes easier to deal with".*

AM7	*"I believe the curriculum is relevant, but we can do so much more. It is not enough to simply acknowledge the existence of digital technologies in fourth industrial era - we must actively incorporate them into our teaching and learning methods. Considering the speed of technological advancements worldwide, we continuously need to evolve our curriculums regularly to reflect these changes accurately. Another case is that in as much as our curriculum is relevant, I think there might be inadequate pedagogical guidelines for digital technologies in EE, leading to a fragmented approach to incorporating technology, therefore fragmenting the learning experience for students."*
ES1	*"Sometimes I feel lecturers are not abreast with the latest technologies we currently use at the present moment, or it might be a case of them not willing to try these technologies. They seem to be stuck in traditional lecturing, which is not stimulating to some of us."*
ES2	*"So far, I have not seen much change regarding the way lecturers teach us, considering that most students, if not all, now use mobile devices and are socially connected. I would be glad to see systemic shifts where lecturers focus on the digital tools used to accomplish a task rather than the outcome".*
ES3	*"Incorporating digital technologies into EE has made the learning experience more dynamic, but there is still a need for hands-on experience outside of the classroom and a more interactive and engaging curriculum to keep students motivated."*
ES4	*"The current pedagogy framework is often too focused on the theoretical concepts of entrepreneurship, but I believe the 4.0 digital technologies offer us a way to bring more real-life cases into the classroom."*
ES5	*"I believe the content we learn does not apply to real-world situations… I need to understand more about the links between what I study in class and how it practices in real situations".*
ES6	*"I am aware that the digitilisation phenomenon is causing various implications through rapid and transformative changes to entrepreneurial activities, but I need to understand, for example, how I can use AI to identify market opportunities or how big data can enhance the quality of my business decisions".*
ES7	*"I feel confident talking to my lecturer and discussing ideas through digital platforms such as social media and MS Teams/Zoom. Having a lecturer listening to my ideas and giving feedback through other digital platforms makes me think differently and deal with the approach differently". The current learning management systems (LMS) are not interactive enough and are a bit outdated for stimulating our creativity".*
ES8	*"It is so crazy how AI has disrupted almost every aspect of human life. However, in terms of how our lecturers teach us…I have not felt much difference. Seeing*

	our entrepreneurship course aligning with such digital disruptions would be good".
ES9	*"I enrolled on the programme with the mindset that I could easily apply what I learned in class, but to my surprise, I feel that our curriculum is just theoretical. For instance, I do not understand how I can apply digital technologies in opportunity identification. Now that we are in the 21st century, lecturers should be able to practically teach us how to leverage these 4.0 digital technologies in entrepreneurship".*
ES10	"*Digital technologies have facilitated seamless networking, with opportunities to connect with entrepreneurs, advisors, and investors through social media platforms."*

6.8.1 Conventional teaching methods

The study found that faculty members mainly use 4.0 digital technologies, such as MS Teams/Zoom, to support virtual lectures and presentations on digital platforms. Faculty members tend to focus on lecturer-focused expository teaching rather than on participatory and collaborative didactics. These findings align with other recent studies suggesting that while 4.0 digital technologies are essential for educational transformation, they alone will not transform didactics (Díaz-Barriga, 2021). Simply adding technology to traditional lecture-based courses is unlikely to improve students' mindsets significantly. Therefore, successful technology integration necessitates faculty members' training, support from institutions, and incentives to encourage the adoption of teaching methods that prioritise student engagement. Hence, this study's findings agree with Reich's, (2020) findings which show that digital technologies enable but do not automatically revolutionise pedagogy. Moreover, the findings further support the findings of Mohamed-Hashim, Tlemsani & Matthews, (2021) who argued that using digital technologies as add-ons to traditional teaching practices does not necessarily transform pedagogical approaches. It can thus be suggested that the capacity for entrepreneurial pedagogy transformation is contingent on the faculty members' decisions and institutional support regarding their implementation.

Based on a thorough analysis of interview extracts from a diverse group of student participants, ES1, ES2, ES4, ES5, ES6, ES7, ES8, and ES9, as presented in Table 7.3, a significant and alarming disparity has emerged concerning the integration of theoretical knowledge with practical learning experiences within EE. These findings

indicate that conventional teaching methodologies dominate the EE landscape at the institutions under investigation. Consequently, the research outcomes revealed notable dissatisfaction among many student participants, including ES2, ES5, ES6, ES8, and ES9, regarding the current instructional practices in EE. They express their disappointment with the prevailing approach, which they believe falls short of providing them with ample opportunities to enhance their skills by utilising advanced 4.0 technological tools and applications.

The study's findings indicate that utilising conventional teaching methodologies may inadvertently restrict students' exposure to authentic, real-world entrepreneurial scenarios, thus hindering their ability to apply their acquired knowledge effectively. These findings corroborate the viewpoints of Weng, Chiu and Tsang, (2022), who stressed that students' ability to apply entrepreneurship in real-world settings is inhibited by the overreliance on theoretical learning without practical engagement. A possible explanation for this deficiency in students' exposure to real-world technological settings could stem from a fundamental disparity between faculty members and students, commonly referred to as the generational gap in their relationship with technology. Faculty members often self-identify as "digital immigrants" as they are familiarised with technological advancements later in life. At the same time, students widely recognise themselves as "digital natives," having raised up alongside these innovations and exhibiting greater inherent comfort and fluency in their utilisation (Prensky, 2001). An understanding of potential pedagogical enhancements and didactic renewal to better address the needs of students who aim to bridge the theoretical knowledge and real-world application gap is critical.

An important finding emerging from this research is that despite the educational advantages of 4.0 technologies, many EE faculty members do not regularly integrate them into their teaching practices. According to this finding, the researcher can deduce that some EE faculty members use technology sporadically or inconsistently rather than incorporating it systematically into their pedagogical methods. These findings are in accord with recent studies of Lavicza et al. (2022), indicating that academic practitioners do not embrace integrating digital technologies in their pedagogy. Instead, they tended to use these technologies occasionally and irregularly. Some of the issues emerging from this finding relate specifically to the gap between the

potential educational advantages brought by 4.0 digital technologies and their actual utilisation by EE faculty members. The data suggest a mismatch between these innovation capabilities and their implementation in EE academic settings.

Additionally, future research should explore effective forms of support and training to enable faculty members transition towards a more consistent and integrated use of digital platforms and tools across their courses. This study raises concerns about the EE faculty's limited utilisation of available teaching technologies. Consequently, there is a growing impetus for curriculum reform to adapt and align with the demands of the 21st-century era. The following section discusses the findings in the context of curriculum reform.

6.8.2 Curriculum Reform

The study found that EE at the institution under study has the potential to undergo a profound pedagogical transformation, particularly when experiential learning is integrated into the curriculum. By providing students with a curriculum that engages in hands-on experiences and actively participates in developing digital skills, they can gain an authentic understanding of what it takes to succeed as students in the digital entrepreneurial landscape. In light of this, HEIs can facilitate this process by inviting successful local and international entrepreneurs to deliver guest lectures and share their insights with students. This practice enhances student engagement and promotes contextual learning through interactive exchanges in real-world scenarios. One unanticipated finding was that the current curriculum neglects how entrepreneurial processes and 4.0 digital technologies interact and shape each other. Hence, some authors have speculated that the curriculum should adopt 4.0 digital technologies content to develop new forms of entrepreneurship that move beyond the conventional institutional boundaries, networks, and entrepreneurship ecosystems (Huang, Henfridsson, Liu, & Newell, 2017). This requires EE to implement technologically based curriculum reforms grounded in AI-powered platforms, big data technologies, and cloud technologies to achieve this. For instance, utilising VR and AR platforms as immersive technologies can provide students with simulated environments to explore and engage in entrepreneurial activities beyond the limitations of physical boundaries. By adopting such advancements, EE effectively

adapts to the evolving demands of the digital era and equips students with the skills and knowledge necessary to thrive in an entrepreneurial landscape driven by technological advancements.

Another finding reveals a significant discovery indicating that the absence of comprehensive pedagogical guidelines contributes to faculty members' inability to adopt 4.0 digital technologies in EE. These findings confirm Ng'ambi's (2013) study, which expounded shortcomings in formal pedagogical guidelines for integrating digital technology into teaching methods among educators. This deficiency hinders several faculty members from implementing these technological advancements such as big data technologies and VR. This deficiency impedes the implementation of a structured and strategic approach to technological integration by several faculty members, therefore, yielding impaired pedagogical justifications for its application. Therefore, curriculum reform through a digital-based approach facilitates EE to align their teaching and assessment methods and learning outcomes with the evolving demands of the upcoming digital economies. With the increasing importance of digital competencies and adaptability in today's educational landscape, the focus on project-based learning has become more paramount, replacing the iterative learning approaches of the past. As the researcher delves into the next subtopic, exploring the realm of technologically enhanced learning is crucial, recognising its potential to further empower students in the face of a rapidly evolving entrepreneurial environment.

6.8.3 Technology-enhanced learning

The current study underscored a notable gap in adopting 4.0 digital technologies. This gap existed between proactive students and faculty members who actively engage in the creation, design, construction, exploration, and collaboration of these technologies in contrast to those who passively consume them. The findings highlight the pressing need for more profound deliberation on effectively integrating 4.0 digital tools into EE. The evidence from this study suggests that it is essential to prioritise interventions that promote profound technological engagements. These interventions should go beyond passive consumption and emphasise active participation and hands-on applications. The present findings align with earlier research conducted by Greenhow, Graham, and

Koehler (2022), who demonstrated that the future of learning necessitates an emphasis on active, experiential learning facilitated by 4.0 digital technologies.

Additionally, Greenhow et al., (2022) contend that students must be able to effectively utilise technology in problem-solving, knowledge creation, and collaborative endeavours. Neglecting to address these issues inevitably perpetuates passive technology usage patterns among faculty members and students, posing significant obstacles to advancing innovative teaching and learning practices across diverse disciplines. Consequently, it is imperative to address this knowledge gap and foster an environment that encourages the active utilisation of technology, empowering faculty members and students alike to embrace novel approaches to entrepreneurship. Thus, HEIs can better equip their stakeholders to navigate the rapidly evolving digital landscape, thereby propelling progress and innovation in the field of entrepreneurship.

The study uncovered a remarkable finding, despite the extensive accessibility of digital mobile devices and connectivity, it is impossible to assume that participants possess genuine opportunities for enriching EE experiences. Acknowledging that mere possession of technology does not automatically translate into acquiring comprehensive digital competencies. Neglecting to embrace these innovative 4.0 digital tools hampers progress and advancement within the EE domain, highlighting a fundamental disconnect between conventional teaching methods and the capabilities offered by contemporary technology. To effectively tackle this issue, it is imperative to investigate the underlying causes of resistance or ignorance and develop comprehensive strategies that facilitate the meaningful integration of 4.0 digital resources in EE.

Finally, the study's findings revealed a notable transformation in the dynamics between faculty members and students in academic settings due to integrating digital tools, such as online forums, webinars, and social media. This integration has fostered a sense of camaraderie among academics and students while concurrently improving crucial communication and collaboration skills. Although previous research by Lubis (2019) has made significant strides in unearthing the role of EE in shaping entrepreneurial ecosystems through digital platforms, participants in the study

expressed reservations regarding the credibility and maturity of EE in harnessing digital opportunities for students and faculty. Shifting the focus to modern teaching methodologies, it is crucial to investigate how these strategies have been adapted to incorporate digital resources and the evolving requirements of faculty members and students.

6.8.4 Contemporary pedagogies

The empirical findings presented in this study contribute to the comprehension of current entrepreneurship pedagogies by offering novel and innovative approaches to EE that extend beyond the conventional lecture-based method centred on theoretical concepts. This allows entrepreneurship faculty members to re-evaluate their conventional teaching techniques in light of recent technological advancements. Consequently, this reevaluation enables the development of novel pedagogical methodologies that align with the demands of the modern entrepreneurial landscape. Therefore, this study supports the findings of Solé-Blanch (2020), who posited that technology in education has emerged as the most potent tool for reshaping pedagogical paradigms.

6.9 Critical interpretive of findings and discussions on Theme 1

This study draws upon participant interviews, yielding invaluable insights into the transformative effects of 4.0 digital technologies within EE. The compelling interview extracts presented in Table 7.3 shed light on the perspectives of faculty members AM2, AM3, and AM6, who readily recognise and embrace the profound impact of these technological advancements on pedagogy. However, despite the notable progress made in leveraging technological innovations to enhance EE experiences, a prevalent concern among most students persists regarding the existing pedagogical approaches employed, as revealed by the viewpoints expressed by ES1, ES2, ES3, ES4, ES5, ES6, ES7, ES8, and ES9. These students articulated their dissatisfaction with current educational policies that exhibit limitations regarding the depth and breadth of their integration of 4.0 digital technologies in entrepreneurial pedagogy.

The researcher unearthed critical findings illuminating the intricate relationship between technology’s exponential growth and human adaptability, aligning

institutional entrepreneurship with pedagogical readiness. Firstly, the research unequivocally confirms the exponential trajectory of technological advancement, mirroring the consensus in existing literature (Elia, Margherita, Ciavolino & Moustaghfir, 2021). Secondly, it contrasts this exponential growth with the linear nature of human adaptability, emphasising the significant challenges posed by the delay in keeping pace with technological developments. Notably, the researcher underscores the pivotal importance of aligning the pace of technological disruptions with entrepreneurship pedagogical preparedness, highlighting the crucial role EE need to play in bridging this gap. Interestingly, the most striking finding is the emergence of a widening rift between technology and faculty members who face mounting pressure to stay abreast of the exponential technological wave. As discussed, these findings underscore the urgency of adapting EE strategies to navigate the challenges posed by the ever-evolving technological landscape and ensure that students are adequately equipped to thrive in this dynamic entrepreneurship ecosystem.

The findings also indicated that the exponential growth of technology vastly outpaces the linear capacity of EE to adapt, leaving faculty members unprepared to provide students with the necessary skills and perspectives to thrive in a radically changing entrepreneurial technological landscape. Hence, EE actors must accelerate their evolution and readiness for technological singularity. Therefore, the study emphasises the need for a coordinated effort to bring EE and 4.0 digital technologies into closer synchronisation with the actual developmental timeline of emerging technologies. Addressing this growing gap requires innovative pedagogical thinking and agile frameworks capable of responding dynamically to technological disruption.

By aligning with the themes identified in Figure 7.3, which were developed during the rigorous data analysis stage, the subsequent section further expounds upon the summary of the key findings derived from the initial research objective.

6.10. Summary of the key findings of Theme 1

- The impact of 4.0 digital technologies on EE is acknowledged, but students' express apprehensions about the current limitations of their integration into teaching methods.

- Exponential growth in technologies is outpacing the linear capacity for EE faculty members to adapt, leaving them unprepared to provide students with the necessary skills.
- There is a pressing need to align the pace of technological advancement with readiness for entrepreneurial pedagogy.
- Conventional teaching methods dominate EE, focusing on lecture-based expository teaching rather than participatory and collaborative approaches. This results in discontent among students regarding missed opportunities to enhance their skills using 4.0 digital technologies.
- Despite the availability of these tools, most faculty members do not regularly integrate 4.0 technologies in their teaching. There is a mismatch between potential and actual implementation.
- Curriculum reform that integrates experiential learning, hands-on digital skills development and content on how entrepreneurial processes and technologies interact is required.
- There is a gap between passive consumption and active engagement with 4.0 technologies. Interventions that promote deep technological engagement are therefore critical.
- Mere access to technology does not translate into high-quality EE. Integration of 4.0 technologies into pedagogy remains a vital issue.
- Contemporary pedagogies that move beyond lecture-based teaching towards more innovative approaches aligned with the digital era are emerging.

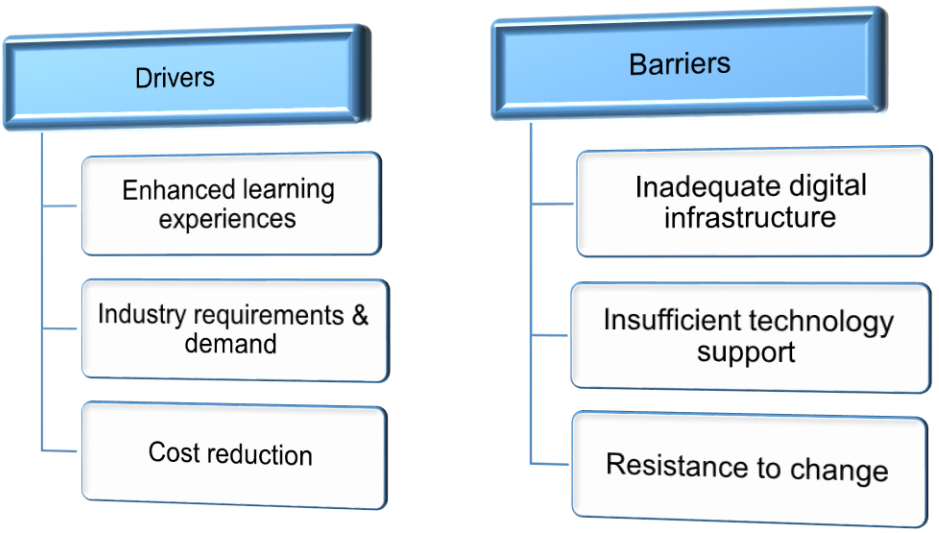
The key finding is that while 4.0 digital technologies hold potential, issues persist regarding their integration into entrepreneurial pedagogy. Curriculum reform, faculty member training, institutional support, and incentives are needed to transform conventional pedagogies and leverage 4.0 technologies more actively and effectively.

6.11. Theme two: Tech Embracing Transformation

The second theme of this study comprised of two primary components: barriers and drivers. To provide a comprehensive analysis, the researcher explored the underlying nature of these components. First, the researcher delved into a deeper understanding of barriers encompassing various factors or circumstances that impede the adoption of

4.0 digital technologies. On the other hand, drivers pertain to factors that motivate individuals to embrace 4.0 digital technologies.

Figure 6. 4 Summary of the research theme and sub-themes for the adoption of industry 4.0 technologies



This section discusses the most significant barriers and drivers for embracing digital transformation within EE. The data on barriers and drivers are evaluated for the current and near future because these indicate how participants could shift towards the future digital transition. The section addresses Research Question 2: **What are the barriers and drivers towards adopting Industry 4.0 and digital technologies?** The findings from the semi-structured interviews also provide verbatim quotes/extracts (see Table 7.4) for the questions asked in the interviews. The interview transcripts from each participant were apportioned into two sections. The first section comprises barrier responses, and the second consists of driver responses.

Table 6. 9 Interview responses regarding the barrier and drivers

Participant	Interview Extracts
AM1	*"The inadequate digital infrastructure on our campus affects both students and faculty. It hampers our ability to provide a seamless digital learning experience and limits the potential of EE. Slow internet and outdated hardware restrict our ability to explore and utilise these technologies effectively."*
	"As senior lecturers, we must know the importance of evolving digital skills and knowledge in today's job market. This is a major driver for us to adopt 4.0 digital technologies in our teaching practices."

AM2	*"As a faculty member, I sometimes hesitate to try new teaching and learning methods, making implementing these latest digital technologies in the classroom difficult. However, I believe that if I approach these changes with an open mind and a willingness to explore new approaches to teaching, I can offer our students a more rewarding educational experience".* *"With the growing demand for digital skills in the job market, we must stay updated and adopt 4.0 digital technologies in our teaching practices. This will enhance our students' employability and help us remain relevant in the ever-evolving entrepreneurship landscape."*
AM3	*"…This could be two-fold. I recognise that as lecturers, we may have limited technical skills and knowledge, but with the proper training and support, we can overcome this barrier and effectively leverage 4.0 digital technologies to enhance our students' learning experiences; sometimes it is rampant technical issues associated with technologies make it challenging to adopt more 4.0 digital technologies."* *"I believe if we are to integrate digital technologies fully, we will be able to provide an enhanced learning experience for our students. Students can immerse themselves in realistic entrepreneurial scenarios through interactive platforms, online resources, and virtual simulations, making learning more engaging and practical."*
AM4	*"If technology is forced down our throats, then the institution will likely face resistance. I should be willing to use a particular technology. Playing catch up with technology is tough…humans learn progressively while technology progresses exponentially, making it challenging to adopt these 4.0 digital technologies in entrepreneurship".* *"However, I believe that improved communication and collaboration are essential to effective teaching and learning. By leveraging advanced digital technologies, we can create a more connected and engaged learning environment that fosters collaborative learning and enhances our students' learning experiences."*
AM5	*"I believe the delays caused by the technical support in resolving technical issues might suggest issues with our digital infrastructure, or it might be an issue of insufficient digital skills. Considering all this, it will be challenging for us, the faculty members, to successfully adopt digital technologies in our lectures".* *"Artificial intelligence can be a vital tool for optimising our processes and maximising efficiency, leading to cost reductions and increasing our productivity. AI can help us automate repetitive tasks and make better-informed decisions."*
AM6	*"As an academic member, I personally feel that I should be able to choose which type of technology I should use in my lectures. Technology adoption should not be some form of dictatorship where we are forced to use a particular software/technology. I*

	should be at liberty to prefer the particular technology that I like. There is no way we can keep up with ever-progressing technology. If the current one works for me, why should I change and adopt the latest?".
	"I think these digital technologies empower students and us to experiment and innovate in a risk-free environment. Through prototyping tools, virtual collaboration platforms, and online marketplaces, we can test business ideas, receive feedback, and refine concepts."
AM7	*"From my experience as an entrepreneurship student, I strongly feel that insufficient technological support is one of our prime obstacles. Adapting to the rapidly changing digital world is tough without enough resources to equip us with the necessary technical skills. It is detrimental to our learning experience, and I hope our university can take necessary actions to improve the situation.".*
	"I recognise that change is inevitable and that as lecturers, we need to remain receptive to new ideas and invest in our professional development to stay up-to-date with the latest advancements and best practices in entrepreneurship education."
ES1	*"I feel that a major barrier to adopting 4.0 digital technologies is the cost associated with purchasing and maintaining these technologies. As students, we may not have the financial resources to access these technologies and benefit from their potential impact on our learning experiences."*
	"I think industry requirements and demand are key drivers in adopting 4.0 digital technologies. To remain competitive in today's marketplace, we must leverage the latest technologies to stay ahead and meet evolving entrepreneurial landscape demands."
ES2	*"Sometimes, not being fully up to date with tech can be a bit of an obstacle when trying to make the most out of digital advances. However, getting extra guidance and training could help us level up our game and create more exciting learning ways."*
	"Yes, using technologies such as virtual reality and gamification can make learning more engaging and immersive. This can lead to greater retention of knowledge and skills."
ES3	*"I believe there is a lack of emphasis on digital skill-building in traditional entrepreneurship education programs, which may hold students back from fully leveraging the potential of 4.0 digital technologies in their entrepreneurial pursuits."*
	"With data analytics and AI, we can make more informed decisions based on real-time data and insights. These technologies can help us get insights and take action sooner than others, leading to improved entrepreneurial outcomes."

ES4	*"I find it challenging to embrace new digital technologies because I am more comfortable with traditional methods. It is hard to break away from what I am used to."*
	"Increased collaboration and networking can help entrepreneurs connect with mentors, investors and other key stakeholders. Digital technologies such as social media can make these connections more accessible and help us build valuable relationships."
ES5	*"The inadequate digital infrastructure at our institution hampers our ability to utilise 4.0 digital technologies fully. Slow internet, outdated hardware, and limited access to necessary software impede our learning experience".*
	"Digital technologies have opened up a world of opportunities for students like me. By leveraging social media and other digital platforms such as Zoom/MS Teams. I can reach other people in the entrepreneurship ecosystem not only locally but also on a global scale, expanding my entrepreneurship knowledge"
ES6	*"I struggle with insufficient technology support. Navigating complex digital tools and platforms is difficult without proper guidance and training. I wish more resources were available to help us overcome these challenges."*
	"In my own experience, adopting 4.0 digital technologies in EE has been instrumental in cost reduction. By leveraging online resources and digital platforms, I no longer need to spend money on expensive textbooks or physical learning materials. This saves me money and ensures I can access up-to-date and diverse educational materials."
ES7	*"I can attest to the challenges we face in optimising our use of digital learning tools due to slow internet speeds and outdated hardware components. It is frustrating when we can't access software applications from certain locations on campus, which can hinder our ability to complete assignments and access course materials efficiently. These barriers impact our learning experience and negatively affect our performance and progress. Our institution must invest in quality digital infrastructure to support us and ensure equitable access for all students."*
	"Digital technologies have opened up a world of possibilities for me in EE. Connecting with global entrepreneurial communities and accessing online resources has broadened my network and gained insights from experienced entrepreneurs and mentors worldwide. This exposure to diverse perspectives and cultures has expanded my entrepreneurial horizons and provided me invaluable collaboration and partnership opportunities."
ES8	*"Ineffective use of digital technology due to insufficient technological support is a significant concern for me. We need access to high-quality resources and technologies*

	to apply our theoretical knowledge and skills. It is frustrating when we lack the tools and infrastructure to execute our ideas effectively."
	"What excites me most about adopting AI or digital platforms in EE is the enhanced learning experience they provide. Traditional lectures and textbooks can sometimes feel detached and monotonous. However, I can engage in dynamic and interactive learning experiences through AI technologies and digital platforms."
ES9	*"I think potential cultural barriers to adopting 4.0 digital technologies in some entrepreneurship education programs, where certain technological advancements may not be embraced due to cultural beliefs or preferences."*
	"Regarding moving with times, AI and digital platforms offer practical solutions. For example, online platforms like LinkedIn provide opportunities to connect with industry professionals, join relevant entrepreneurship communities, and stay updated with the latest trends and demands. Additionally, AI-powered analytics tools can help me gather insights from market data, consumer behaviour, and competitor analysis."
ES10	*"I have experienced first-hand how slow internet speeds and old hardware can create significant obstacles in our learning experience. It is frustrating when essential activities like accessing online resources, collaborating virtually, and utilising interactive platforms become difficult and time-consuming. These challenges not only impact our productivity but also affect the quality of our education. The presence of outdated hardware, such as computers and devices with limited processing power and storage capacity, only worsens these challenges. It's essential for educational institutions to provide the necessary technological infrastructure to support digital learning and ensure a seamless and effective learning experience."*
	"As an aspiring entrepreneur, I understand the importance of having the right skills and knowledge to succeed in business. By learning big data tools and techniques, I am better equipped to meet industry requirements and demands and ensure my future career success."

6.11.1. Inadequate digital infrastructure

The impact of inadequate digital infrastructure on successfully implementing 4.0 digital technologies in EE emerged as a significant sub-theme from the interviews. This section provides a detailed and comprehensive account of the challenges an insufficient digital infrastructure poses and its effects on students and faculty members. The analysis of the interviews indicated a shared concern among the participants regarding deficiencies in the digital infrastructure within EE. These

deficiencies not only present obstacles to the effective utilisation of 4.0 digital technologies but also hinder the ability of faculty members to advance their pedagogical approaches adequately. Participants in the study, including AM1, ES5, ES7, and ES10, expressed their concerns about slow internet speeds, outdated hardware components, and the unavailability or inaccessibility of certain software applications in specific areas of the campus. These findings align with previous studies, highlighting similar challenges in EE. For instance, Lubis (2019) emphasised the significant challenges faced by EE in shaping entrepreneurial ecosystems because of the unaffordable and unreliable high-speed broadband infrastructure. The researcher identified these factors as significant inhibitors impeding the optimised use of digital learning tools.

A possible explanation for these findings could be the absence of a clear digital foresight, insufficient capabilities, and inadequate commitment towards meaningful implementation of digital strategies within EE. This infrastructure discrepancy could be attributed to the incapability HEIs in embracing these cutting-edge technologies. Achieving this could involve developing investment plans focused on acquiring state-of-the-art equipment aligned with current needs and ensuring the availability of adequate technical support throughout the entire usage cycle. By doing so, HEIs can establish a solid foundation for successful implementation in the future.

6.11.2 Insufficient Technology Support

A substantial portion of the participants (AM3, AM5, AM7, ES2, ES6, ES7, ES8 & ES10) highlighted the lack of adequate technological support as a significant obstacle in their EE experience. Furthermore, inability to access updated software, hardware, and other tools provided by their respective faculties negatively affected their ability to apply 4.0 digital technologies in EE.

The findings from this study highlight a significant concern expressed by many participants regarding the utilisation of 4.0 digital technology in their EE experiences. Specifically, students identified insufficient technological support as a primary obstacle in effectively applying these 4.0 digital technologies. Despite being equipped with theoretical knowledge of technological advancements, students face challenges

regarding practical implementation owing to limited resources and guidance (Akram, Abdelrady, Al-Adwan & Ramzan, 2022). Moreover, students are often frustrated by the absence of practical training opportunities, as the discrepancy between abstract theories and practical implementation hinders their advancement. This disharmony between theoretical knowledge and real-world application could be due to a potential misalignment between educational curricula and industry requirements (Lackéus, 2015). As a result, the rapid pace of technological advancements compounds this issue, exacerbating the situation.

A comprehensive approach that engages academia and industry is imperative to tackle the pressing issue of insufficient technological support that hinders students' utilisation of 4.0 digital technology in EE. This approach could entail regular revision and updating of curricula by EE to keep pace with the rapid technological advancements. Moreover, fostering partnerships and collaborations between academia and entrepreneurs can facilitate the exchange of knowledge and resources, ensuring students have access to the latest technological advancements (Padilla-Meléndez, Del Aguila-Obra, Lockett & Fuster, 2020). By addressing the lack of adequate technological support, HEIs can equip students with the necessary practical skills and tools, enhance their learning experiences, and better prepare them for future entrepreneurial endeavours in an increasingly digitised world. However, despite its potential benefits, technological advancements in HE are often met with resistance to change.

6.11.3 Resistance to change

Successful implementation of 4.0 digital technologies in EE is impeded by several barriers as revealed by the study, primarily stemming from the resistance to adopting new methodologies. This insight sheds light on EE's challenges when fully embracing these emerging 4.0 digital technologies. Consequently, there is an urgent need for proactive initiatives to create a supportive environment that effectively addresses and overcomes such barriers associated with resistance to change.

Further findings from the study indicated that comfort and familiarity with conventional approaches reinforced by potential cultural barriers were significant impediments in

the adoption of 4.0 digital technologies. Faculty members' reluctance to change could be attributed to their comfort zone with traditional teaching and learning approaches, therefore impeding the use of advanced digital tools and platforms. In addition, insufficient exposure to 4.0 digital technologies, technophobia and concerns about the efficacy of digital resources were other aspects revealed by the study that led to the resistance to change. This aligns with the study by Sajdak and Młody (2023) which showed that rejection or avoidance of technology led to the resistance to change. A culturally responsive approach is imperative to overcome obstacles influenced by culture while aligning digital learning experiences with cultural values. Considering this, it is essential to engage stakeholders from different cultural backgrounds and promote cultural awareness among faculty members and students.

After a comprehensive analysis of the primary barriers identified in the study, the researcher's attention now shifts towards exploring the drivers that facilitate the adoption of 4.0 digital technologies. By conducting an in-depth examination of these factors, the researcher aimed to enhance understanding of how they effectively enable and empower faculty members and students to embrace 4.0 digital technology as an instrument for teaching and learning purposes.

6.11.4 Enhanced Learning Experiences

This section presents the findings and discussion of the study, which aimed to explore enhanced learning experiences as significant drivers of 4.0 digital technologies in EE.

The ability of digital platforms like Ms Teams, Zoom, social media and Google Meet facilitated an extensive channel for connecting students with the global network as revealed by the study. Thus, online platforms have a remarkable impact on students' horizons as they facilitate interaction with seasoned entrepreneurial experts by participating in webinars and engaging in virtual mentorship programs as exemplified by ES4, ES5, and ES7. This exposure to the global network enables a far-reaching understanding of multifaceted markets while considering the different cultural values and norms that shape entrepreneurial theory and practices, further enriching students' perspectives. Consequently, endowing students with invaluable insights and essential connections to fortify their breakthroughs within the entrepreneurial ecosystem

influenced by technological dynamics. These findings corroborate the ideas of Zhang, van Gorp & Kievit, (2023) that show the level of digital technology is positively associated with entrepreneurial ecosystems and this positive relationship is strengthened in nations with a supportive culture, high-quality institutions, networks and technological advancement.

6.11.5 Industry requirements and demand

This section analyses the findings and subsequent discussion derived from the participants' feedback, explicitly focusing on the role of ever-evolving industry requirements and demand as drivers for adopting 4.0 digital technologies. The study recognised the importance of staying abreast of the evolving demands within the industry as a motivating factor behind integrating these digital technologies. By addressing the dynamic needs of the industry, the adoption of 4.0 digital technologies can effectively equip EE with the tools and resources necessary to prepare students for the challenges and opportunities they encounter in the business world.

The recognition by participants' AM1, AM2, AM7, ES1, ES9, and ES10 of staying abreast with industry requirements emphasises the need for EE to incorporate 4.0 digital technologies to bridge the gap between academia and industry. Additionally, students' interest in practical learning experiences reflects their understanding of the importance of hands-on skills in the job market. Therefore, adopting 4.0 digital technologies such as virtual simulations and gamification allow students to develop practical skills such as problem solving valued by industries. This aligns with Umachandran's (2022) observations, indicating that gamification encourages students to reflect upon and solve problems.

6.11.6 Cost reduction

The study's findings shed light on the significant role of cost reduction as a driving force for the adoption of 4.0 digital technologies in EE. Integrating these technologies provides cost-effective solutions to learning, effectively removing financial barriers that often impede students from accessing high-quality education. The student participants clearly recognised the value of 4.0 digital technologies in minimising the costs associated with learning resources, transportation, and course materials.

Participants ES1 and ES6 stressed cost reduction as a significant driver of 4.0 digital technology adoption. Instead of student purchasing expensive hard copies of textbooks usually aligned with conventional learning methods, they are now able to purchase soft copies of textbooks which are much cheaper. Furthermore, integrating 4.0 digital technologies facilitates the utilisation of digital platforms and online resources, which are often more affordable or accessible. By leveraging these resources, students can significantly reduce their expenses by accessing up-to-date and relevant educational materials (Ally & Samaka, 2013). Moreover, incorporating digital technologies into EE also mitigates transportation costs. On-campus learning typically requires students to commute to their educational institutions, which incurs transportation expenses.

By embracing 4.0 digital technologies, students can access educational content and engage in learning activities from the convenience of their homes or any location with an internet connection. Hence, the study's findings confirm those of prior studies, (Hussin, 2018; Oke & Fernandes, 2020; Alakrash & Razak, 2022) which indicated that digital technologies enhance convenience and accessibility for students in educational settings.

6.12. Critical interpretive of findings and discussions on Theme 2

The section presents a critical analysis of the findings, focusing on the implementation and assimilation of 4.0 digital technologies in EE. Through thoroughly examining these extracts, several overarching themes surfaced: deficient digital infrastructure, inadequate technological support, and resistance to change, which presented notable challenges in adopting 4.0 digital technologies in EE. Moreover, the findings underscored the driving forces behind this adoption, including enriched learning experiences, fulfilment of industry requirements and demands, and cost reduction. The findings and discussion section were structured based on the key themes identified in the interview extracts to enhance clarity and organisation.

6.13 Summary of the Key Findings of Theme 2

- **Inadequate Digital Infrastructure**: This study found that insufficient digital infrastructure is a significant challenge in adopting 4.0 digital technologies in EE. Participants expressed concerns about slow internet speeds, outdated hardware components, and limited access to necessary software applications on campus. This lack of infrastructure hampers the utilisation of 4.0 digital technologies and the advancement of pedagogical approaches.
- **Insufficient Technology Support**: Participants, including faculty members and students, highlighted the lack of adequate technological support as a significant obstacle. They faced difficulties accessing the updated software, hardware, and tools needed for applying 4.0 digital technologies in EE. The gap between theoretical knowledge and practical implementation has hindered progress.
- **Resistance to Change**: The study revealed that resistance to new methodologies and technologies is a significant barrier to successfully implementing 4.0 digital technologies in EE. This resistance was attributed to comfort with traditional teaching methods, technophobia, reliance on established practices, and cultural barriers. Overcoming this resistance requires faculty development, digital literacy training, and a supportive environment encouraging innovation.
- **Enhanced Learning Experiences**: 4.0 digital technologies were found to enhance learning experiences in EE significantly. Students benefited from global connectivity and engaged with experts and peers worldwide through online platforms, webinars, and virtual mentorship programs. This exposure has enriched their perspectives and provided valuable insights into diverse markets and entrepreneurial practices.
- **Industry Requirements and Demand**: Participants recognised the importance of staying updated with evolving industry requirements, which motivated the adoption of 4.0 digital technologies in EE. These technologies help bridge the gap between academia and industry by equipping students with practical skills valued by employers. Practical learning experiences, including virtual simulations and gamification, are highlighted.
- **Cost Reduction:** Cost reduction has become a significant driver for adopting 4.0 digital technologies in EE. Participants acknowledged the cost-saving benefits of digital textbooks, online resources, and reduced transportation expenses. Digital

technologies offer more affordable and accessible educational materials, enabling students to learn from anywhere through an internet connection.

Overall, Theme 2 highlights the challenges and opportunities associated with integrating 4.0 digital technologies into EE, emphasising the importance of addressing infrastructure deficiencies, providing technological support, overcoming resistance to change, and leveraging the benefits of an enhanced learning experience, industry alignment, and cost reduction. The following theme explores the insights of faculty members and students regarding the adoption and utilisation of 4.0 digital technologies. This transition allows for a comprehensive understanding of the perspectives and experiences of faculty members and students in the EE, shedding light on their perceptions, challenges, and recommendations for incorporating these technologies into EE.

6.14 Theme 3: Insights on digital transformation

The third theme, shown in Figure 7.5, probes deeper into faculty members' and students' intricate and multifaceted perceptions and practices concerning the integration of 4.0 digital technologies in EE. The discussion on this theme centred on how participants perceived these technological advancements and examined their practices in real-world scenarios. The researcher gained more comprehensive understanding on the subject matter by scrutinising the interaction of faculty members and students with technology within EE setting. This crucial area deserves sufficient attention amidst today's rapidly evolving entrepreneurship landscape.

Figure 6. 5 Summary of research themes

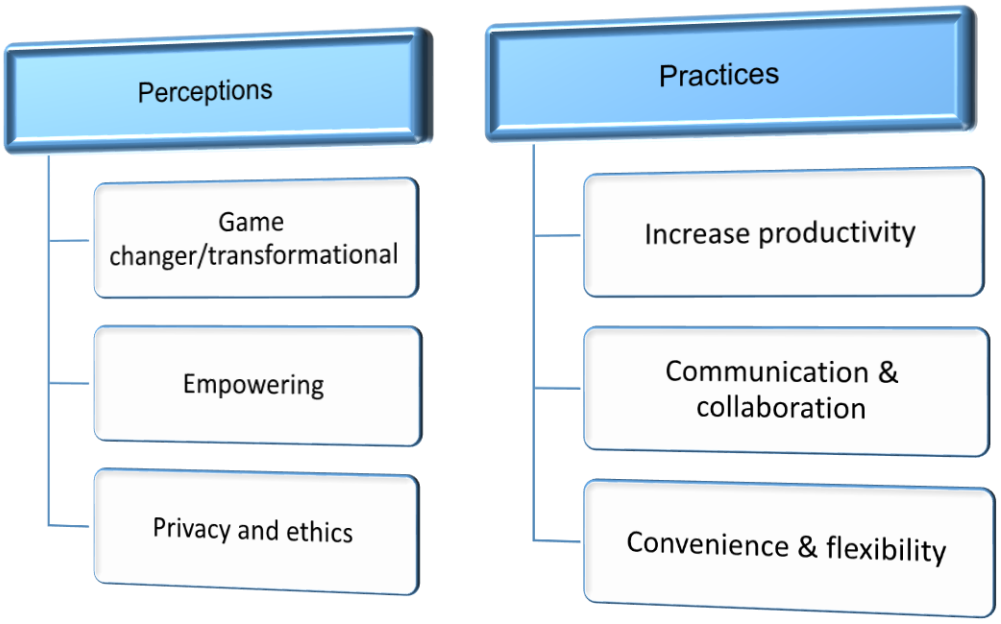


Table 6. 10 Interview responses on faculty members and students' insights

Participants	Interview Extracts
AM1	*"I firmly believe that adopting 4.0 digital technologies in entrepreneurship education is essential for preparing our students for the digital economy. By integrating these technologies into our practices, we can provide students with valuable skills and knowledge that will empower them to navigate the challenges of technological advancements and potential issues such as technological unemployment."*
AM2	*"From my perspective, embracing 4.0 digital technologies in entrepreneurship education allows us to create a dynamic learning environment that reflects the realities of the modern business landscape. By incorporating these technologies into our curriculum and teaching practices, we can equip our students with the skills necessary to leverage technology for innovation and address concerns surrounding technological unemployment through creative and sustainable entrepreneurial ventures."* *"I believe technology can be a powerful tool for good, but we must use it ethically and responsibly. Our responsibility is to ensure that our students understand the importance of upholding ethical standards and respecting privacy rights when adopting 4.0 digital technologies in entrepreneurship education. By emphasising the ethical use of technology, we can empower our students to make informed decisions and contribute to a positive and responsible digital ecosystem".*

AM3	*“Technologies are pertinent when transmitting and storing module material such as tutorial letters and assignments and communicating feedback. I have social media accounts like Facebook and Twitter, but hardly log in. Actually, I have forgotten some of my login credentials”.*
AM4	*"In my opinion, adopting 4.0 digital technologies in entrepreneurship education allows us as faculty members to bridge the gap between technological advancements and their societal impact. By incorporating these technologies into our teaching practices, we can encourage students to critically examine the consequences of digitalisation, including the potential for technological unemployment, and inspire them to develop innovative solutions that create value in a rapidly changing world."*
AM5	*“I understand that the fear of being replaced by technologies is a valid concern. Technological advancements and artificial intelligence have undoubtedly impacted various industries, including education. It is natural to worry about how these advancements might affect our roles as educators and whether our expertise and experience will still hold value in the face of automation and digitalisation”.* *“I think privacy and ethics should be at the forefront of our discussions surrounding adopting 4.0 digital technologies in entrepreneurship education. In today's interconnected world, we must equip our students with the knowledge and skills to navigate these technologies responsibly. By emphasising the importance of protecting personal information and making ethical choices, we can help shape the next generation of ethical entrepreneurs who prioritise the well-being and trust of their customers. Let us foster a learning environment where privacy and ethics are not just ideals but fundamental principles that guide our students' entrepreneurial journeys”.*
AM6	*“In my opinion, as long as the current systems are doing their job well, we shouldn't mess with them unnecessarily. After all, why fix what’s not broken?”* *“I believe social media is for the young and is a very informal way of communicating educational material. I personally use the LMS when posting any module material or relaying important information to the students. So, I do not use social media as it consumes my time unnecessarily and is addictive”.*
AM7	*“I appreciate the transformative potential of 4.0 digital technologies in entrepreneurship education. By emphasising practices and perspectives related to these technologies, we can prepare our students to navigate the complexities of the digital era, including concerns about technological unemployment. Through experiential learning and collaborative projects, we can cultivate an*

	entrepreneurial mindset that equips students to adapt, innovate, and create meaningful employment opportunities."
ES1	*“I firmly believe that integrating 4.0 digital technologies in entrepreneurship education equips us with the necessary tools to navigate the ever-changing business landscape. Through hands-on practices and a forward-thinking perspective, we can harness the power of technologies like artificial intelligence, data analytics, and automation to drive innovation, make informed decisions, and create sustainable ventures.”*
ES2	*"I see the adoption of 4.0 digital technologies in entrepreneurship education as a game-changer. It enables us to harness the power of online platforms, social media, and digital marketing strategies to reach a wider audience and promote our entrepreneurial ventures effectively. It opens up new avenues for growth and expansion."*
ES3	*“To be honest, if I'm getting things done efficiently in my work, there's no need to switch up my methods”.*
ES4	*"I see incorporating 4.0 digital technologies in entrepreneurship education as an enabler for inclusive and accessible learning. It removes geographical barriers, making education accessible to students from diverse backgrounds. It democratises entrepreneurship education and empowers aspiring entrepreneurs, regardless of their location or socioeconomic status."*
ES5	*"I strongly believe that embracing 4.0 digital technologies in EE is crucial for staying ahead in today's fast-paced business landscape. By practising and integrating these technologies into our learning experience, we can develop a competitive edge and enhance our understanding of the digital tools that drive modern businesses."*
ES6	*" I appreciate the emphasis on practising and embracing 4.0 digital technologies in entrepreneurship education. These perspectives allow us to explore the transformative power of technologies like cloud computing, big data, and cybersecurity. By understanding the implications and possibilities of these technologies, we can effectively navigate the digital landscape and make informed decisions for our entrepreneurial endeavours.*
ES7	*"I think adopting 4.0 digital technologies in EE nurtures our continuous innovation and disruption mindset. It encourages us to think outside the box, explore emerging technologies, and embrace entrepreneurial opportunities in sectors like fintech, e-commerce, and sustainable innovation”*
ES8	*“One practice that I think is important for me to adopt is to be proactive in seeking opportunities to use digital technologies. I can join online entrepreneurial communities, participate in virtual events, and use e-learning platforms to enhance my skills and knowledge. This way, I can leverage these technologies to my advantage and gain a competitive edge”*

ES9	*“as a student, I am enthusiastic about embracing 4.0 digital technologies in entrepreneurship education. By actively engaging with these technologies, applying them practically, collaborating with others, remaining adaptable, and considering ethical aspects, I aim to maximise my learning and prepare myself for the digital future of entrepreneurship”.* *“I have my personal laptop and a smartphone, which enable me to access my modules from anywhere as long as I am connected to the internet. I do not need to go to the campus. Most of my peers and I communicate via social media platforms such as WhatsApp and Facebook Messenger”.*
ES10	*"In my opinion, integrating 4.0 digital technologies in entrepreneurship education encourages experimentation and risk-taking. It provides a safe environment to test our entrepreneurial ideas through prototyping, virtual marketplaces, and online simulations. This hands-on experience allows us to learn from failures and iterate our business strategies for future success."*

6.14.1 Game changer/Transformational

According to the feedback from the interview, several participants, such as AM1, AM2, AM4, AM7, ES1, ES5, ES6, ES7, ES8, ES9 and ES10 acknowledged the potential for transformation that 4.0 digital technologies hold within the context of EE. They highlighted the importance of incorporating these technologies into the curriculum and teaching methods to prepare students with the necessary skills and knowledge to handle the digital era’s challenges and opportunities. This view is in line with studies that recognises the significant effect of Industry 4.0, highlighting the importance of HEIs in adjusting to these technological changes. According to Prifti, Knigge, Kienegger, & Krcmar (2017), Industry 4.0 marks a fresh era in the industrial revolution leading to major transformations in institutional activities and offering new opportunities and obstacles. Hence, HEIs must make it a priority to focus on EE so that students can be equipped with the necessary skills and mindset to succeed in today’s constantly changing digital environment (Nabi et al., 2017).

Participant ES2 emphasised the possibility of 4.0 digital technologies to enhance the scope and impact of entrepreneurial endeavours using online platforms, social media and digital marketing strategies. The idea is backed by studies that highlight the significance of digital technologies in improving business expansion, market reach and customer involvement (Taiminen & Karjaluoto, 2015). While participants ES6 and ES7

stressed the importance of 4.0 digital technologies in promoting innovation, disruption and continuous learning attitudes. This is consistent with the literature emphasising the significance of cultivating an entrepreneurial mindset and adopting new technologies to recognise and take advantage of fresh opportunities (Neck, & Corbett, 2018). Additionally, participant ES10 recognised the importance of incorporating 4.0 digital tools in EE to support experimentation, taking risks and continuous learning with the use of prototypes, virtual markets and online simulations. This interactive method is backed by educational theories that highlight the significance of hands-on learning and real-world implementation in cultivating entrepreneurial skills (Kassean, Vanevenhoven, Liguori, & Winkel, 2015).

6.14.2 Empowering

Several participants believed that integrating 4.0 digital technologies in EE can empower students and aspiring entrepreneurs. Participants emphasised how these technologies have the potential to make learning inclusive and accessible, democratise EE and equip students with the necessary digital tools and knowledge to navigate the digital landscape proficiently. Hence participant ES4 expressed that incorporating 4.0 digital technologies in EE serves as a facilitator for inclusive and accessible learning. It eliminates geographic obstacles, allowing students from various backgrounds to access HE. As such, it equalises access to EE and gives a boost to potential business owners, irrespective of their geographic location or their economic background. This viewpoint supports the idea that digital technologies have the potential to make education more accessible and empower individuals by giving them access to educational resources and opportunities that were once restricted or unavailable (Becker et al., 2018). Moreso,utilising digital platforms and online learning environments can assist EE expand its reach to a broader audience, promoting inclusive and fair access to knowledge and skills (Means, Toyama, Murphy, & Baki, 2014).

Participant ES8 emphasised the importance of being proactive in seeking opportunities to use 4.0 digital technologies, stating, “One practice that I think is important for me to adopt is to be proactive in seeking opportunities to use 4.0 digital technologies. I can join online entrepreneurial communities, participate in virtual

events and use e-learning platforms to enhance my skills and knowledge. This way, I can leverage these technologies to my advantage and gain a competitive edge. ”This sentiment resonates with the literature on the empowering potential of 4.0 digital technologies in enabling individuals to actively engage in their learning and professional development (Arquero & Romero-Frías, 2013). By leveraging online communities, virtual events and e-learning platforms, students and aspiring entrepreneurs can access a wealth of resources, networks and opportunities for skill development, ultimately empowering them to take control of their entrepreneurial journeys (Laal & Ghodsi, 2012). Furthermore, participant ES9 expressed enthusiasm about embracing 4.0 digital technologies in EE, stating, “As a student, I am enthusiastic about embracing 4.0 digital technologies in EE. By actively engaging with these technologies, applying them practically, collaborating with others, remaining adaptable and considering ethical aspects, I aim to maximise my learning and prepare myself for the digital future of entrepreneurship.” This response aligns with the literature on the importance of developing digital literacy and competencies in the 21st century (Ferrari, 2012). By actively engaging with 4.0 digital technologies, collaborating with peers, and considering ethical implications, students can develop the skills and mindset necessary to navigate the digital landscape effectively, empowering them to succeed in the digital economy (Sá & Serpa, 2020).

6.14.3 Privacy and ethics

Participants expressed concerns about privacy and ethical considerations surrounding the adoption of 4.0 digital technologies in EE. These concerns highlight the importance of addressing potential risks and fostering responsible practices in the integration of these technologies. Participant AM2 emphasised the need to ensure the ethical use of technology, stating, “I believe technology can be a powerful tool for good, but we must use it ethically and responsibly. Our responsibility is to ensure that our students understand the importance of upholding ethical standards and respecting privacy rights when adopting 4.0 digital technologies in EE. By emphasising the ethical use of technology, we can empower our students to make informed decisions and contribute to a positive and responsible digital ecosystem.”

This sentiment aligns with the literature that emphasises the importance of ethical considerations in the adoption of emerging technologies, particularly in educational contexts (Brey, 2012). As digital technologies become more pervasive, ensuring that students are equipped with the knowledge and skills to navigate ethical dilemmas and respect privacy rights is crucial for fostering responsible entrepreneurial practices (Brush & Munroe, 2019). Participant AM5 highlighted the need to address privacy and ethics in the discussions surrounding the adoption of 4.0 digital technologies in EE, stating, “I think privacy and ethics should be at the forefront of our discussions surrounding adopting 4.0 digital technologies in EE. In today’s interconnected world, students must be equipped with the knowledge and skills to navigate these technologies responsibly. By emphasising the importance of protecting personal information and making ethical choices, faculty members can help shape the next generation of ethical entrepreneurs who prioritise the well-being and trust of their customers. This perspective aligns with the literature that recognises the potential risks associated with the misuse or unintended consequences of digital technologies, such as data breaches, privacy violations and ethical lapses (Tene & Polonetsky, 2016). By integrating privacy and ethical considerations into the curriculum, educational institutions can empower students to navigate these challenges responsibly and contribute to the development of trustworthy and ethical entrepreneurial practices (Solove, 2007).

6.14.4 Increase productivity

Several participants in the interviews highlighted their perceptions of 4.0 digital technologies as practices that can increase productivity in EE. They recognised the potential of these technologies to enhance efficiency, streamline processes, and optimise learning experiences.

Participant AM3 stated, “Technologies are pertinent when transmitting and storing module material such as tutorial letters and assignments and communicating feedback.” This perception aligns with the literature that recognises the role of digital technologies in facilitating efficient content delivery, communication and feedback mechanisms in educational settings (Bates, 2015). By leveraging these technologies,

faculty members can streamline processes, save time and increase productivity in disseminating information and providing feedback to students.

Participant ES9 mentioned, “I have my personal laptop and a smartphone, which enable me to access my modules from anywhere as long as I am connected to the internet. I do not need to go to the campus. Most of my peers and I communicate via social media platforms such as WhatsApp and Facebook Messenger.” This practice aligns with research that highlights the productivity benefits of mobile learning and digital communication tools (Frohberg, Göth & Schwabe, 2009). By enabling remote access to educational resources and facilitating seamless communication, these technologies can increase flexibility, reduce time and location constraints and ultimately enhance productivity for both faculty members and students.

Furthermore, participant ES4 stated, “I see incorporating 4.0 digital technologies in EE as an enabler for inclusive and accessible learning. It removes geographical barriers, making education accessible to students from diverse backgrounds.” This perspective is supported by literature that recognises the productivity gains associated with inclusive and accessible education facilitated by digital technologies (Sá & Serpa, 2018). By removing geographical barriers and enabling access to education for a diverse student population, these technologies can optimise the utilisation of educational resources and increase overall productivity in the learning process.

6.14.5 Communication and Collaboration

Some participants in the interviews highlighted their perceptions of 4.0 digital technologies as practices that facilitate communication and collaboration in EE. They recognised the potential of these technologies to enable seamless interaction, exchange of ideas and collaborative learning experiences.

Participant ES9 mentioned, “Most of my peers and I communicate via social media platforms such as WhatsApp and Facebook Messenger." This practice aligns with the literature that recognises the role of social media and digital communication tools in facilitating real-time communication, information sharing and collaboration among students (Manca & Ranieri, 2016). By leveraging these technologies, students can

engage in discussions, share resources and collaborate on projects, fostering a collaborative learning environment.

Participant ES2 stated, “I see the adoption of 4.0 digital technologies in EE as a game-changer. It enables us to harness the power of online platforms, social media and digital marketing strategies to reach a wider audience and promote our entrepreneurial ventures effectively.” This perception is supported by research that highlights the potential of digital technologies in enabling communication and collaboration with diverse stakeholders, including customers, partners, and industry professionals (Brunetti, et al., 2020). By leveraging online platforms and digital marketing strategies, aspiring entrepreneurs can effectively communicate their ideas, collaborate with others, and expand their reach.

Furthermore, participant ES6 expressed, “I appreciate the emphasis on practising and embracing 4.0 digital technologies in EE. These perspectives allow us to explore the transformative power of technologies like cloud computing, big data, and cybersecurity.” This aligns with the literature that recognises the importance of collaborative practices and communication in leveraging emerging technologies such as cloud computing and big data for entrepreneurial ventures (Ghosh, Hughes, Hughes & Hodgkinson, 2021). By fostering collaboration and effective communication through these technologies, entrepreneurs can access and analyse data, share resources, and make informed decisions.

6.14.6 Convenience and flexibility

Several participants in the interviews highlighted the convenience and flexibility offered by 4.0 digital technologies in EE. They recognised the potential of these technologies to provide accessible and flexible learning experiences, catering to the diverse needs of students and fostering a conducive environment for entrepreneurial pursuits.

Participant ES9 stated, “I have my personal laptop and a smartphone, which enable me to access my modules from anywhere as long as I am connected to the internet. I do not need to go to the campus.” This perception aligns with the literature that emphasises the convenience and flexibility offered by digital technologies in enabling

anytime, anywhere access to educational resources and learning materials (Means et al., 2014). By leveraging mobile devices and internet connectivity, students can engage with their coursework at their convenience, reducing the constraints of physical locations and fixed schedules.

Participant ES4 expressed, “I see incorporating 4.0 digital technologies in EE as an enabler for inclusive and accessible learning. It removes geographical barriers, making education accessible to students from diverse backgrounds." This perspective resonates with the literature that recognises the role of digital technologies in providing flexible and inclusive learning opportunities, particularly for students from diverse backgrounds or those facing geographical barriers (Makoelle & Somerton, 2019). By removing these barriers, 4.0 digital technologies offer greater convenience and flexibility, enabling a wider range of individuals to pursue EE.

Furthermore, participant AM3 mentioned, “Technologies are pertinent when transmitting and storing module material such as tutorial letters and assignments and communicating feedback.” This statement aligns with the literature that highlights the convenience and flexibility afforded by digital technologies in facilitating efficient content delivery, submission of assignments and timely feedback mechanisms (Bates, 2015). Therefore, leveraging these technologies, faculty members and students can streamline processes, reducing the need for physical interactions and enabling greater flexibility in their educational endeavours.

6.15 Critical interpretive of findings and discussions on Theme 3

This chapter initiates by revisiting research objective 3, **which aims to analyse the perceptions and practices of participants regarding 4.0 digital technologies within the EE** domain. Faculty members and students’ comprehension and interpretation of technological advancements necessitate the researcher to determine the primary areas of interest and the extent of 4.0 technology integration in EE settings. Thus, understanding participants’ utilisation of these technologies, their experiences, motivation and associated practices establishes a firm foundation for future discussions.

Participants were keen to share their unique perspectives and practices during the interviews regarding 4.0 digital technologies' impact on EE. The conversations were insightful as participants shared personal experiences, motivations, and varying opinions on the technological advancements. Upon scrutiny, it became evident that most participants in the study held an overwhelmingly favourable perception towards 4.0 digital technologies. Their perception of these advanced technological innovations was informed by a theoretical comprehensive understanding of the multifarious benefits of 4.0 digital technologies instead of hands-on experience.

One interesting revelation uncovered by this study regarding the essential qualifications required for effective EE. While proficiency in the subject matter is unquestionably crucial, it became evident that an additional layer of technological proficiency is indispensable in the 21st century. Hence, faculty members must not only possess knowledge expertise in entrepreneurship but also demonstrate proficiency in knowledge transfer through 4.0 digital technologies. Whereas subject matter expertise is undoubtedly significant, the ability to impart that knowledge is equally crucial. The findings of this study underscore a critical aspect of EE that often goes overlooked, the evolving role of faculty members in shaping the learning experience. This revelation challenges the conventional notion that domain expertise alone suffices in educational settings. While Deroncele-Acosta, Palacios-Núñez, and Toribio-López (2023) argue that EE inherently requires a fusion of subject-specific expertise and pedagogical proficiency, this study extends this perspective by highlighting technological proficiency as a vital addition to the requisites of EE in the 21st century.

The students' perspectives reveal the ease with which they utilise social networking platforms such as Facebook and Twitter for both academic and non-academic purposes without encountering limitations in terms of time or location. These findings indicate that students predominantly utilise these social networks as communication channels, which aligns with previous research conducted in Singapore (Wang, Tchernev, & Solloway, 2012), emphasising the convenience of using Facebook for communication and interaction with peers. These results affirm the increasing integration of internet-mediated socialisation into the lives of young individuals (Kirschner & Karpinski, 2010).

Upon further investigation, it was observed that certain faculty members, such as AM3 and AM6, exhibit a lesser inclination towards social media platforms. This observation is enthralling, considering that faculty members possess sufficient knowledge about various common social networking sites and are registered users to some extent. However, their level of engagement on these platforms appears to be less dynamic compared to students who display higher activity rates, as noted by participant AM6.

In a broader context, this study emphasises the significance of 4.0 digital technologies for students and their usage patterns. While most students demonstrated proficiency in utilising these digital tools, their usage frequency varied depending on their intended purpose or specific tasks. For many students, social networks and communication applications like WhatsApp are essential mediums for personal, social, and academic interaction. They provide opportunities to fulfil communication needs irrespective of physical location. Despite the prevalence of 4.0 digital technologies in the lives of students and faculty members, it is evident that traditional spaces still hold significance.

Nonetheless, faculty members appear to hold mixed opinions regarding whether these technologies are mere complements or potential replacements for existing techniques. The study's findings reveal that most participants perceive technological advancements as fundamentally transformative to EE experiences rather than merely supplementary tools. This recognition of technology's significant impact and transformative potential in EE aligns with previous research. Notably, Liesa-Orús, Latorre-Cosculluela, Vázquez-Toledo, and Sierra-Sánchez (2020) also found that professors acknowledge the transformative capabilities of ICTs in positively influencing student learning and developing 21st-century skills. The convergence of these findings suggests a broader consensus on the profound role of technology in reshaping entrepreneurship practices and experiences, transcending its traditionally supportive function. Furthermore, the observation that faculty members held favourable perceptions towards 4.0 digital technologies in EE yet lack proficiency in effectively utilising them leading to hesitance in integrating these technologies aligns with prior research. While positive attitudes towards educational technologies are commonly reported (Yilmaz & Bayraktar, 2014; Seraji, Ziabari & Rokni, 2017; Kilag et al., 2023), some studies reveal a disconnect between attitudes and skills in seamlessly

adopting these tools (Reddy & Babu, 2024). Faculty members reluctance stems from factors like insufficient training, time constraints, workload concerns, and unfamiliarity with implementation (Al-Maqbali & Raja Hussain, 2022). The literature underscores providing professional development to bridge this gap by enhancing technological pedagogical knowledge and skills for confident technology integration (Hartman, Townsend & Jackson, 2019).

6.16 Summary of the Key Findings of Theme 3

- Perceptions of 4.0 Digital Technologies - Participants in the study, including faculty members and students, displayed overwhelmingly positive perceptions of 4.0 digital technologies. They recognised the multifarious benefits of these technologies and their transformative impact on various aspects of modern life.
- Qualifications for Effective EE - The study revealed that expertise in the subject matter alone is insufficient for effective EE. Technological proficiency has emerged as a critical requirement for faculty members who need subject expertise and the ability to transfer knowledge to students effectively. This highlights the evolving role of faculty members in shaping their learning experiences.
- Integration of Social Media - Students relying heavily on 4.0 digital technologies found social networking platforms, such as Facebook and X (formerly Twitter), for academic and non-academic purposes. These platforms are essential communication channels facilitating peer interactions and access to online learning materials.
- Differing Levels of Social Media Engagement - Most faculty members registered social media users, however, their engagement levels varied. Some, such as AM6, exhibited lower activity than students, suggesting a generational divide in social media usage patterns.
- Varied Usage Patterns of 4.0 Digital Technologies - Students demonstrated proficiency in using 4.0 technologies, with varying usage frequencies depending on specific tasks and purposes. Social networks and communication apps such as WhatsApp play a significant role in personal, social, and academic interactions, regardless of physical location.
- Transformative Nature of 4.0 Digital Technologies - Participants generally perceived 4.0 digital technologies as fundamentally transformative rather than

supplementary to existing EE techniques. They recognised the potential of technology to revolutionise EE experiences.

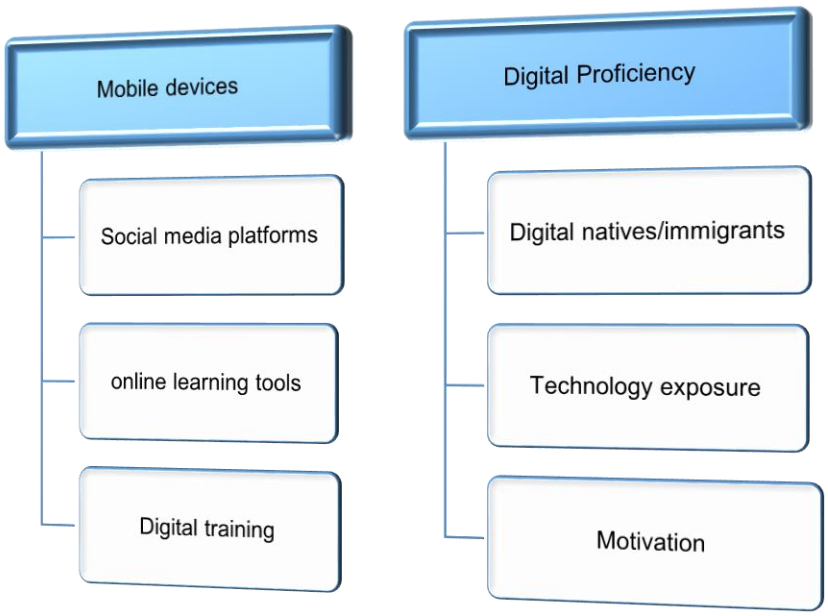
- Digital Proficiency and Incorporation - While favourably inclined towards 4.0 digital technologies, faculty members exhibited varying proficiency levels. This knowledge gap has contributed to hesitance in fully incorporating these technologies into EE systems and pedagogical practices. Comprehensive digital training and support are essential for harnessing the full potential of these technologies in EE.

This study highlights the positive perceptions of 4.0 digital technologies among faculty members and students, emphasising the need for subject expertise and technological proficiency in EE. It also underscores the significance of social media in EE, generational differences in usage, and the transformative potential of technology in shaping the entrepreneurial landscape. Furthermore, the study emphasises the importance of addressing the digital skill gap among faculty members to maximise the benefits of 4.0 digital technologies in EE.

6.17 Theme 4: Digital competencies

The fourth theme was the level of digital literacy competency (Figure 7.6. describes these sub-themes).

Figure 6. 6 Summary of themes and sub-themes related to digital literacy



The findings from the semi-structured interviews also provided verbatim quotes/extracts (see Table 7.6 for the answers provided during the interviews). The interview extracts for each participant are presented in Table 7.6 below.

Table 6. 11 Interview responses regarding their digital literacy

Participants	Interview Extracts
AM1	*"I struggle to apply social media and other technologies to real-life entrepreneurship situations. Learning how to leverage AI/Big data in opportunity identification or risk mitigation would be interesting."*
AM2	*"As a faculty member with strong digital competency, I believe in leveraging technology to enhance entrepreneurship education. I incorporate interactive online platforms, virtual simulations, and data-driven tools to give students real-world entrepreneurial experiences and insights."*
AM3	*"I acknowledge the importance of technology in entrepreneurship education. I may not be proficient in all digital tools, but I strive to learn and integrate basic technologies such as online presentations, email communication, and document sharing to facilitate student learning."*
AM4	*"Honestly, I'm not exactly an expert on these technologies… I am just enough to get by. So, if you want to really innovate and do something creative with them, it helps to have some serious digital know-how. I am not so sure whether to consider myself as digitally literate or not".*
AM5	*"I strive to create a blended learning environment. I integrate technology into my entrepreneurship courses by utilising learning management systems, multimedia presentations, and online group discussions. While I may not be an expert, I continuously improve my digital skills to meet the evolving needs of my students."*
AM6	*"I am a faculty member who faces challenges with digital competency in entrepreneurship education. However, I acknowledge the significance of technology in today's world and work collaboratively with more digitally skilled colleagues to develop innovative and engaging learning experiences for students."*
AM7	*"I am excited about exploring technology's potential in entrepreneurship education. I am in the process of familiarising myself with various digital tools and platforms, and I'm eager to collaborate with students to discover new ways of incorporating technology into our learning journey."*
ES1	*"I believe I am capable of interacting with many social media platforms, but I struggle to apply more advanced technologies in my entrepreneurial learning"*
ES2	*"As a digitally competent student, I actively seek out online resources and platforms to supplement my entrepreneurship education. I participate in online forums, attend webinars, and engage in collaborative projects using digital tools. These digital skills*

	have allowed me to explore innovative business ideas and connect with like-minded entrepreneurs globally."
ES3	*"I rely on patient and supportive faculty members to guide me through the digital aspects of entrepreneurship education. I appreciate clear instructions, step-by-step guidance, and opportunities for hands-on practice to enhance my understanding of digital tools in the context of entrepreneurship."*
ES4	*"I am confident in my digital literacy skills and have utilised various online resources to enhance my understanding of entrepreneurship concepts. I am comfortable using digital marketing strategies and have experience managing my business's social media accounts."*
ES5	*"I make use of online resources provided by the institution to enhance my entrepreneurship education. I engage in online tutorials, collaborate with classmates using digital platforms, and leverage online research tools to gather market insights. I am willing to learn and adapt to new technologies as they arise."*
ES6	*"I rely on the guidance and resources faculty provide to navigate entrepreneurship education in the digital realm. I am open to learning new technologies and appreciate when faculty members offer support and training to improve my digital skills."*
ES7	*"I'm well-versed in digital technologies, I can demonstrate my competency by showcasing my ability to create business plans using digital tools, and analyse market trends through data and analytics."*
ES8	*"I appreciate faculty members who provide clear instructions and support for using digital tools in entrepreneurship education. I actively seek assistance from peers and make an effort to improve my skills by attending workshops and tutorials offered by the institution."*
ES9	*"While I have some basic digital skills, I am eager to develop my digital competency further in the context of entrepreneurship education. I am actively seeking opportunities to enhance my knowledge and skills in areas such as digital marketing and e-commerce."*
ES10	*"I'm really into social media, mostly for keeping in touch and networking. However, I struggle when it comes to applying these technologies to real-life entrepreneurship situations. It would be interesting to learn how to leverage technologies such as AI/Big data in opportunity identification or mitigating risks".*

6.17.1 Social Media Platforms

Several participants expressed their perceptions and practices concerning the use of social media platforms in the context of digital competencies for EE. This sub-theme of social media platforms aligns with the broader theme of digital competency, as it

highlights the importance of leveraging these platforms for various purposes, such as communication, collaboration, and promotion of entrepreneurial ventures.

Participant ES1 stated, "I believe I am capable of interacting with many social media platforms, but I struggle to apply more advanced technologies in my entrepreneurial learning." This perception reflects the recognition of social media platforms as a component of digital competency, while acknowledging the need for further development in other advanced technologies (Martzoukou, Fulton, Kostagiolas & Lavranos, 2020.).

Participant ES4 mentioned, "I am confident in my digital literacy skills and have utilised various online resources to enhance my understanding of entrepreneurship concepts. I am comfortable using digital marketing strategies and have experience managing my business' social media accounts." This response highlights the practical application of social media platforms for digital marketing and business promotion, which is supported by literature emphasising the importance of social media in entrepreneurial ventures (Yevseitseva, Liulchak, Semenda, Järvis & Ponomarenko, 2022).

Furthermore, participant ES10 expressed, "I'm really into social media, mostly for keeping in touch and networking. However, I struggle when it comes to applying these technologies to real-life entrepreneurship situations." This sentiment aligns with studies that recognises the value of social media platforms for networking and building connections within the entrepreneurial ecosystem, while also acknowledging the need for further skill development in leveraging these platforms for practical entrepreneurial activities (Manca, & Ranieri, 2016).

The use of social media platforms in EE is well-supported by literature. Social media can facilitate collaborative learning, peer-to-peer interactions and the exchange of ideas among students and educators (Manca & Ranieri, 2016). Additionally, these platforms can provide opportunities for entrepreneurs to engage with their target audience, build brand awareness, and gather valuable insights through social listening and analytics (Permatasari & Anggadwita, 2019).

6.17.2 Online Learning Tools

Several participants expressed their perceptions and practices concerning the use of online learning tools in the context of digital competencies for EE. This sub-theme of online learning tools aligns with the broader theme of digital competency, as it highlights the importance of leveraging these tools to facilitate learning, collaboration, and knowledge sharing in the digital era.

Participant AM2 stated, “As a faculty member with strong digital competency, I believe in leveraging technology to enhance EE. I incorporate interactive online platforms, virtual simulations and data-driven tools to give students real-world entrepreneurial experiences and insights.” This response showcases the utilisation of online learning tools, such as interactive platforms, simulations and data-driven tools to provide practical and engaging learning experiences for students. This approach aligns with the literature that emphasises the importance of incorporating technology-enhanced learning environments and experiential learning in EE (Downie, Gao, Bedford, Bell & Kuit, 2021).

Participant ES5 mentioned, “I make use of online resources provided by the institution to enhance my EE. I engage in online tutorials, collaborate with classmates using digital platforms and leverage online research tools to gather market insights.” This response highlights the use of various online learning tools, including tutorials, collaboration platforms, and research tools, to support and enhance the entrepreneurship learning experience. This practice is supported by literature that recognises the benefits of online learning tools in fostering collaboration, self-directed learning and access to diverse resources (Chen, Ifenthaler & Yau, 2021).

Furthermore, participant AM5 stated, “I strive to create a blended learning environment. I integrate technology into my entrepreneurship courses by utilising learning management systems, multimedia presentations, and online group discussions.” This response reflects the implementation of online learning tools, such as LMS, multimedia presentations and discussion forums to facilitate a blended learning approach. This aligns with research that highlights the advantages of blended

learning in EE, combining face-to-face instruction with online components for a more comprehensive and flexible learning experience (Thai, De Wever & Valcke, 2020.).

The use of online learning tools in EE is well-supported by literature. These tools can provide access to a wide range of resources, enable collaborative learning, facilitate experiential activities and promote self-directed learning (Mensah,et al., 2021). Additionally, online learning tools can contribute to the development of digital competencies, which are essential for aspiring entrepreneurs in the digital age (Basilotta-Gómez-Pablos, Matarranz, Casado-Aranda & Otto, 2022).

6.17.3 Digital Training

Several participants highlighted the importance of digital training as a sub-theme aligned with the broader theme of digital competency in EE. Digital training refers to the acquisition of knowledge, skills, and practical experience related to the use of digital tools and technologies, which is essential for developing digital competencies (Napal- Fraile, Peñalva-Vélez & Mendióroz- Lacambra, 2018).

Participant ES3 stated, “I rely on patient and supportive faculty members to guide me through the digital aspects of EE. I appreciate clear instructions, step-by-step guidance and opportunities for hands-on practice to enhance my understanding of digital tools in the context of entrepreneurship.” This response underscores the need for structured digital training, where faculty members provide guidance, instructions and practical opportunities for students to develop their digital competencies within the entrepreneurship curriculum (Falloon, 2020).

Participant ES8 expressed, “I appreciate faculty members who provide clear instructions and support for using digital tools in EE. I actively seek assistance from peers and make an effort to improve my skills by attending workshops and tutorials offered by the institution.” This sentiment highlights the value of digital training through workshops, tutorials and peer support, enabling students to acquire the necessary skills and knowledge to effectively utilise digital tools in their entrepreneurial pursuits (de Waal & Maritz, 2022).

6.17.4 Digital Proficiency levels

Several participants, such as AM3, AM4, AM6, ES3 and ES6, expressed challenges or limited proficiency with 4.0 digital technologies, suggesting that they may be considered digital immigrants. For instance, AM4 stated, “Honestly, I’m not exactly an expert on these technologies… I am just enough to get by. So, if you want to really innovate and do something creative with them, it helps to have some serious digital know-how. I am not so sure whether to consider myself as digitally literate or not.” This response indicates a lack of confidence and advanced digital skills, which is characteristic of digital immigrants who have adopted digital technologies later in life and may struggle to keep pace with rapid technological advancements (Prensky, 2001).

On the other hand, participants like ES2, ES4 and ES7 demonstrated a higher level of digital competency and familiarity with various digital tools and platforms suggesting that they may be considered digital natives. For example, ES4 mentioned, "I am confident in my digital literacy skills and have utilised various online resources to enhance my understanding of entrepreneurship concepts. I am comfortable using digital marketing strategies and have experience managing my business’ social media accounts.” This response reflects a level of digital fluency and the ability to leverage digital tools effectively, which is often associated with digital natives who have grown up immersed in the digital world (Thompson, 2013).

The distinction between digital natives and digital immigrants in the context of digital competency for EE is well-documented in the literature. Digital natives, having grown up surrounded by digital technologies, tend to have a natural affinity and adaptability when it comes to using digital tools and platforms (Prensky, 2001; Palfrey, & Gasser, 2011). In contrast, digital immigrants may face challenges in adopting and integrating 4.0 digital technologies into their practices, as they have had to adapt to an environment that was not inherently digital during their formative years (Vodanovich, Sundaram & Myers, 2010).

However, it is important to note that while the digital native/immigrant divide can provide insight into individuals' general attitudes and experiences with digital technologies, it should not be viewed as an absolute or rigid classification. Both digital natives and digital immigrants can develop digital competencies through effective training, exposure and hands-on experience (Malach & Kysil, 2019).

6.17.5 Technology Exposure

Several participants highlighted the importance of technology exposure as a sub-theme aligned with the broader theme of digital competency in entrepreneurship education. Technology exposure refers to the degree of familiarity, access, and practical experience individuals have with various digital tools and technologies, which plays a crucial role in developing digital competencies (Blikstein, Kabayadondo, Martin & Fields, 2017).

Participant AM7 stated, "I am excited about exploring technology's potential in EE. I am in the process of familiarising myself with various digital tools and platforms, and I'm eager to collaborate with students to discover new ways of incorporating technology into our learning journey." This response reflects a willingness and openness to gaining exposure to 4.0 digital technologies, recognising the importance of hands-on experience and collaboration in integrating technology into the EE process (Young, Wahlberg, Davis & Abhari, 2020).

Participant ES9 expressed, "While I have some basic digital skills, I am eager to develop my digital competency further in the context of EE. I am actively seeking opportunities to enhance my knowledge and skills in areas such as digital marketing and e-commerce." This sentiment highlights the desire for increased technology exposure, specifically in areas relevant to entrepreneurial ventures, such as digital marketing and e-commerce platforms (Monllor & Soto-Simeone, 2020). Furthermore, participant AM2 mentioned, "As a faculty member with strong digital competency, I believe in leveraging technology to enhance EE. I incorporate interactive online platforms, virtual simulations, and data-driven tools to give students real-world entrepreneurial experiences and insights." This response showcases how faculty members with high levels of technology exposure can create immersive and practical

learning experiences by integrating various digital tools and simulations into the curriculum (Radianti, Majchrzak, Fromm & Wohlgenannt, 2020).

The importance of technology exposure in developing digital competencies for EE is well-supported by literature. Exposure to a wide range of digital tools and technologies can foster digital literacy, which is essential for aspiring entrepreneurs to navigate the digital landscape, leverage technology for innovation and develop successful ventures (Kraus, Kraus & Shtepa, 2021). Hands-on experiences, practical applications and access to digital resources can enhance students' understanding and proficiency in utilising digital technologies for entrepreneurial purposes (Trongtorsak, Saraubon & Nilsook, 2021.).

Additionally, technology exposure can contribute to the development of digital skills and mindsets necessary for entrepreneurial success, such as adaptability, problem-solving and continuous learning (Reaves, 2019). By providing opportunities for technology exposure, HEIs can better prepare students for the rapidly evolving digital entrepreneurial ecosystem and equip them with the competencies required to thrive in a technology-driven business environment.

6.17.6 Motivation

Several participants highlighted motivation as a sub-theme aligned with the broader theme of digital competency in EE. Motivation plays a crucial role in the development and application of digital competencies, as it drives individuals to actively engage with digital technologies, seek learning opportunities and overcome potential barriers or challenges.

Participant ES8 expressed, "I appreciate faculty members who provide clear instructions and support for using digital tools in EE. I actively seek assistance from peers and make an effort to improve my skills by attending workshops and tutorials offered by the institution." This response demonstrates a strong motivation to enhance digital competencies by actively seeking guidance, support and learning opportunities through workshops and peer collaboration (Niemi & Multisilta, 2016).

Participant ES2 mentioned, “As a digitally competent student, I actively seek out online resources and platforms to supplement my EE. I participate in online forums, attend webinars and engage in collaborative projects using digital tools.” This statement reflects a high level of motivation to leverage 4.0 digital technologies and resources for self-directed learning and collaboration, actively seeking out relevant platforms and engaging in various digital activities to enhance their entrepreneurial knowledge and skills (Mohammadi, 2024.).

Furthermore, participant AM7 stated, “I am excited about exploring technology’s potential in EE. I am in the process of familiarising myself with various digital tools and platforms and I’m eager to collaborate with students to discover new ways of incorporating technology into our learning journey.” This response highlights the motivation to embrace digital technologies, continuously learn and adapt and actively seek opportunities to integrate technology into the teaching and learning process (Kasimia & Ulum, 2023).

6.18 Critical interpretive of findings and discussions on Theme 4

This section offers a comprehensive and coherent account of the study’s findings and discussions, focusing on research objective four, **which sought to assess digital literacy levels among faculty members and students**. The study employed qualitative methodology, explicitly semi-structured interviews, and thematic analysis. Several key themes and sub-themes emerged after interviews with diverse participants, as shown in Table 6. These findings shed light on the digital literacy landscape within the EE context.

The findings revealed divergent levels of digital literacy among the study participants, encompassing faculty members and students. The interviews revealed a spectrum of digital literacy proficiencies, with specific faculty members showcasing a commendable aptitude in this domain. Nevertheless, it was evident that some participants faced difficulties in specific areas, such as effectively leveraging advanced digital tools for pedagogical purposes or undertaking research activities. Similarly, a notable disparity in digital literacy levels emerged among the student cohorts. While certain students demonstrated adeptness in digital communication and retrieving

information online, others encountered obstacles, such as collaborative online work or critically assessing digital information.

In the context of EE, specific faculty members, AM2, AM3, AM5, AM6, and AM7 exhibited a commendable grasp of 4.0 digital technologies. These individuals recognised the significance and potential of digital tools to enrich their entrepreneurial experiences. However, AM1 and AM4 encountered challenges when attempting to implement these tools in real-life entrepreneurship scenarios. This finding underscores the need for additional support and training to bridge the gap in implementation skills.

Regarding the students, a subset of participants, ES1, ES2, ES4, ES5, ES9, and ES10, demonstrated foundational digital literacy competencies, such as managing social media accounts and utilising online learning tools. However, a predominantly passive approach emerged when evaluating students' capacity and proficiency in utilising 4.0 digital technologies for EE. Most participants expressed willingness to incorporate these technologies into their entrepreneurial endeavours, contingent upon receiving pertinent guidance and training in the requisite digital skills. This highlights the critical importance of offering tailored digital literacy training programs and supporting faculty members and students to bridge the gap between their current abilities and desired proficiency levels.

Furthermore, the findings unearthed diverse influential elements shaping levels of digital literacy. Among these elements, access to technology or exposure to it has emerged as a noteworthy determinant, wherein participants who faced limitations in accessing digital devices or reliable internet connectivity confronted barriers in developing their digital skills. Additionally, prior digital training has surfaced as another crucial factor, as individuals exposed to digital tools and resources demonstrate higher levels of digital literacy. Moreover, individual motivation has emerged as an influential element, whereby participants who exhibited a strong drive to learn and adapt to new technologies demonstrated enhanced digital competency. This resonates profoundly with the research conducted by Ceipek, Hautz, Petruzzelli, De Massis & Matzler, (2021) whose findings illuminate the profound impact of individual motivation on the attainment and proficiency of digital skills. By comprehensively examining these

elements, this study provides insight into the multifaceted nature and determinants of digital literacy.

The study further significantly contributes to the field by offering valuable insights into the unique digital literacy requirements of faculty members and students operating within the context of EE. The findings underscored the significance of integrating practical and experiential exercises to enhance digital skills in EE programs. These findings echoe the revelations of Rasiah, Somasundram, and Tee (2019) as well as those of Yusof, Murad and Yusof, (2022) who suggested the pivotal role of integrating practical and experiential exercises into educational endeavors aimed at enhancing digital proficiencies. Moreover, promoting collaboration between academics' adept in digital technologies and those grappling with digital challenges can create a conducive setting for encouraging creative and engaging learning experiences (Trongtorsak, Saraubon & Nilsook, 2021). By connecting digital natives and digital immigrants, collaborative efforts can be utilised to create innovative teaching methods that make use of 4.0 digital technologies. Hence, such collaborative projects can improve the educational environment by providing immersive learning experiences that resonate with modern learners and help them develop the necessary digital skills for success in a technology-driven society (Trongtorsak et al., 2021).

Nevertheless, the study focused on the intricate nature of evaluating an individual's level of digital literacy proficiency. In an educational landscape where students and faculty members utilise computers and mobile digital devices, it has become increasingly difficult to categorise individuals as proficient or lacking in their ability to navigate technology-driven tools and resources. This raises pertinent inquiries concerning the effectiveness of existing assessment approaches and the necessity for a more holistic comprehension of digital literacy encompassing multifaceted dimensions. The simple act of using social media does not necessarily indicate or prove digital competence. These findings conflict with the studies conducted by Xu, Yang, MacLeod and Zhu (2019), which uncovered empirical evidence linking social media competence to digital citizenship. Proficiency in social media constitutes only a fraction of the broader proficiency in effectively navigating and utilising 4.0 digital technologies. This is consistent with the findings of Cabezas-González, Casillas-Martín, and Garcia-Valcarcel Munoz-Repiso (2021), whose research revealed a

negative correlation between frequent online communication among students, high usage of social networks and digital competence levels. Therefore, it is imperative to adopt a comprehensive and nuanced approach when assessing and fostering digital competence, moving beyond a narrow emphasis on social media engagement.

6.19 Summary of the Key Findings of Theme 4

- **Divergent Levels of Digital Competence:** The study revealed varying levels of digital literacy among faculty members and students. Some participants demonstrated a strong aptitude for digital tools, while others faced challenges using 4.0 digital technologies for pedagogical or research purposes.
- **Digital Literacy in the Context of EE**: Several faculty members grasped 4.0 digital technologies and recognised their importance in enriching entrepreneurial experiences. However, others have encountered obstacles when implementing these tools in real-life entrepreneurship scenarios, highlighting the need for additional support and training.
- **Student Digital Literacy**: Several students demonstrated foundational digital literacy competencies; however, there was a predominantly passive approach to using 4.0 digital technologies for EE. Most students were willing to incorporate these technologies into their entrepreneurial endeavours, contingent upon receiving relevant guidance and training.
- **Factors Shaping Digital Literacy Levels:** The study identified several influential factors that affect digital literacy, including technological exposure or access, prior digital training, and individual motivation. Participants with access to digital resources and a solid drive to learn demonstrated higher levels of digital competency.
- **Unique Digital Literacy Requirements**: The findings highlight the unique digital literacy requirements of faculty members and students in EE. Practical and experiential exercises, collaboration between individuals with varying digital competencies, and exposure to cutting-edge technologies have been identified as strategies for enhancing digital literacy.
- **Challenges in Evaluating Digital Literacy:** This study emphasises the complexity of assessing digital literacy in an EE landscape using ubiquitous technology. Superficial evaluations such as familiarity with social media may not

accurately capture individuals' true digital expertise. More refined assessment methods that consider the multifaceted dimensions of digital literacy are needed.

This study provides insights into the diverse levels of digital literacy among faculty members and students in EE. This underscores the significance of tailored training programs, collaboration, and advanced technology exposure to enhance digital skills. Additionally, this study calls for re-evaluating assessment methods to better capture the nuanced nature of digital literacy in today's technology-driven educational environment.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

The concluding chapter 8 serves as a reflective and insightful recap of the initial research objectives described in Chapter 1. Its rationale is to provide a concise and comprehensive summary of the empirical findings revealed in the study. Furthermore, this chapter suggests a model or framework based on research findings that could contribute to a new body of knowledge. It also recognises the limitations inherent in the study, considering any existing gaps that require further exploration and investigation. Ultimately, the chapter culminates with well-considered recommendations and suggests promising avenues for future research endeavours in the field.

7.1 The Re-Visit of Research Objectives

Four specific objectives guided this study, and each was thoroughly examined and reported in detail. The study objectives were delineated as follows:

7.1.1 Research Objective 1: To investigate the impact of 4.0 digital technologies on developing an entrepreneurial pedagogical framework that fosters an entrepreneurial mindset among students.

The findings revealed a limited integration of 4.0 digital technologies such as AI, VR, Big data analytics and cloud computing into entrepreneurial pedagogical frameworks and learning experiences. Hence, SA HEIs must take a proactive stance in revamping their EE programs to meet the requirements of the Industry 4.0. This requires a thorough evaluation of existing entrepreneurial curriculums and pedagogical methods, along with integrating experiential learning, project-based strategies and real-life scenarios to promote an entrepreneurial mindset in students. Developing partnerships with industry partners, accomplished entrepreneurs and pertinent stakeholders is essential for creating and executing EE programs that meet both present and future technological skills needs. Therefore, South African HEIs should also allocate resources to provide training to their faculty in order to improve their knowledge and proficient utilisation of Industry 4.0 digital technologies in the field of EE. In addition, it is crucial for South African HEIs to create specific entrepreneurship hubs or accelerators that offer hands-on assistance, guidance, and resources to upcoming student entrepreneurs.

The limited technological integration distinctly restricts the maximum potential impact of 4.0 technologies in creating immersive, interactive, and personalised learning experiences which have been evidenced to enhance entrepreneurial knowledge and skills (Moraes et al, 2023). Therefore, the South African Department of Higher Education and Training (DHET) needs to develop a thorough comprehensive national strategy for incorporating Industry 4.0 technologies into EE programs by providing funding for HEIs to improve infrastructure, purchase necessary technologies and offer training. Moreover, establishing partnerships with private companies, industry groups and entrepreneurial organisations is essential for fostering knowledge sharing, creating internship opportunities and securing financial support for entrepreneurial projects. Moreover, innovative pedagogical approaches in EE programs need to be supported by policies and incentives, along with consistent assessments and evaluations, to guarantee their significance and efficiency.

The severe underutilisation of 4.0 digital technologies is concerning given their vast capabilities to transform passive learning and deliver enriched EE. As established by recent research studies (Li & Wong, 2023; Lin, Huang & Lu, 2023), leveraging 4.0 technological advancements facilitate customised and self-directed learning, provide prompt feedback, and enable data-driven assessment of EE. However, the scenario under the institution studied indicates a persistent over-reliance on conventional pedagogies in EE.

These findings illuminate the pressing need to incorporate 4.0 technologies into EE through redesigning curricular undertakings and pedagogical approaches. Consequently, the study provides a foundation for further research to assess the efficacy of 4.0 digital tools in developing entrepreneurial mindsets. In particular, evaluative studies are critical in comparing traditional and technology-enhanced pedagogies. Additionally, the findings also underscore the urgency of equipping EE faculty members with digital and pedagogical competencies along with institutional support systems to optimise 4.0 technology adoption. Hence, providing faculty with digital training in these areas is vital. Addressing these gaps is essential for shaping future-ready entrepreneurial graduates who can thrive in the digital era. In summary, the study highlights the need to integrate 4.0 digital technologies into EE through curricular and pedagogical reforms, equip faculty members with new competencies, and conduct comparative assessments.

7.1.2 Research Objective 2: To identify the driving forces and barriers to adopting industry 4.0 digital technologies in EE.

Pursuing enriched learning experiences, enhanced student engagement, industry demands and requirements, cost reduction, and the quest for enhanced global competitiveness were identified as crucial driving forces to 4.0 technology adoption. For example, incorporating 4.0 interactive and immersive digital tools such as VR technology enhances learning experiences whereby students can immerse themselves in simulated environments and replicate realistic scenarios. As a result, students can actively engage in a simulated business environment by utilising VR to explore various entrepreneurship strategies, conduct market trend analyses, and effectively identify target audiences. Consequently, faculty members can also make informed decisions, experiment with diverse pedagogical approaches, and closely observe the subsequent consequences of their actions within a risk-free virtual setting. While these factors underscore the rationale for integrating 4.0 technologies into EE, the study also unearthed significant obstacles that inhibit this integration.

The study's findings uncovered the inadequacy of pedagogical preparedness as a major impediment that manifested in instructional design and pedagogical strategies. These findings highlight the necessity for targeted initiatives aimed at improving faculty members' digital and pedagogical competencies, to fully utilise these 4.0 technologies effectively. Another barrier revealed by the findings is the resistance to change usually resulting from disruptions to conventional teaching methods. The key implication drawn from this is the need for proactive mitigation through fostering a digital culture while providing an extensive training and support during transitions. Limited awareness and comprehension of 4.0 technologies among faculty members also emerged as a barrier, underscoring the value of comprehensive professional development programs to build technological knowledge.

However, the findings emphasize insufficient digital infrastructure as one of the most critical constraints, severely limiting access to interactive and immersive learning experiences. This highlights the urgency of substantial investments in robust, equitable, and reliable infrastructure to enable the seamless integration of 4.0

technologies within EE. The infrastructure barrier, in particular, aligns with previous studies such as Oke and Fernandes (2020), which further validate this challenge.

Overall, the study makes significant contributions by uncovering specific driving forces and barriers associated with 4.0 digital technology adoption in EE. The research provides a foundation to inform targeted strategies to leverage the drivers and mitigate the obstacles. Recommended strategies include training programs to build digital and pedagogical capabilities of faculty members, change management initiatives to facilitate transitions, technological awareness building, and most critically, initiatives to strengthen digital infrastructure. By purposefully addressing the barriers while harnessing the drivers identified, EE can foster environments optimally suited to prepare students with essential future-ready digital skills. Further research can build on these findings by developing frameworks to assess the effectiveness of the proposed integration strategies. Additional studies may also examine comparisons across different geographical and institutional contexts.

7.1.3 Research Objective 3: To explore faculty members' and students' perspectives and practices related to digital technologies in Industry 4.0.

The study comprehensively examined faculty members' and students' perspectives and practices regarding integrating Industry 4.0 digital technologies in EE. The findings revealed a generally positive attitude towards these technologies and an awareness of their potential to transform EE. However, it is crucial to consider the possible drawbacks and ethical concerns associated with heavy reliance on 4.0 digital technologies.

One of the primary focal points revolved around the potential repercussions of interpersonal interactions between students and faculty members. Despite technology's diverse advantages, the importance of direct engagement for academic advancement and socialisation should not be neglected. It is crucial to strike a delicate equilibrium between technology-mediated interactions and personal connections to ensure a comprehensive learning experience. While the emergence of cutting-edge technologies such as ChatGPT has ignited ethical deliberations. Questions have been posed about whether students should excessively rely on AI tools to fulfil their academic obligations effortlessly (Gamage, Dehideniya, Xu & Tang, 2023). It becomes evident that the establishment of ethical guidelines and meticulous contemplation of

technology integration in EE programs are essential to ensure that these advancements truly benefit and empower students from diverse backgrounds. South African HEIs and policymakers must prioritise ethical considerations and responsible technology use to create an inclusive and equitable learning environment that fosters entrepreneurial mindsets and prepares students for the demands of the evolving entrepreneurial landscape (Rane, Choudhary, Tawde & Rane, 2023).

Despite these concerns, faculty members and students demonstrated a shared understanding of the need to adapt to changes in Industry 4.0. Their enthusiasm for leveraging these technological advancements in academic practice is evident. However, there is a need for further knowledge and expertise to integrate these technologies effectively into the specific context of EE.

To address this, faculty members and students should seek additional digital training and resources to enhance their understanding and proficiency in utilising 4.0 digital technologies in EE. This can involve professional development programs, workshops, and collaborations with experts in the field. By equipping themselves with the necessary knowledge and skills, both groups can harness the full potential of these technologies while maintaining the human elements crucial for comprehensive and compelling learning experiences.

In conclusion, while the study indicated a positive attitude towards 4.0 digital technologies among faculty members and students, it is essential to carefully navigate the potential drawbacks and ethical considerations associated with their integration into EE. Balancing technology-mediated interactions with in-person engagement and addressing ethical concerns are essential for a holistic EE experience. Moreover, investing in ongoing training and development empowers faculty members and students to leverage these technologies within the specific context of EE effectively. By doing so, EE can benefit from the transformative potential of industry 4.0 while upholding the fundamental principles of a well-rounded and ethical educational environment.

7.1.4 Research Objective 4: To determine the level of digital literacy of faculty members and students.

The study found significant disparities in digital proficiency between faculty and students. While 60% of students tended to display advanced technological skills with digital tools and resources, faculty members were more polarised with some exhibiting expert-level abilities but others demonstrating only basic competencies (Counselman-Carpenter & Aguilar, 2022). The semi-structured interviews revealed faculty members perceived greater barriers to developing digital literacy including lack of time, training resources, and motivation. These findings align with past literature examining differing technology adoption rates between digital native students and digital immigrant faculty (Murray, 2022; Thompson, 2022). However, Counselman-Carpenter and Aguilar (2022) emphasise faculty members' challenges may involve institutional and workload constraints rather than strictly age or attitude. A scaffolded approach to training tailored to individuals' baseline proficiency shows promise in improving adoption of digital tools across age groups (Thompson, 2022).

These findings align with previous research on digital immigrant and native faculty members in technology-integrated teaching. Prior studies have emphasised the significance of a scaffolded training approach that involves assessing participants' skills and providing rigorous training to facilitate effective behavioural change. Counselman-Carpenter and Aguilar further reinforce this point, underscoring its importance in delivering effective digital education (Counselman-Carpenter & Aguilar, 2022).

While digital literacy is a complex construct to measure, the findings underscore its importance in EE contexts. Participants voiced concern about graduating students lacking preparatory skills in navigating the Industry 4.0 landscape. Both faculty and students emphasised the need for accessible, practical training in areas such as online collaboration, data analytics, research literacy, and project management software. Those entering entrepreneurial careers require fluency across an evolving suite of technologies to remain competitive (Counselman-Carpenter & Aguilar, 2022).

Furthermore, training programs tailored to the unique needs of various academic disciplines should be developed and implemented. For instance, entrepreneurship students may require specialised training in industry-specific software, thus benefitting from the instruction in data analysis tools pertinent to the entrepreneurship field.

Incorporating guest speakers and experts in Industry 4.0 can enrich the academic experience by providing real-world perspectives and insights.

Digital literacy skills are indispensable for academic and professional accomplishments as emphasised by the study's findings. Therefore, ongoing training to enhance the digital skills of faculty members and students is crucial. However, a paramount concern in the digital era pertains to cybersecurity threats, privacy issues, and the reliability of online information sources. Faculty members should conscientiously integrate cybersecurity awareness into the curriculum, educating students on safeguarding their online activities, practising safe browsing, and protecting their personal data. Simultaneously, they should foster students' critical thinking skills, enabling them to discern the credibility of digital resources and effectively identify misinformation. Concurrently, students play an integral role in the digitalisation process. To this end, students should adopt a proactive approach to learning by seeking opportunities to expand their digital knowledge beyond classroom confines.

Online courses, tutorials, and independent studies are invaluable resources. Staying abreast of the rapidly evolving digital landscape, including the latest technological developments, cybersecurity threats, and privacy issues, is essential. Engaging with reputable technology news sources and blogs can facilitate this endeavour. Moreover, the importance of information verification and data management cannot be overlooked. Students should develop the habit of rigorously fact-checking and verifying online information sources before incorporating them into their academic work. Effective data management practices such as regular backups and robust password management are crucial for securing digital assets and maintaining data integrity. By adhering to these comprehensive recommendations, faculty members and students collectively contribute to the seamless and successful adoption of Industry 4.0 while concurrently addressing the concerns and challenges highlighted in the findings.

7.1.5 Research Objective 5: Recommendations for HEIs to improve EE through industry 4.0 technologies.

Based on the study's findings, the following recommendations guide South African HEIs seeking to enhance EE by integrating Industry 4.0 technologies. One key

practice implication is the establishment of robust industry-academia collaborations. South African businesses should actively seek partnerships with HEIs, offering real-world case studies, mentorship programs, and internship opportunities for EE students. Such collaborations provide invaluable practical experience and industry insights, bridging the gap between theoretical knowledge and the realities of entrepreneurship. These partnerships can offer valuable knowledge and experience, aligning students with industry trends and challenges. These findings confirm that such collaborations facilitate a deeper understanding of the practical applications of Industry 4.0 technologies.

Second, HEIs should develop dedicated courses focusing on Industry 4.0 technologies or integrate these technologies into existing entrepreneurship programs, where appropriate. Establishing incubators and accelerator programs can create immersive experiences that foster collaboration among students from diverse backgrounds. For example, experts can introduce students to tools such as Figma, a collaborative web application for interface design to create, share, and test designs for websites, mobile applications and other digital products and experiences. These programs provide a platform for students to learn from experienced entrepreneurs and gain practical insights into launching successful businesses using emerging technological platforms. These findings underscore the benefits of immersive experiences and emphasise the importance of experiential learning for entrepreneurial students.

Lastly, HEIs must prioritise the professional development of faculty members, particularly in acquiring digital skills relevant to Industry 4.0 technologies. The study emphasised the significance of empowering faculty members to effectively guide and mentor students in adapting to technological advancements. Providing targeted training and resources to faculty members enhances their ability to navigate and integrate these technologies into the curriculum, resulting in a more impactful EE experience.

By implementing these recommendations, HEIs can improve their overall performance, better serve their students and communities, and remain at the forefront of educational innovation. These suggestions are grounded in the study's findings, which demonstrate the importance of adapting EE to the demands of the digital era

and addressing the specific challenges and opportunities presented by Industry 4.0 technologies.

7.2 Concluding Remarks

The research conducted in this study indicated that various factors influence the integration of 4.0 digital technologies in EE. These factors encompassed institutional leadership support, resource availability, training opportunities, and alignment with pedagogical practice. For instance, institutional leadership support is crucial for driving the adoption and implementation of 4.0 digital technologies in EE settings. Additionally, the availability of necessary resources and appropriate training programs further facilitates the successful integration of these technologies. Moreover, aligning 4.0 digital technologies with pedagogical practices ensures they are effectively integrated into the teaching and learning processes.

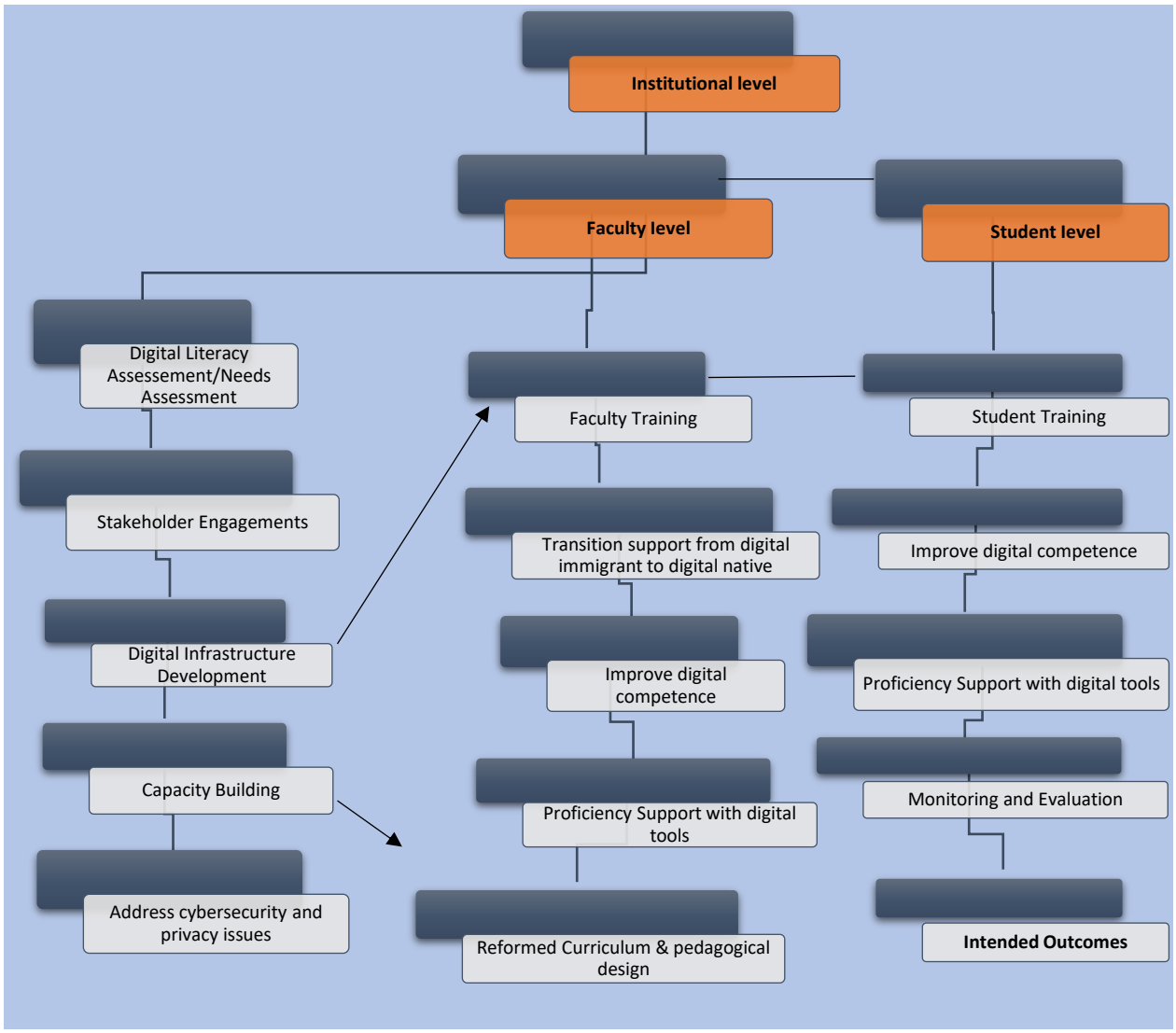
However, it is essential to consider the concerns raised by experts regarding the potential adverse effects of these technological advancements on student well-being and learning capabilities. Some argue that increased reliance on 4.0 digital technologies may adversely impact students' well-being by leading to sedentary behaviour, social isolation, or a decreased attention span. Furthermore, there are concerns about the potential impact on students' learning capabilities, such as decreased critical thinking skills or over-reliance on automated tools.

Therefore, when evaluating the benefits and drawbacks of implementing new technologies in entrepreneurial settings, it is crucial for faculty members and institutions to ensure that the integration of 4.0 digital technologies in EE is approached thoughtfully and balanced, maximising the benefits while mitigating any potential adverse effects.

7.3 Study's contribution to the new body of knowledge

Below Figure 8.1 shows the proposed model framework derived from the study's empirical findings, with the potential to make a substantial contribution to the existing body of knowledge. This proposed model provides a framework for effectively integrating Industry 4.0 technologies into EE to foster an entrepreneurial mindset among students. The research findings highlight the potential of these advanced technologies and the associated challenges that must be addressed.

Figure 7. 1: The digital entrepreneurship enrichment model (DEEM)



7.4 Key Components of the DEEM Model

The proposed DEEM model for integrating Industry 4.0 technologies into EE is a carefully structured framework that addresses the key components in a well-orchestrated flow.

- **Institutional Level** - This initial stage focuses on the strategic direction of the HEI. It involves developing a vision, goals, and policies to guide the adoption of digital literacy and Industry 4.0 technologies within entrepreneurship programs. Key activities include conducting needs assessments, benchmarking other institutions, and securing leadership support.
- **Faculty and Student Level** - This stage engages faculty and students directly in the integration process through awareness campaigns, training, and

incentive programs. Strategies are tailored based on the unique needs and challenges of each group determined through surveys and focus groups.

- **Digital Literacy Assessment** - This component underscores the importance of assessing the digital proficiency levels of faculty and students. Structured assessments of faculty and students' existing digital literacy skills are conducted using questionnaires, audits, and performance tasks. This provides crucial data to inform training needs and benchmark progress.
- **Assessment of Digital Infrastructure -** Based on assessment insights and stakeholder engagements, this stage focuses on modernising the institution's digital infrastructure, ensuring the necessary hardware, software, internet connectivity, and tech support for effective Industry 4.0 technology adoption. Establishing a cutting-edge digital infrastructure is imperative for seamlessly integrating Industry 4.0 technologies into EE. This stage involves a comprehensive assessment of the existing technological landscape, including hardware, software, network capabilities, and IT support systems.
- **Stakeholder Engagement** - Engaging diverse stakeholders is pivotal for aligning the integration of Industry 4.0 technologies with real-world needs and ensuring successful implementation. This stage involves proactively identifying and collaborating with key stakeholder groups such as industry partners, entrepreneurs, government agencies, and community organisations. Activities encompass conducting stakeholder mapping exercises, facilitating focus group discussions, and establishing advisory boards or steering committees.
- **Capacity Building** - With infrastructure in place, comprehensive training programs are implemented to build faculty and student competencies in utilising Industry 4.0 technologies via workshops, simulations, and certifications.
- **Reformed Curriculum and Pedagogy Design** - The entrepreneurship curriculum and instructional approaches are updated to seamlessly integrate new technologies aligned with learning objectives. Course content, assessments, and experiential learning activities are enhanced.
- **Monitoring & Evaluation** - Continuous improvement mechanisms like surveys, focus groups, and outcome data analysis are instituted to regularly assess the integration and optimise accordingly.

- **Intended Outcomes** - The ultimate objectives of this well-structured model are comprehensive and compelling. HEIs implementing this model are expected to overcome challenges and successfully integrate Industry 4.0 technologies into EE, enhance learning experiences, foster entrepreneurship mindset, digital skills, creativity, critical thinking, problem-solving, innovation, interdisciplinary collaboration, and alignment with the evolving industry landscape, preparing students to excel in the digital era, and become future-ready entrepreneurial leaders.

The primary contribution of this study represents a groundbreaking and transformative paradigm for EE that seamlessly integrates the cutting-edge technologies of Industry 4.0. At its core, this study introduced a pioneering and unprecedented model, denoted as DEEM, which serves as a beacon of structured guidance for HEIs seeking to leverage advanced technologies such as AI, VR, Big Data Analytics, and the IoT to revolutionise the landscape of EE.

What truly sets this model apart is its unparalleled capacity to address the multifaceted challenges associated with technological integration comprehensively. This includes the strategic direction of institutions, infrastructure modernisation, engagement of diverse stakeholders, the transformation of curricula and pedagogical approaches, the establishment of robust industry partnerships, and continuous evaluation of outcomes. It is, therefore, envisioned not merely to augment but also to redefine the essence of EE, moving away from conventional, classroom-centred theoretical models towards immersive, technology-driven experiential learning.

The core innovation within this model lies in its potential to act as a catalyst for the effective adoption of Industry 4.0 technologies across HEIs. It was meticulously designed to instil an entrepreneurial mindset and equip students with the requisite digital skills to thrive in an entrepreneurial landscape defined by digital transformation. The novelty of this approach lies in its provision of a comprehensive roadmap for the transformation of not just educational practices but also the mental paradigms, instructional methods, technological tools, student experiences, and, ultimately, the outcomes of EE. By strategically infusing advanced technologies, this model can be used in a profound metamorphosis in EE, forging a pioneering path toward cultivating

entrepreneurial competencies that align seamlessly with the demands of the digital age.

7.5 Research Limitations

This study has yielded valuable insights; however, it is crucial to acknowledge and address the limitations inherent in ensuring a nuanced interpretation of the findings. The cross-sectional and exploratory nature of the research indicates that the conclusions drawn are preliminary, necessitating additional longitudinal studies and a more rigorous research framework to validate and enhance the reliability of the findings.

One significant limitation of the sample size and the specific context in which the study was conducted may restrict the generalisability of the findings. Future studies could consider incorporating larger and more diverse samples encompassing various educational settings to overcome this limitation. By doing so, a broader understanding of the subject matter can be achieved, and the findings can be applied to a broader range of contexts. Moreover, employing more robust methodologies would strengthen the validity and applicability of the research outcomes.

Another limitation is the scope of the study, which was focused solely on a single institution. This selective scope introduces the possibility of contextual bias, particularly considering that the institution offers entrepreneurship programmes. Future research should include multiple HEIs with varying curriculum orientations to enhance the reliability and comprehensiveness of the findings. This approach would enable a more holistic assessment and minimise potential biases stemming from a specific institutional context.

A comprehensive understanding of adopting digital technologies in EE can be achieved by actively addressing these limitations and expanding the scope of future research. This significantly advances field knowledge and provides a solid foundation for evidence-based educational policy and practice decision-making. Exploring additional longitudinal studies, utilising rigorous research methodologies, and considering diverse samples and contexts strengthens the reliability and generalisability of the findings. Ultimately, these efforts lead to a more robust understanding of the role and impact of 4.0 digital technologies in the context of EE, facilitating informed decision-making and enhancing the quality of EE worldwide.

7.6 Future Research

While the present investigation has yielded intriguing and significant findings with implications for entrepreneurship scholars, faculty members, policymakers, and other stakeholders, it is important to recognise the need for further research to enhance the comprehensiveness and generalisability of these findings. To address this, it is recommended to incorporate a larger sample size and expand the study's scope by involving multiple institutions nationwide.

One of the limitations of the current study is the institutionally specific sample, which may limit the direct applicability of the findings to students from HEIs with curriculum orientations different from those of the participating institution. To ensure a more representative sample and broaden the generalisability of the research outcomes, future investigations should strive to include students from a diverse range of HEIs, including those with non-business orientations. By incorporating participants from various institutional contexts, the research outcomes reflect a more comprehensive understanding of the adoption and impact of 4.0 digital technologies in EE.

By addressing these recommendations, future research can provide valuable insights into the adoption and impact of 4.0 digital technologies in EE across diverse institutional contexts. This expanded scope and larger sample size enhance the validity and applicability of the findings, contributing to advancing knowledge in the field. Moreover, this research guides evidence-based decision-making and informs educational policies and practices in different institutional settings.

The practical implications of this comprehensive study are substantial. Entrepreneurship scholars benefit from a broader understanding of how 4.0 digital technologies influence EE, enabling them to refine theories and develop more effective pedagogical approaches. Faculty members gain insights into best practices for integrating digital technologies into entrepreneurship curricula, enhancing students' learning experiences. Policymakers will have access to evidence-based recommendations to inform policy decisions related to EE and technological integration. By bridging the gap between research and practice, this comprehensive study contributes to advancing the field and ultimately fosters the development of a more innovative and entrepreneurial society.

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Appendix A: Interview Guide

Interview Guide

Student Interview Questions

General

1. Please Indicate your age band
   (21-24); (25-35); (35-45); (45-55); (55-65)
2. Kindly confirm your year of study.
3. Do you consider yourself understanding and knowledgeable regarding 4.0 digital technologies in general? Are you familiar with AI, Big data, Cloud and IoT?

Drivers and Barriers

1. What drives/influences you to use digital technologies in your learning?
2. What do you think are the main barriers or sources of technology resistance? How could they be addressed?
3. What specific challenges have you encountered in using technology? How could faculty better support students in making these connections?
4. What are the main advantages of using digital platforms/technologies in your learning?
5. Do you have any concerns that would make you have reservations about accepting digital technologies?
6. Do you hesitate and need more time when using MyUnisa tools in your learning?
7. Overall, describe how 4.0 digital technologies have impacted your learning?

Practices and Perspectives

1. What do you think of the technical support regarding the struggles you face integrating digital technologies in your work? Does the university offer assistance/training support to you?
2. How have you leveraged these technologies specifically in your courses or entrepreneurship education programs? How do you think digital technology will make your learning better?
3. Are you pressured to use digital technologies when studying/learning?

4. Are you thinking critically on how to integrate technology in your daily work activities?
5. How are you using social media platforms such as Twitter, Facebook, and chats for discussion and knowledge exchange?
6. How often do you use Ms Teams/Zoom and Skype for collaboration or learning? If not, why? If yes, how is your experience?
7. In your opinion, how could the curriculum be reformed to bring more hands-on, practical experiences into the classroom using 4.0 digital technologies?

Digital Literacy

1. What type of mobile device do you own? Desktop/Laptop/Tablet/Smartphone?
2. How well do you understand the basic functions of computer hardware/software components?
3. What other modes of communicating besides emails you use with the faculty members, if any?
4. Do you find it easy to learn something by watching it on the computer screen?
5. Are you thinking critically on how to integrate technology in your daily work activities?
6. How would you characterise your level of computer literacy? What are some of the programs and application with which you are familiar?
7. How well do you use digital technologies such as AI, Big Data, Cloud Computing and IOT in your daily life or studying?
8. How often do you use Ms Teams/Zoom and Skype for collaboration or learning? If not, why? If yes, how is your experience?

Faculty member interview questions

General

1. Please Indicate your age band
   (21-24); (25-35); (35-45); (45-55); (55-65)
2. How long have you been lecturing Entrepreneurship?
3. Do you consider yourself understanding and knowledgeable regarding 4.0 digital technologies in general? Are you familiar with AI, Big data, Cloud and IoT?

Drivers and Barriers

1. Can you elaborate on how these 4.0 digital technologies have impacted your teaching methods and the breadth of content you are able to cover in Entrepreneurship course?
2. What do you think of the technical support in terms of the struggles you face integrating digital technologies in your work? Does the university offer assistance/training support to you?
3. Do you have any concerns that would make you have reservations about accepting digital technologies offered to you?
4. Can you give examples of how you have used technologies like social media, Zoom, MS Teams etc. to engage with students? What has been your experience?
5. What would you consider as the main benefits of using digital /technologies in your learning?
6. What would you also consider as the main barriers hindering you from using digital technologies efficiently and effectively?

Entrepreneurship Pedagogy Framework

1. How have the digital technologies impacted/influence your mode of teaching and researching/delivering Entrepreneurship content?
2. How have you incorporated 4.0 digital technology into lecturing Entrepreneurship? If not, are you thinking critically about how to integrate technology into your daily work activities?
3. In what ways have you adapted your teaching methods or curriculum to align with changes in entrepreneurship education?
4. What role does technology like AI, automation, virtual reality etc. now play in how you educate students on entrepreneurship? How has this changed over time?
5. How are you finding integrating digital technologies to the current pedagogical approaches?
6. Is the current entrepreneurship pedagogy framework equipping students with knowledge on how to use digital technologies in identifying opportunities or risks?

7. How have 4.0 digital technologies assisted in redesigning the traditional entrepreneurial learning experience by personalising the learning pathway through innovative modalities?
8. How do you leverage new digital technologies in unique ways to shift the conventional modes of entrepreneurship education?

Practices and Perspectives

1. How has technology impacted your work activities? Would you consider it positive or negative? And why?
2. Do you have an option to choose which technology you would want to use in your work, or the faculty imposes the technology to be used by its members?
3. How often do you use 4.0 digital technologies in your work. Has the quality changed, how productive have you been?
4. How well do you use technology in collaboration/interaction with students? If not, why and if yes, how?
5. In what ways are you leveraging industry connections and integrating practical experiences into entrepreneurship education?
6. How are concepts like experiential learning, project-based learning etc. being incorporated into entrepreneurship courses today?
7. What do you think of the technical support in terms of your struggles in integrating digital technologies in your work?
7. Do you perceive technology integration as no more than an extra burden on both teachers and students; with little educational value for time and effort invested?
8. How are your students experiencing digital technology in their lessons? What do they think about 4.0 digital technologies and learning?
9. How would you classify the faculty technologies? are they innovative and digital technology-driven techniques or they are still conventional methods? And why do you say so.

Digital Literacy

1. What type of mobile device do you own? Desktop/Laptop/Tablet/Smartphone?
2. How well do you understand the basic functions of computer hardware/software components?
3. Do you find it easy to learn something by watching it on the computer screen?

4. Are you thinking critically on how to integrate technology in your daily work activities?
5. How would you characterise your level of computer literacy? What are some of the programs and application with which you are familiar?
6. How well do you use digital technologies such as AI, Big Data, Cloud Computing and IOT in your daily life or studying?
7. How often do you use Ms Teams/Zoom and Skype for collaboration or learning? If not, why? If yes, how is your experience?

Appendix B: Participant Information Sheet

PARTICIPANT INFORMATION SHEET

15 June 2022

Title: **Impact of digital technologies on entrepreneurship education within institutions of higher education in the industry 4.0 era.**

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Dear Prospective Participant

My name is Fidel Mugunzva, and I am doing research project under the supervision of Prof Germinah Chiloane, and co-supervisor Dr Ntise Manchidi, a senior lecturer and a chair of department of Applied Management. I have been accepted by the University of South Africa (UNISA) to pursue my studies in the Doctor of Philosophy in Business Management (Full Dissertation). We are inviting you to participate in a study entitled "Impact of digital technologies on entrepreneurship education within institutions of higher education in the industry 4.0 era".

WHAT IS THE AIM/PURPOSE OF THE STUDY?

The aim of this study is to explore digital technology influenced modes of teaching, researching, and learning EE that will change the focus to inculcating a culture of creativity, innovation and cultivate the spirit of self-reliance instead of job-seeking learners. Hence this study sought to explore the current and future digital technologies that transform EE within the HE system in SA

I am conducting this research to explore industry 4.0 technologies that could enhance pedagogical practices and approaches and the development of learning tools that assess innovation-related skills that are critical in the economy.

WHY AM I BEING INVITED TO PARTICIPATE?

You are being invited to participate in this study due to your involvement or role in entrepreneurship education either as a student or academic member. By so doing you are engaged in the actual implementation of technology.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY /WHAT DOES THE RESEARCH INVOLVE?

You are invited to be interviewed about your experiences as a role player in entrepreneurship education with regard to the impact of digital technologies. The study involves semi-structured interviews, depending on your role and involvement, you will be asked about your personal experiences with and thoughts about the learning/teaching approaches, adoption of technologies in the studies etc. The duration of the interview might vary from participant to participant. It is generally expected to last between 15-20 minutes but can be shorter or longer on occasion.

CAN I WITHDRAW FROM THIS STUDY?

The participation in the study is voluntary If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any given time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

The research project proposed aims to explore digital technology influenced modes of teaching, researching, and learning entrepreneurship education (EE) that will change the focus to inculcating a culture of creativity, innovation and cultivate the spirit of self-reliance. Hence this study sought to explore the current and future digital technologies that transform EE within the HE system in SA. Digital technologies, which respond to the ever-changing societal and educational needs, would be the hallmark of HE within this revolution. However, the borderline question was whether the field of EE is prepared to deal with challenges brought about by industry 4.0. The economic benefit can be drawn from this study due to its applicability to EE in the South African HEIs and the resulting improved entrepreneurial pedagogical frameworks impacted by industry 4.0 technologies. Furthermore, the study aims to provide an opportunity for relevant arguments and opinions to be heard, collated, analysed, and presented in an objective and systematic manner.

WHAT IS THE ANTICIPATED INCONVENIENCE/RISKS OF TAKING PART IN THIS STUDY?

No risks are anticipated in this study and should any unforeseen one occurs, it will be very minimal. To ensure your anonymity, no personal identifiers will be used in the report. The data obtained from the study will be kept confidential in a secured storage requiring password/pin for access.

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WILL WHAT I SAY BE KEPT CONFIDENTIAL?

Firstly, your participation in this study is confidential. Your name will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be given a pseudo code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods.

Your answers may be reviewed by people responsible for making sure that research is done properly, including a supervisors and members of the Research Ethics Committee. However, these individuals will maintain confidentiality by signing a confidentiality agreement Otherwise, records that identify you will be available only to the researcher working on the study.

HOW WILL INFORMATION BE STORED AND ULTIMATELY DESTROYED?

Hard copies of your answers will be stored by the researcher for a period of 5 years in a locked cupboard/filing cabinet at UNISA for future research or academic purposes. Electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

There is no compensation for participating in this study. However, your participation will be a valuable addition to our research and findings could lead to greater understanding of the impact of digital technologies on entrepreneurship education.

HAS THE STUDY RECEIVED ETHICAL APPROVAL?

This study has received written approval from the Research Ethics Committee of the College of Economic and Management Sciences, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS?

If you would like to be informed of the final research findings, please contact Fidel Mugunzva on +263711369596 or 43135552@mylife.unisa.ac.za. The findings are accessible as soon as the study is completed.

Should you require any further information or want to contact the researcher about any aspect of this study, please also contact Fidel Mugunzva on +263711369596 or email 43135552@mylife.ac.za

Should you have concerns about the way in which the research has been conducted, you may contact Dr Ntise Manchidi manchnh@unisa.ac.za.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.

Fidel I. Mugunzva

APPENDIX C: CONSENT TO PARTICIPATE IN THIS STUDY FORM

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 anonymously processed into a research report, journal publications and/or conference proceedings.

I agree to the recording of the <insert specific data collection method>.

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

Participant name & surname…… (please print)

Participant signature……..Date……

Researcher's name & surname……(please print)

Researcher's signature……..Date……

Witness name & surname.....(please print)
Witness's signature…….....Date….....