Cape Peninsula
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FACTORS INFLUENCING THE ADOPTION OF IMMERSIVE TECHNOLOGIES IN HIGHER EDUCATION

By

Olivia Keneilwe Kgosiejang

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In the Faculty of Informatics and Design at the Cape Peninsula University of Technology

Supervisor: Dr Errol Francke

Co-supervisor: Dr Sheethal Tom

Cape Town

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DECLARATION

I, Olivia Keneilwe Kgosiejang, declare that the contents of this dissertation represent my unaided work and that the dissertation has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

Signed:  Date: 25.04.2024

ABSTRACT

The adoption of immersive technologies, such as augmented reality (AR) and virtual reality (VR), in higher education, has the potential to revolutionise teaching and learning by providing interactive and engaging experiences. However, the integration of these technologies is influenced by numerous factors that must be understood to facilitate their effective implementation. Immersive technology simulation systems have conquered the world not only in education systems but also in industries across the world, such as health systems, e-commerce, and more, which are using immersive technologies. These advancements in technology provide students in higher education with the opportunity to enhance their electronic learning.

This study explores the factors influencing the adoption of immersive technologies in higher education through a qualitative research approach. It is aimed at answering the research questions on the factors that could influence the adoption of immersive technologies in higher education. To achieve the aim and objectives of this study, one of the South African universities was selected as a case study. The study employed a qualitative research method, conducting online interviews with students and staff from the IT department at Cape Peninsula University of Technology Cape Town Campus. The purposive sampling method was used to select participants with relevant experience and knowledge of immersive technologies. The collected data were analysed using thematic analysis to identify key themes and patterns related to the adoption process.

TOE framework was used to guide the research questions. The study identified several critical factors influencing the adoption of immersive technologies, including technical infrastructure, curiosity, pricing reduction, organisational culture, financial resources, technology training, and stakeholder involvement. Additionally, the research highlighted the importance of management support and the relative advantage of these technologies in enhancing educational outcomes. The findings provide valuable insights for higher education institutions seeking to adopt immersive technologies and contribute to the broader understanding of the challenges and opportunities associated with the implementation.

This study's contributions are theoretical. It enriches the existing literature on technology adoption in education; methodologically, it demonstrates the utility of qualitative research in exploring complex adoption processes; and it offers actionable recommendations for institutions aiming to integrate immersive technologies into their educational frameworks.

KEYWORDS: adoption, adoption of immersive technologies, Augmented Reality, higher education, immersive technologies, immersive learning, TOE, Virtual Reality.

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DEDICATION

This dissertation is dedicated to my late grandfather, Isaac Ketlareng Kgosiejang (1943-2018). He always advocated for education and instilled the significance of education in us. I would also like to dedicate this work to my late grandmother, Goitseone Elizabeth Kgosiejang (1950-2001). Although you are not here with us, you would have been proud of this moment. I extend this dedication to my late uncle, Tebogo Lawrence Kgosiejang (1978-2006). I wish you were here to witness our achievements. Lastly, I want to dedicate this to my beloved sister, Amogelang Antoinette Monnaemang (1988-2023). You were my cheerleader, and I would have been so proud. Although you left us unexpectedly, it is God's will (thato keya Modimo).

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CLARIFICATION OF BASIC TERMS

Adoption of immersive technologies: Nastiti *et al.* (2022) define the adoption of immersive technologies as the acceptance of virtual content with the physical world.

Augmented Reality: Fombona-Pascual *et al.* (2022:2) define AR "as a system that integrates 3D virtual objects into 3D real spaces, in real-time".

Immersive Learning: Immersive learning is defined as an educational experience that is as close as possible to an authentic cultural and social environment (Tyrrell *et al.*, 2022).

Immersive Technologies: Pavithra *et al.* (2020:119) define immersive technologies as being in line with the amalgamation of "virtual content with the physical environment" so that end users interact naturally with combined reality.

Virtual Reality: Rojas-Sánchez *et al.* (2022:2) define VR "as an immersive and interactive three-dimensional computer-generated environment in which interaction can occur on multiple sensory channels such as touch and position."

Virtual Learning: Virtual learning is a mode of instruction in which teachers and students are not physically present in the same location or at the same time (Dung, 2020).

GLOSSARY

Abbreviations	Explanations
4IR	Fourth Industrial Revolution
AR	Augmented Reality
CPUT	Cape Peninsula University of Technology
DOI	Diffusion of Innovation
HMD	Head Mounted Display
IT	Information Technology
LMS	Learning Management System
MR	Mixed Reality
PG	Postgraduate
SA	South Africa
TAM	Technology Acceptance Model
Tech	Technology
TOE	Technology Organisation Environment
TPB	Theory of Planned Behavior
UCT	University of Cape Town
UJ	University of Johannesburg
UWC	University of Western Cape
VAR	Virtual Augmented Reality
VR	Virtual Reality
XR	Extended Reality

1 CHAPTER 1: INTRODUCTION & BACKGROUND

1.1 Background

The fourth industrial revolution (4IR) consists of several technologies, such as augmented reality, virtual reality, big data, and artificial intelligence, although not limited to these. The 4IR forms an environment in which virtual and physical systems collaborate in an adaptable way worldwide.

Immersive technologies are a set of advanced digital technologies that create or extend reality by immersing users in a simulated environment, often blurring the lines between the physical and digital worlds (Sherman & Craig, 2018). These technologies are recognised as the foundational elements of contemporary digital experiences, including Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), each offering varying levels of immersion and interaction (Partarakis & Zabulis, 2024). Fombona-Pascual *et al.* (2022:2) define augmented reality (AR) "as a system that integrates 3D virtual objects into 3D real spaces, in real-time". It can be denoted that AR is creating the physical world into the user interface for digital content, as it has turned out to be one of the technological advancements in the world. Virtual reality (VR) has been defined by Rojas-Sánchez *et al.* (2022:2) as "an immersive and interactive three-dimensional computer-generated environment in which interaction can occur on multiple sensory channels such as touch and position."

With the 4IR at the global doorstep, several developments in the technological arena are taking place and continue to shape the way individuals interact with technologies, from simple to more technologically advanced systems (Eheazu & Ibanga, 2022). On the same note, Mystakidis (2022) further states that immersive technologies are not limited to the Information Technology (IT) industry. However, industries across the world, including institutes of higher learning, are grasping the new norm of using immersive technologies. To better understand the subject under investigation in the current study, it is worth defining what immersive technology is. Despite the lack of a standardised definition for the term, due to its varied interpretation (Handa *et al.*, 2012), Pavithra *et al.* (2020) define immersive technology in line with the amalgamation of the "virtual content with the physical environment" so that the end users interact naturally with combined reality. Thus, students at higher institutes of learning are also not spared in the immersion process. Students make use of technology for several reasons related to their education, such as using computers to do their assignments, checking notifications on Learning Management Systems (LMS) such as the Cape Peninsula University

of Technology's Blackboard Collaborate, the University of Cape Town's Brightspace, the University of Zululand's Moodle to name but a few. Students also use mobile apps and social networks to get information on what is happening around the university. These technologies are a platform for students to learn about different technologies that are developed around the world.

The use of advanced technological applications has conquered the world in the 21st century (Pagani & Pardo, 2017). Pavithra *et al.* (2020) concur with Quan (2019) that technology has become a prerequisite aspect of day-to-day running on the academic platform. Students are perceived to be the core stakeholders in the equation of the continued growth in technology as they are linked to old, new, and future technologies (Chigona, 2018). Virtual and Augmented reality, as well as 3D, has contributed to the fourth wave of computing innovation (Mystakidis, 2022). With the advent of the notorious Coronavirus (COVID-19) pandemic in early 2020, which changed the way learning in schools and institutes of higher learning (El Said, 2021; Du Plessis *et al.*, 2022), it is along this essence that this study is aimed at understanding the factors for the adoption of immersive technologies in higher education in the African context. Technology is redefining the role and functions of lectures in higher education (Handa, 2012:2). Therefore, students must adjust to the new organisational culture and structures of learning. Porto (2020) postulates that students and lecturers should be given support, skills, and opportunities to adapt to the new technology, and doing so will provide a competitive edge in improving students' learning activities. According to Prabhakaran *et al.* (2022), knowledge and skills are crucial to advance students' learning development.

The research question in this study will explore the factors influencing the adoption of immersive technologies as well as the institution's technical infrastructure and organisational culture. Some scholars (Carmeli *et al.*, 2008; Porto, 2020) denote that technology infusion studies did not often mention organisational culture as an influential factor in the use of technology. Therefore, this study will investigate and identify the organisational culture at higher institutions. Porto (2020) further elaborates that teacher training, beliefs, administrative policies, and infrastructure at an institution are explored in studies that investigate technology infusion. According to Iljins *et al.* (2015), organisational culture can be a motivating factor in any organisation, and it can be deemed as a change management process. Thus, it is fundamental to consider organisational culture as a factor in this study that could influence the adoption of immersive technologies at an institute of higher learning.

This study's research problem has identified a need for innovative technology to help support students in enhancing their learning in higher education (Ayu, 2020). Thus, the study seeks to close the identified gap in the literature.

1.2 Research Problem

There is limited literature on the willingness to adopt immersive technologies in higher education (Stenberg & Nilsson, 2020:3). In this context, the usage of immersive technologies has not been tested at the higher learning institution of technology in the Western Cape. Thus providing the current study with the motivation to investigate the factors for the adoption of immersive technologies in higher education. Additionally, higher education institutions could miss opportunities to enhance teaching and learning through 21st-century innovative technology adoption. According to Southgate *et al.* (2019), there is a need for innovative technology to help support students in enhancing their learning in higher education.

This could be a problem for students in higher education where immersive technologies have not been adopted and implemented since these technologies may improve learning experiences in terms of engagement, motivation, the time required, knowledge and skills, student satisfaction, creativity, and innovation (Winstead, 2021).

Despite the growing interest and potential of immersive technologies such as virtual reality (VR) and augmented reality (AR) in improving learning outcomes, the adoption of these technologies in educational outcomes remains inconclusive (Poupard *et al*., 2024). Therefore, this study identified and understood the multifaceted factors influencing the adoption of immersive technologies in higher education. Hopp et al. (2020) study's outcomes provided sufficient proof for the need to explore the topic of the adoption of VAR at higher learning as 80% of participants, such as lecturers, suggest VR learning for their classes (Hopp et al., 2020). Additionally, the integration of VR in engineering education has resulted in a 60% increase in learning outcomes from hands-on experiments when compared to traditional teaching methods. Furthermore, 83% of participants expressed higher satisfaction levels with the use of VR in their learning experience (Anjos et al., 2024). Therefore, it is of paramount significance for institutions of higher learning to adopt learning systems that enhance teaching and learning remotely without too many interruptions. Immersive technologies could provide easy interactive learning and engagement between students and the learning material.

Mark and Thomas (2021) stated that immersive technologies allow students to learn in environments they could not physically be in; however, it is possible virtually. Previous research conducted by Kye (2021), which focused on immersive technologies study in Korea,

revealed that it had been forecasted that the market and people's everyday lives are bound to change further than the domain of entertainment and games due to the implementation of immersive technologies. There is, however, a lack of research about immersive technologies studies, especially in higher learning organisations of technology in South Africa (SA). Hence, this study was conducted at the Cape Peninsula University of Technology in South Africa.

It could affect the students' outcomes due to limited equipment at the higher learning institute. The adoption of immersive technologies in higher education will support learner engagement as it provides digitally generated artificial content and environments that accurately reproduce real-life situations. Therefore, if the benefits above are not provided to students, they will be missing the new skills that immersive technologies are providing. Embracing advanced teaching and learning systems such as immersive technologies could enable conducive learning for the students. Immersive technologies can promote a prominent level of socialisation in learning even with the restrictions of lockdown.

Marks and Thomas (2022:1287) state that the adoption rates of immersive technologies have not been tested at higher education institutions; hence, it is anticipated that the outcome of this research will help solve the identified problem. Oke and Fernandes (2020) state that the nature of education and learning in higher learning has not been adopted or actively transformed through immersive technologies; rather, it has remained static as mobile devices and social media are more functional in South African education.

A study to investigate the factors that could influence the adoption of immersive technologies in a higher education institution in South Africa could address the identified problem.

1.3 Aim, Objectives, and Research Questions

1.3.1 Aim

This study investigated the factors that could influence the adoption of immersive technologies in a higher education institution in South Africa. Furthermore, it aimed to provide a comprehensive analysis of the adoption of immersive technologies factors that could guide policy-making and institutional strategy in the educational field.

1.3.2 Objectives

This study aimed to achieve the following three objectives:

RO1: To examine how an institution's technical infrastructure influences the adoption of immersive technologies in higher education.

RO2: To identify how an institution's organisational culture influences the adoption of immersive technologies in higher education.

RO3: To identify how an institution's external factors influence the adoption of immersive technologies in higher education.

1.3.3 Research Questions

The research questions comprised one main research question (MRQ) supported by three sub-questions (SR1 – SR3)

Main Research Question

MRQ: What are the factors that could influence the adoption of immersive technologies in a higher education institution in South Africa?

Sub Questions

SQ1: What effect does an institution's technical infrastructure have on the adoption of immersive technologies in higher education?

SQ2: How does an institution's organisational culture influence the adoption of immersive technologies in higher education?

SQ3: How do an institution's external factors influence the adoption of immersive technologies in higher education?

Table 1.3: Research Questions and Objectives

MRQ: What are the factors that could influence the adoption of immersive technologies in a higher education institution in South Africa?	**AIM**: This study aimed to investigate the factors that could influence the adoption of immersive technologies in a higher education institution in South Africa.
How will sub-questions be answered?	The main question will be answered, and the objectives will be met.
SQ1: What effect does an institution's technical infrastructure have on the adoption of immersive technologies in higher education?	**RO1:** To examine how an institution's technical infrastructure influences the adoption of immersive technologies in higher education.
SQ2: How does an institution's organisational culture influence the adoption of immersive technologies in higher education?	**RO2:** To identify how an institution's organisational culture influences the adoption of immersive technologies in higher education.
SQ3: How do an institution's external factors influence the adoption of immersive technologies in higher education?	**RO3:** To identify how an institution's external factors influence the adoption of immersive technologies in higher education.

1.4 Research Design

This research was guided by the exploratory research design as the study focuses on exploring the in-depth adoption of immersive technologies in higher education. The study was carried out using a qualitative method, which is the most appropriate for answering the research questions to achieve the aim of the research. A South African University of Technology was used as a case study to collect data using semi-structured interviews. The data collected from the participants were analysed using thematic analysis. The qualitative method is best suited for this study as it gives details and allows a greater understanding of people's experiences and opinions.

1.5 Significances, Outcomes

1.5.1 Significance

The importance and key of this research is to lay the foundation for academics in the investigation of the usage of immersive technology at the higher learning institute and to highlight the key elements of the CPUT's existing applications/technology. This research will help in assessing the performance immersive technology could bring from a student's perspective. In addition, this research will give a better understanding of the technology or factors that could influence the adoption of technology in higher education and at CPUT.

Immersive technology has revolutionized higher education. Immersive technology should be implemented in higher education because it will enhance students' performance and broader education systems. This study proposes an immersive technology framework.

1.5.2 Outcomes

The outcomes of this study will assist higher institutes in improving their organizational culture and technical infrastructure to meet the demands of students. This may, in turn, help improve the teaching and learning of not only CPUT but other tertiary institutions at large.

1.6 Theoretical, Methodological and Practical Contributions

Theoretical contribution - The theory can be useful in developing higher institutions' organisational culture and technical infrastructure in South African universities. In particular, the factors that could influence the adoption of immersive learning are developed on a comprehensive analysis of the management involvement to influence the technical infrastructure and their vital support as their involvement has an important influence on the adoption of immersive technologies.

Methodological contribution—This research study's methodology will provide insight into qualitative methodology. It will offer an empirical understanding of the research problem and outline strategies that could be adopted in future research of a similar nature.

Practical Contribution—This research aims to investigate the factors that could influence the adoption of immersive technologies. These factors will assist higher institutions in making decisions about whether to adopt them.

1.7 Delimitations & Limitations of the Study

This research was conducted in a single case study in the Western Cape, South Africa. Due to time constraints, the findings may not be generalisable to other institutions that have adopted immersive technologies. It was limited to understanding the factors for the adoption of immersive technologies in higher education at the Cape Peninsula University of Technology. The study was restricted to IT postgraduate students and staff at the Cape Peninsula University of Technology only in the Faculty of Informatics and Design, Information Technology Department.

The study was limited to Information Technology faculty only because the participants had relevant experience and knowledge of immersive technologies. This study was limited in exploring more insights on the topic due to limited time as this is a 50% dissertation. Furthermore, while the study collected rich qualitative data through interviews, the findings represent the perspectives of a small sample, which might not fully capture the diverse views across the institution or interview other institutions. Addressing these limitations in future research could help provide a more robust and comprehensive picture of the institutional readiness for adopting immersive technologies in higher education. As a result, the scope of the study may not fully encompass all relevant factors influencing the adoption of immersive technologies and organisational readiness. It could potentially affect the depth and comprehensiveness of the findings.

Research Ethics

This research considered the following ethical requirements to ensure the reliability of this research. Ethical clearance was acquired from the Ethics Committee in the Faculty of Informatics and Design at CPUT. The researcher was aware of ethical issues such as:

Anonymity principle – The researcher kept the identity of the participants anonymous.

Confidentiality – Assuring individuals participating that the information collected will not be disclosed to anyone who is not part of the study (Trochim, 2006). A confidentiality agreement ensures that all information remains between the researcher and the respondent.

Informed consent – Participants were aware of the processes to be followed before taking part in the research.

Voluntary Participation - Voluntary participation is whereby participants willingly consent to participate without being coerced (Saunders *et al.*, 2019).

1.8 Summary of the Chapter

Chapter One presented the introduction and background of the study as well as the research problem, aim, objectives, and design. The outline below details the structure of the study.

1.9 Structure of this Research

Chapter One: Introduction

This chapter introduces the study. It highlights the main research questions, research objectives, key questions to be answered by the study, and terms related to the research, which are stated and clarified. In addition, it discusses the data collection methods, data analysis, limitations to the study, ethical issues considered, and the significance of the study. The study aims to provide an understanding of the factors that could influence the adoption of immersive technologies in higher education in South Africa.

Chapter Two: Literature Review

Chapter two broadly discusses the existing literature relevant to this study. It focuses on the review of literature on the adoption of immersive technologies. The factors and the impact of the adoption of immersive technologies impacts are presented. Secondary data, such as journals, books, internet sources, and articles, is used to gather information in this section. The theoretical framework TOE is presented in this section. TOE frameworks consist of 3 contexts, which are technology, organisation, and environment context, which is also outlined. These contexts are influential on technology adoption. This study adopts the TOE framework to guide the study on the factors that could influence the adoption of immersive technologies in higher education.

Chapter Three: Research Methodology

This chapter focuses on the different methods that are used to gather data and present the population and sample size of the study. The research methodology chapter provides details on how the research objectives were achieved. The development of the interview guide instrument is presented. Lastly, the section discusses the ethical considerations that were taken into consideration when conducting this study.

Chapter Four: Data analysis and findings

Chapter four presents the results of the gathered data. This section covers the presentation and analysis of research findings. Data presentation and analysis are completed in this chapter.

Chapter Five: Conclusion and Recommendations

This chapter concludes the study and provides recommendations.

Conclusion

This chapter has concluded chapter one of the study, and the following chapter of the literature review will be introduced.

2 CHAPTER 2: LITERATURE REVIEW

This chapter presents an extensive review of existing literature, focusing on factors influencing the adoption of immersive technologies in higher education. Secondary data, such as journals, books, internet sources, and articles, have been consulted in this section to gather relevant insights. According to Ridley (2012:3), the literature review outlines the importance of the construction of research questions. The literature review is centred on the information and factual aspects that aid the knowledge of the factors for the adoption of immersive technologies in higher education. The following sections explore institutional readiness, an understanding of immersive technologies, their use in higher education, learning outcomes, and the advantages and challenges of adopting immersive technologies.

2.1 Institutional Readiness of Immersive Technologies Adoption

Institutional readiness is a critical factor influencing the successful adoption of immersive technologies, such as virtual reality (VR) and augmented reality (AR) within higher education institutions (Ghaleb *et al*.,2021). Ahmad et al. (2024) argue that the readiness of the institution to adopt immersive technologies consists of several factors such as infrastructure, staff & faculty readiness. In particular, the technological infrastructure serves as the foundation for integrating these tools into educational settings. For immersive technologies to function effectively within an academic environment, institutions must ensure the availability of high-speed internet, sufficient bandwidth, and advanced computing resources (Sherman & Craig, 2018). Therefore, without the necessary infrastructure, such as advanced computing resources, the implementation of immersive technologies will face significant obstacles.

For instance, institutions with outdated or limited technological resources may struggle to offer effective immersive learning experiences (Ernfors, 2023). Mohamed (2023) emphasises that hardware such as VR headsets and AR devices is essential for creating engagement and providing immersive experiences that are seamless and enhance learning. Thus, the success of these technologies is heavily reliant on the institution's ability to support them with the necessary infrastructure. In addition to technological considerations, faculty and staff readiness is essential for the adoption. Gutierrez-Bucheli et al. (2024) highlight that the technical proficiency and pedagogical preparedness of educators play a crucial role.

Further, it is elaborated that faculty must be trained not only in using these tools but also in effectively integrating them into their curricula to enhance student learning outcomes. Krajčovič et al. (2022) argue that immersive technologies often require a shift in teaching

methods, necessitating ongoing professional development for educators. Abdeen (2020) agrees with Krajčovič et al. (2022) that professional development programs are necessary to provide ongoing support and training to help faculty and staff develop the necessary skills and confidence to use these technologies. Without the institutional commitment to such training programs, the full potential of these technologies may not be realised (Ahir *et al*., 2020).

In summary, institutional readiness for adopting immersive technologies in higher education is determined by multiple factors, including the adequacy of technological infrastructure and the preparedness of faculty and staff. Institutions that address these aspects are better positioned to successfully integrate immersive technologies into their educational practices, enhancing the learning experiences of students.

2.2 Understanding of Immersive Technologies

Immersive technologies are defined as the simulation of the real world through the virtual world by allowing users to perceive virtual components as a part of the real world and have an immersive experience (Turan & Karabey, 2023). Immersive technologies such as VR and AR enhance virtual learning environments to have flexible learning opportunities that allow unlimited learning anywhere (Alzahrani, 2020). Virtual Reality offers three-dimensional (3D) computer-generated environments, allowing users to interact with virtual spaces (Yung & Khoo-Lattimore, 2019). On the other hand, AR overlays digital information onto the real world, enhancing real-world scenes with additional context (Akçayır & Akçayır, 2017).

AR and VR are the primary technologies under immersive technologies, whilst MR and XR are a combination of AR and VR. VR allows students to experience environments they would otherwise not have access to. Therefore, it replaces the real world as it gives interaction and movement within the immersed environment Shen et al. (2022). In contrast, AR enriches real-world learning with virtual enhancements (Calvet, Bourdin, & Prados, 2019).

Sherman and Craig (2018) emphasise the importance of head-mounted displays (HMDs) for providing immersive experiences in VR, noting that such tools allow users to navigate virtual environments in ways that enhance learning retention and understanding. Similarly, AR can be accessed through mobile devices such as smartphones and tablets, offering flexible learning opportunities (Mohamed, 2023). The distinct capabilities of these technologies can be leveraged to enhance student learning, making them valuable tools in higher education.

Figures 2-1 and 2-2 illustrate the tools for VR and AR as well as how the technologies work. VR stimulates all the user's senses.

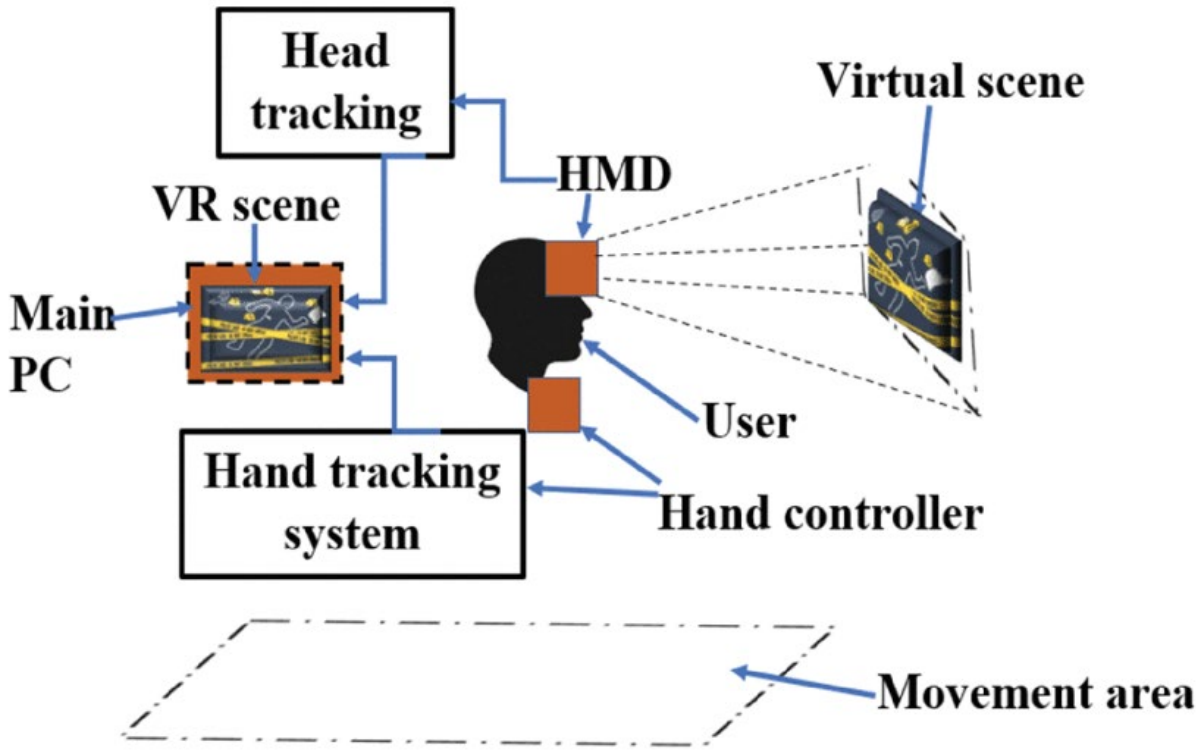


Figure 2-1 VR diagram (Maneli & Isafiade, 2023:12475)

Low *et al.* (2022) state that AR provides part of VR but remains closer to the real environment. The author further elaborates that AR uses overlays that are visually modelled on real-world scenes, and users benefit from enhanced visuals in addition to real-time visuals. Therefore, users gain knowledge through AR applications by interacting with real-time learning materials (Low *et al.*, 2022).

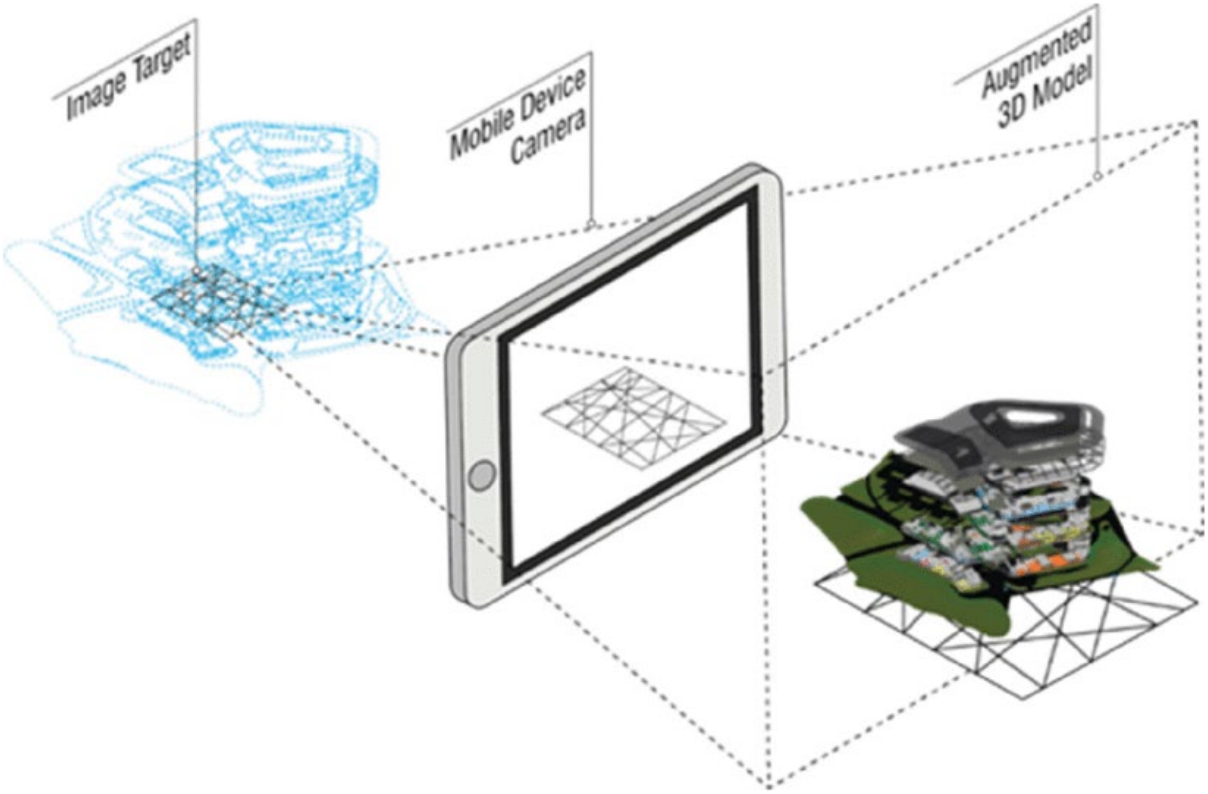


Figure 2-2 AR diagram (Maneli & Isafiade, 2023:12475)

2.2.1 The Use of Immersive Technologies in Higher Education

Immersive technologies have become increasingly relevant in higher education due to their potential to transform learning experiences. According to Abdeen (2020), immersive technologies are a significant instrument that instructors and students can utilise to advance their education, whether in the institute or in any location they are based. This flexibility is particularly beneficial for students with special needs, such as those with autism. It can be noted that engagement is a vital attribute that helps persons with autism disorder enhance their interactivity and focus on their tasks (Telisheva et al., 2022:8). This study by Telisheva et al. (2022) concurred with Abdeen (2020) to show the significance of immersive technologies for learning in enhancing the student's engagement.

However, Marks and Thomas (2022) argue that VAR technology is in the premature phases of being implemented in education. These two authors further believe that immersive learning can be conducted in settings that are normally inaccessible to scholars through spatial models and 360 ° collaborative video (Marks & Thomas, 2022). Thus, Immersive technology provides students with experiences in a variety of physically inaccessible environments. Therefore, through the implementation of immersive technology in higher education, students can access any environment and model in a virtual world and will be allowed to interact with other peers

virtually (Yung & Khoo-Lattimore, 2019). The impact of the COVID-19 pandemic further accelerated the need for immersive and remote learning solutions (Mulenga & Marbán, 2020). Institutions worldwide turned to remote applications like Microsoft Teams and Google Hangouts, but immersive technologies offer deeper, more interactive alternatives for remote education (Szopiński & Bachnik, 2022).

Immersive technologies are deemed beneficial in higher education. Students make use of these technologies to enhance their learning, and several authors in their papers identified that the use of VAR in education provides significant improvement. South African universities such as the University of Western Cape, the University of Johannesburg, and Cape Town University have implemented immersive technologies in their course. For instance, UWC implemented VAR in their PG Diploma (Ntaba & Jantjies, 2019). UWC students identified the importance of using VAR in their course, as they identified that the use of these technologies improved their engagement, and they enjoyed learning in an immersed environment (Ntaba & Jantjies, 2019). It can be noted that immersive technologies are an effective opportunity to optimise the learning and teaching processes in higher education.

2.2.2 Adopting VAR Technology in Higher Education.

Research shows that the adoption of immersive technologies can significantly enhance learning outcomes. Mystakidis *et al.* (2022) articulated that the integration of Virtual and Augmented Reality (VAR) technologies in higher education has garnered significant attention due to their potential to transform traditional learning environments and highlight that these technologies provide students with experiences that foster deeper engagement with learning materials. This is particularly evident in the case of virtual simulations that allow students to explore complex concepts in a more interactive manner (Matome & Jantjies, 2021).

Baxter and Hainey (2024) support the claims made by Mystakidis et al. (2022) that VAR technologies, encompassing Virtual Reality (VR) and Augmented Reality (AR), offer immersive experiences that can enhance students' interactions with educational content, thereby potentially improving learning outcomes. Several studies have highlighted the positive impact of VAR technologies on student engagement and learning.

Supporting this, a report by Price Waterhouse Coopers (PWC, 2020) underscores the potential of virtual learning environments to boost student engagement significantly. The study found that students immersed in virtual learning were up to 75% more active in applying what they had learned compared to those in traditional learning environments. Moreover, students using VR technology showed a 40% improvement in learning outcomes, a figure that surpasses the

35% improvement observed among students in conventional learning. This data suggests that the immersive nature of VR can greatly enhance the retention and application of knowledge, making it a promising tool in educational contexts.

Furthermore, Winstead (2021) claims that virtual learning environments promote more interaction between students and instructors, a factor that has been shown to improve student concentration and understanding of complex concepts. However, Hamilton et al. (2021) point out that traditional learning methods still have their place, particularly for students who may struggle with the steep learning curve of immersive technologies. Virtual learning is a mode of instruction where teachers and students are not physically present in the same location or at the same time (Dung, 2020). This approach uses various digital tools and technologies such as IT applications, VR, multimedia resources, the Internet, and videoconferencing to deliver course content and facilitate learning (Dung, 2020). Murray (2015) defines traditional learning as a conventional educational system where instruction takes place in a physical classroom setting. In this approach, all students receive the same information delivered in a uniform structure and through a standardised interface, ensuring a consistent learning experience for every learner. In addition, this increased interaction is seen as a key factor in enhancing students' concentration and learning speed (Hill & Du Preez, 2021). In virtual learning environments, students can experience simulations and scenarios that closely mimic real-world situations, which can help in developing practical skills and a better understanding of theoretical concepts (Tene *et al*., 2024). Meanwhile, traditional learning students are more equipped with theory than experiment (Hamilton *et al*., 2021).

Positive results were reported on the usage of immersive learning in SA by studies conducted in UJ (Penn & Ramnarain, 2019) and UWC (Ntaba & Jantjies, 2019). A study was conducted at UJ whereby a “30-item pre-attitude test was administered to assess students’ attitudes towards chemistry, followed by PhET chemistry simulation learning interventions” (Penn & Ramnarain, 2019). Subsequently, students wrote a post-attitude test. The study identified that students showed a positive attitude towards virtual learning and scored higher on the post-attitude test. Ntaba and Jantjies (2019) revealed that the adoption of AR and VR in higher education contributed to learner engagement and enhanced learning outcomes.

The existing literature on VAR technology in higher education presents a mixed yet optimistic view of its impact on learning outcomes. While studies such as those by Matome and Jantjies (2021) and PWC (2020) demonstrate clear benefits in terms of student engagement and knowledge retention, other researchers highlight the practical challenges that must be overcome for these technologies to be more widely adopted and effective.

2.2.3 Advantages and Challenges of Adopting Immersive Technologies in Higher Education

This section identifies the advantages and challenges of adopting immersive technologies.

2.2.3.1 Advantages (Benefits)

According to Shen *et al.* (2022), in a study conducted in China, immersive technologies have the potential to provide a good learning experience for students in higher education. This school of thought (Shen *et al.*, 2022) further identified the potential benefits of adopting immersive technologies, such as reducing cognitive overload, providing enjoyment, and increasing motivation for students to learn. Furthermore, Jantjies et al. (2018) report that VR and AR technologies offer students unlimited access to practice sessions and create unique blended experiences between the physical and digital worlds.

In addition, a study conducted at the University of Western Cape in South Africa (Jantjies *et al.*, 2018:43) states that experiential learning is a good opportunity for students as immersive technologies have proved to be effective in learning. Although immersive technologies generate unique experiences by blending the physical world with digital reality, they have challenges that need to be considered before their implementation. (Handa, 2012:2; Pavithra, 2020). These technologies can broaden the education systems by improving the adoption of new technologies. Additionally, Immersive technologies can be a useful tool to enhance the students' learning experience (Sanfilippo *et al.*, 2022).

2.2.3.2 Challenges and Criticism

Despite the promising potential of VAR technologies, their adoption in higher education has not been without challenges. Radianti et al. (2020) argue that while immersive technologies like VR and AR hold significant promise, they have yet to achieve widespread adoption in higher education. The authors identify several barriers to adoption, including usability issues, costs, the quality of display systems, the incidence of motion sickness among users, and recognition inaccuracies in AR systems. These challenges can hinder the effective implementation of VAR technologies and may limit their potential to improve learning outcomes. Moreover, Radianti et al. (2020) suggest that the novelty of VAR technologies may contribute to their mixed reception in educational settings. Landers and Armstrong (2017) agree with Radianti et al. (2020) that while some educators and institutions are quick to adopt these technologies, others remain sceptical, often due to concerns about the cost, the need for specialised training, their utility and potential steep learning curve as well as the perceived lack of evidence supporting their efficacy in improving learning outcomes.

As much as AR/VR adoption has great benefits it offers, it also has challenges to consider, such as the time commitment to educate/ train students to use these technologies, as well as the perceived complexity of the use of VAR (Matsika & Zhou, 2021). Serrano-Ausejo and Mårell-Olsson (2023) concur with Matome and Jantjie (2019) as they identified the lack of knowledge students and teachers have on technology and the fear of using immersive technologies. Therefore, it can be noted that there could be a possibility that the time to educate the students and educators could take long for them to get used to using immersive technologies. Additionally, the complexity of the use of VAR needs to be taken into consideration, as students and educators might find it hard to adjust to using VAR applications for their learning (Taghian *et al.*, 2023). The main issue students encounter in the use of visual learning is with Internet access; it can be a challenge to have a slow Internet connection (Matome & Jantjie, 2019).

Developing countries such as South African higher education institutions have not fully adopted immersive technologies in their education, for instance, medical training, due to the lack of infrastructure, which is considered as the deter in the adoption process (Solomon, 2020) In addition to the challenges, a lot needs to be considered before the adoption as finances might be constrained. This is due to the expensiveness of the adoption process (Matsika and Zhou,2021). Most importantly, the readiness of the institution must be identified before the adoption process, as this will reduce the challenges in the adoption process (Ernfors, 2023).

Mohamed (2023) identified that AR uses mobile devices and Google glasses, whereas VR uses Google glasses as well as HDM head tracking. Therefore, Megatami *et al.* (2023) claim that these tools could cause motion sickness if they are used for a long time, and students complained of having headaches after utilising the HDM head tracking system. Swallow *et al.* (2022) state that resistance to change has been identified as a challenge in the adoption process. The students take time to adapt to the new form of learning as they are used to traditional learning. Thus, it is not easy to rapidly adapt to the new uses of VAR (Solomon, 2020; Radianti *et al.*, 2020).

The study conducted by Ntaba and Jantjies (2019) on immersive technologies identified challenges such as users complaining about feelings of isolation. This is because immersive technologies make users to be physically detached from one another. A study by Poupard et al. 2024 reveals that VR, which often induces extraneous cognitive load, can hinder learning, particularly for novice learners. On the contrary, AR tends to optimise cognitive load, benefiting novice learners but showing reduced effectiveness for those with intermediate experience.

The effects on intrinsic motivation remain inadequate (Poupard *et al.,* 2024). However, the impact of VR and AR on learning could vary significantly based on factors such as subject matter, instructional design, and individual learner differences (Tene *et al.,* 2024). The ongoing evolution of VAR technologies, along with continued research and development, will play a crucial role in addressing these challenges. As institutions experiment with and refine their use of VR and AR in educational contexts, it will be important to focus on improving usability, reducing costs, and providing adequate training for educators and students.

2.3 Adoption of Technology

Rogers (2003: 49) defined innovation as “an idea, practice, or object perceived as new by an individual or other unit of adoption”. Technology has become a prerequisite aspect of day-to-day operations not only on academic platforms but also in businesses and many other industries. Some factors need to be considered before the adoption of any technology, such as the readiness of the organisation, finances, and technical infrastructure of the organisation (Ernfors, 2023). This will reduce the likelihood of risks that may occur during the adoption. The adoption of information technology innovation involves the adoption process, which includes initiation, decision to adopt, and implementation (Huda *et al.*, 2023).

The most used theories in the investigation of technology adoption are the Technology Acceptance Model (TAM), the Diffusion of Innovation (DOI) theory, the institutional theory, the theory of planned behaviour (TPB), the TOE Framework, and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Oliveira & Martins, 2011:110). The below curve shows five stages of technology adoption that can used.

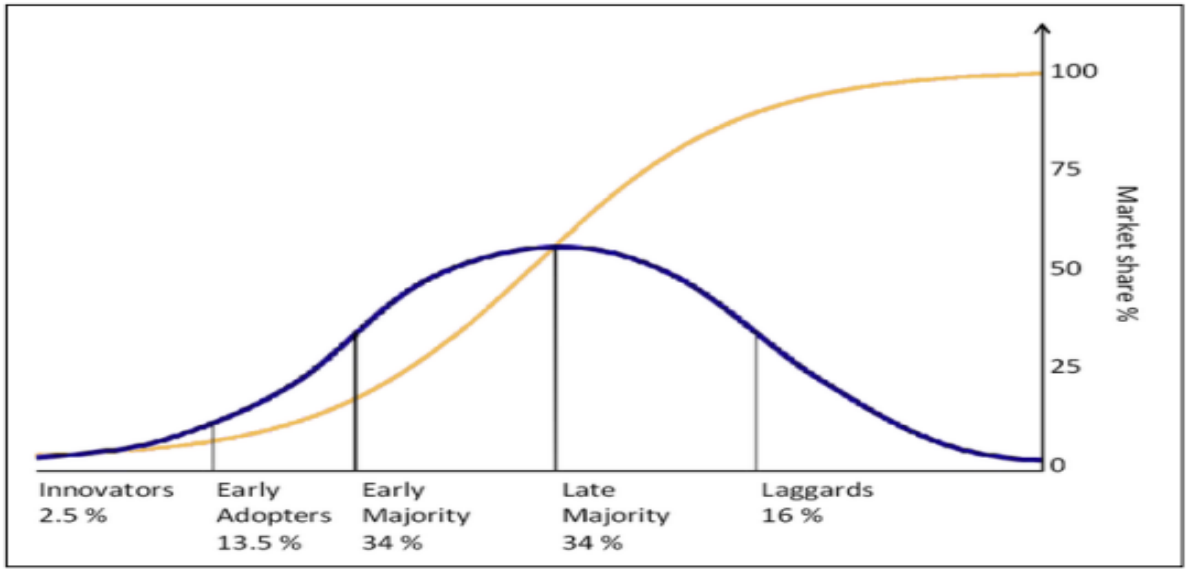


Figure 2-3 Rogers' Adopter Categories- Diffusion of Innovation Model (Rogers, 2002; Dube & Gumbo, 2017:39)

The five stages of adopters illustrate the innovator's population of 2.5% and identify that the innovators are young individuals who are not afraid to take risks. In addition, early adopters have a population of 13.5%; it can be noted that innovators influence these adopters, and they can take risks as well. There are early majority adopters with a population of 34%. These individuals refer to the previous adopters to learn about the operation of the technology and see how they can operate and adapt. The second last of the adopter's late majority, with the same population as the early majority, are sceptical of innovative technology, they are resistant to change, and they investigate the costs of the technology, advantages, and disadvantages of the product. The last stage is the laggards, which have a population of 16%. This generation consists of the older ones with less income, which makes it unaffordable for them to adopt innovative technologies. Laggards value the reliability and stability of old products and may adopt new technologies as they go on promotion.

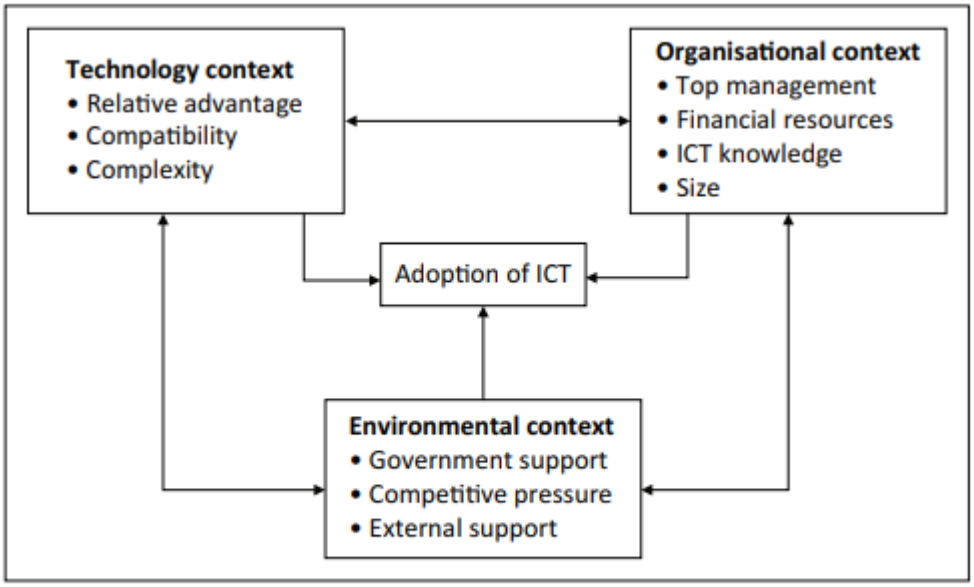
The table below displays related findings on the adoption of immersive technologies in higher learning in South Africa.

Table 2-1 Studies Related to the Adoption of Immersive Technologies and Their Outcomes

Authors	Title	Objective	Findings
Ntaba and Jantjies (2019)	Open distance learning and immersive technologies: A Literature analysis	To investigate how augmented and virtual reality is currently being used to enhance higher education.	The study's findings identified that Augmented and Virtual Reality adoption in higher learning institutes significantly impacts learner engagement and improves students' learning results. Additionally, literature has shown that immersive learning is used as an accompaniment to traditional learning rather than replacing it.
Hill and Du Preez (2021)	A Longitudinal Study of Students' Perceptions of Immersive Virtual Reality Teaching Interventions	The objective of the study was to explore students' perceptions of the use of VR as a teaching intervention during lectures in an undergraduate taxation module.	The findings show that students were optimistic about participating in VR learning. Based on their reflection, they stayed positive during their academic year as the VR implementation was rolled out on three different occasions. Students agree that VR is an efficient and innovative way to improve education.
Elme *et al.* (2022)	Immersive virtual reality in STEM: is IVR an effective learning medium, and does adding self-explanation after a lesson improve learning outcomes?	To investigate the effects of an immersive virtual reality (IVR) science simulation on learning in a higher educational setting.	The study's results suggest that the IVR class was efficient and effective for learning. However, including a written self-explanation task did not contribute to the effectiveness of learning after a long IVR session. Therefore, the IVR lesson is identified as an effective way to enhance learning.
Shen *et al.* (2022)	Exploring the factors influencing the adoption and usage of Augmented Reality and Virtual Reality applications in tourism education within the context of the COVID-19 pandemic	Influencing factors that determine the acceptance of Augmented Reality and Virtual Reality applications in tertiary tourism education within the context of the current pandemic.	The results showed that factors such as perceived usefulness, hedonic motivation, and price value are significant forecasting factors for the adoption and use of AR/VR technology.

2.4 Theoretical Framework

This section will discuss the framework that will guide the study. This study will use the Technology-Organization-Environment (TOE) framework by Tornatzky and Fleischer (1990). As shown in Figure 2-4, the TOE framework consists of three contexts: Technology, Organization, and Environment. These three contexts guide the decision to adopt innovation, which will be elaborated on in this section.



Source: Tornatzky, L.G., Fleischer, M. & Chakrabarti, K., 1990, *Processes of technological innovation*, Lexington Books, Lexington, MA.

ICT, Information and communication technology.

Figure 2-4 Technology-Organization-Environment (TOE) framework (Jere & Ngidi, 2020:3)

2.4.1 TOE Framework

According to Tornatzky and Fleischer (1990), the Technology-Organization-Environment framework outlines the factors that could impact an organisation's adoption of technology. The technology context investigates the internal and external technologies available in an establishment. The organisational context describes the organisation's attributes, such as staff capacity and structure. The environmental context discusses external forces such as competitors, industry, and regulations.

According to Baker (2012), TOE illustrates the factors that could influence the adoption of immersive technologies. This framework is an organization-level theory that describes the three contexts that could influence technology adoption. Tornatzky and Fleisher (1990) mentioned these contexts above.

2.4.2 The Technological Context

The technological context refers to the internal and external technologies relevant to the organisation (Tornatzky & Fleisher, 1990). Researchers like Grover (1993) and Mishra *et al.* (2007) state that current studies on the TOE framework have found that the TOE framework is widely applicable to innovation adoption. The technological context shows the suitable technologies and the existing technology of the establishment or institution, including the ones existing in the market, although not in use, such as immersive technologies, metaverse, and VAR that are currently in the marketplace but not used in higher institutes (Gangwar *et al.,* 2015). This framework will assist in identifying the current technologies at CPUT and the immersive technology to be adopted by the institution. Abrahams (2010) states that the organisation's current technologies are crucial in the adoption process as they depict the rate of technological change the higher institute can afford. This will influence organisations' decision to adopt the technology.

2.4.3 The Organisational Context

The context of an organisation refers to the organisation's features and resources, such as its culture, staff capacity, size, and infrastructure. It can be said that there are limited circumstances in which organisational context will affect the adoption. Organisational factors have been identified to promote innovation; moreover, it is studied to identify the factors that could influence the adoption process of innovation (Galbraith 1973; Tushman and Nadler 1986).

2.4.4 The Environment Context

According to Oliveira and Martins (2011), the environmental context refers to the external factors that can influence an organisation's technology adoption. It consists of factors such as the regulatory environment and competitive pressure in the TOE framework for this study. The regulatory environment refers to government regulations and policies that may either encourage or hinder technology adoption (Felemban *et al.*, 2024). On the other hand, competitive pressure refers to the competitive pressure within the market and the presence of technology providers (Zhu *et al.,* 2006). The environmental context reflects the external pressures and incentives that drive organisations toward adopting new technologies. For instance, in a highly competitive industry, organisations might adopt new technologies to gain a competitive edge.

Based on the above discussion of the TOE framework, Figures 2-5 show the researcher's conceptual framework that will be used in the study.

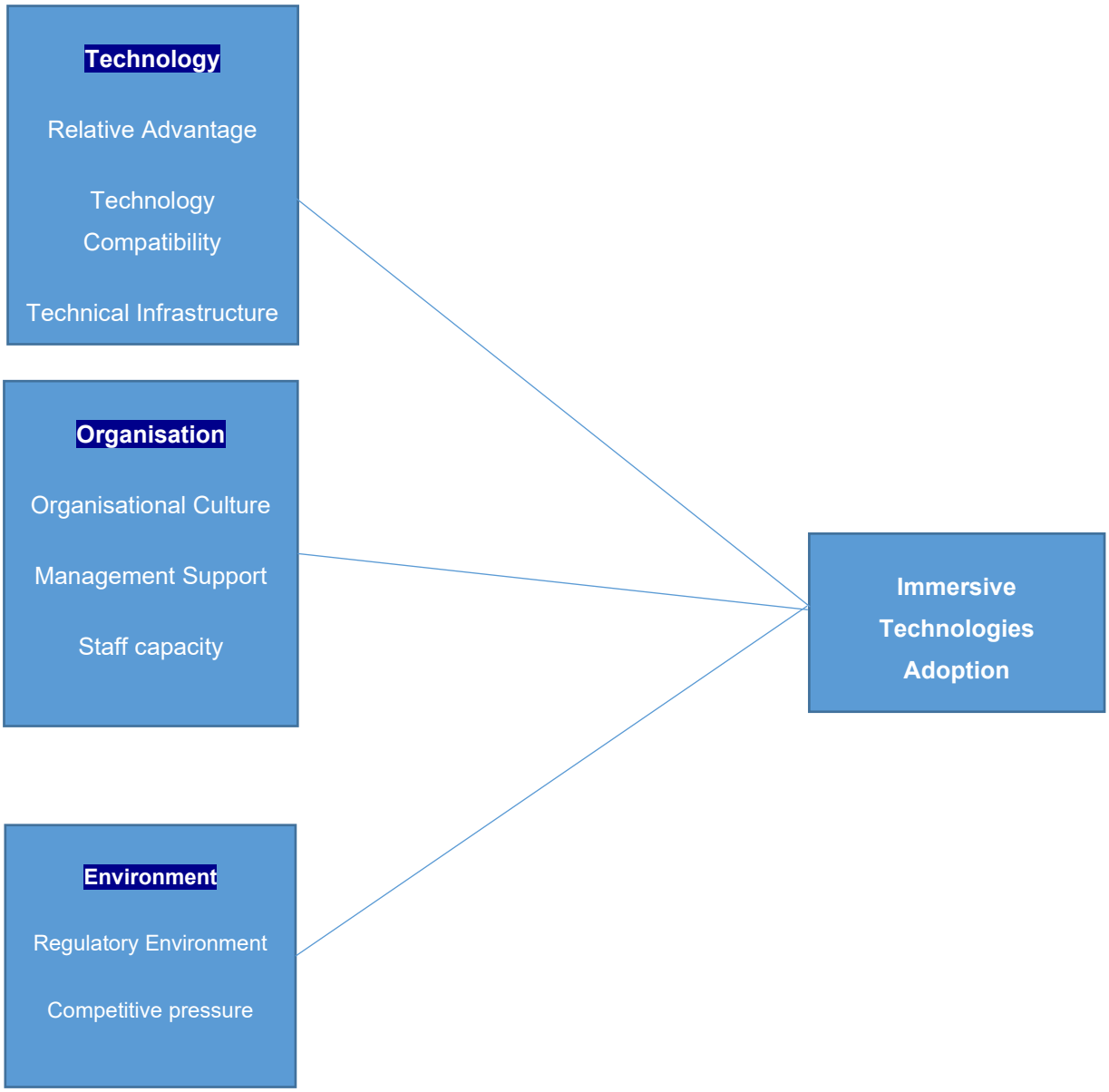


Figure 2-5 Technology-Organization-Environment (TOE) Conceptual Framework for the Research Study

2.5 TOE Factors that are Used to Guide the Study

2.5.1 The Technological Context

The technological context refers to the internal and external technologies relevant to the organisation. This includes both the existing technologies within the organisation and the modern technologies under consideration. Key factors within this context include:

2.5.1.1 Relative advantage

Rogers (2002) defines relative advantage as “the degree to which an innovation is perceived as better than the idea it supersedes.” Technology's benefits contribute to the influence of technology adoption. The relative advantage may be able to comprehend the results of the adoption as it will be able to lay out the advantages of the innovation, including the total cost of ownership (Amini & Bakri, 2015).

2.5.1.2 Technology Compatibility

Compatibility has been defined by Tashkandi and Al-Jabri (2015) as “the degree to which the innovation fits with the potential adopter’s existing values, previous practices, and current needs”. Technology compatibility is crucial in technology adoption as it determines whether the current technology will be suitable for the new technology adoption (Choi *et al.*, 2020:10). Determining the compatibility of the technology is the factor that will provide an idea on the decision-making in terms of the adoption. This will also outline the organisation’s technical ability to adopt new technology.

2.5.1.3 Technical Infrastructure

Bonga (2018) identifies that technical infrastructure investigates the technology that is suitable and existing technology as well as the ones that are available in the market. The technological context highlights the importance of technological characteristics in the adoption decision, emphasising that organisations are more likely to adopt technologies that are seen as beneficial, easy to use, and compatible with their current systems.

2.5.2 The Organisational Context

The organisational context focuses on the internal characteristics of the organisation that influence technology adoption. These key factors include organisational culture, top management support, staff capacity and organisational readiness.

2.5.2.1 Organisational Culture

Schein, 2010 defines organisational culture as the shared values, norms, beliefs, and practices that shape the behaviour and practices within an organisation. Druhova and Li (2024) state that it encompasses the norms, shared values, and underlying assumptions that influence how members interact and work together. Organisational culture is more than just a reflection of established practices within a company; it is a core element that shapes strategic directions and guides the overall orientation of business activities (Druhova & Li, 2024). Therefore, in terms of the adoption of immersive technologies, organisational culture can influence the adoption or hinder the process. Furthermore, Bamidele (2022) asserts that an organisation's

culture is shaped as it navigates and adapts to both external and internal challenges. It can be noted that a strong organisational culture aligns the organisation's goals with its member of staff behaviours, fostering an environment that supports strategic objectives and drives performance (Schein, 2010). This plays a crucial role in the acceptance of a new technology (Na *et al.*, 2022). Institutional culture also plays a significant role in the readiness to adopt immersive technologies. Al-ma'aitah (2024) elaborates that a culture that values innovation supports technological experimentation, and encourages collaboration across departments can significantly facilitate the adoption process. Conversely, institutions with a more traditional or conservative approach to education may encounter resistance to change, making it more difficult to implement new technologies (Moran, 2016).

2.5.2.2 Top Management Support

Top management plays a crucial role in the decision-making in terms of the adoption process. Top management that sees the benefits of innovative technology adoption, such as immersive technologies adoption, will support the initiative and provide the resources (Amini & Bakri, 2015). Their support influences the implementation of new technology and limits resistance to change from other members.

2.5.2.3 Staff Capacity

Staff capacity falls within the organisational structure and outlines the size of the staff (Lusthaus, 2002). Hameed et al. (2012) proclaim that larger organisations often have more resources to adopt new technologies but may face greater complexity in implementation.

2.5.2.4 Organisational Readiness

Senyo *et al.* (2016) define organisational readiness as the organisation’s ability to adopt new technologies. It can be evaluated by the organisation’s resources, such as technical infrastructure, finances, and top management. The structural and human resources aspects enhance the organisation’s readiness to adopt new technology. This context underscores that organisational attributes, such as size, culture, readiness, and leadership, are critical determinants in the adoption process.

2.5.3 The Environment Context

The environmental context refers to the external factors that can influence an organisation's technology adoption. These factors include the regulatory environment and competitive pressure.

2.5.3.1 Regulatory Environment

Oliveira *et al.* (2014) state that the regulatory environment refers to the support from the government to encourage innovation within the organisation. It is significant for the government's intervention in assisting higher institutes of education to adopt new technologies. It can be costly to adopt immersive technologies due to a lack of resources to maintain compliance with the regulations.

2.5.3.2 Competitive Pressure

According to Amini and Bakri (2015:127), "The level of pressure experienced by the firm from competitors within the industry is referred to as competitive pressure." External factors such as competitive pressure influence the adoption of modern technology. The organisation can feel the pressure if other parties within the industry have improved their technical infrastructure and adopted new technology. The adoption of innovation is a strategic way of outshining your competitor in the market. Therefore, this will bring a better marketing strategy.

The environmental context reflects the external pressures and incentives that drive organisations toward adopting new technologies. For instance, in a highly competitive industry, organisations might adopt new technologies to gain a competitive edge (Low *et al*., 2011).

2.6 TOE Summary

The TOE framework provides a comprehensive and structured approach to examining the factors that influence technology adoption in organisations. By considering the technological, organisational, and environmental contexts, researchers and practitioners can gain a deeper understanding of the complexities involved in the adoption process. This theoretical framework remains a valuable tool for studying technology adoption across various industries and technological innovations. Further empirical research is needed better to understand the long-term impacts of VAR on learning outcomes and to develop best practices for their implementation in higher education. Lecturers and students can benefit from the adoption of VAR in higher institutes as it is a beneficial technology. The next section will cover the research design and methodology.

3 CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This section outlines the design and research methodology used for the completion of this research. In this section, aspects such as population, sample, data collection, and analysis are discussed. Research has been defined by Adam (2021:388) “as the creation of new knowledge and/or the use of existing knowledge in a new and creative way so as to generate new concepts, methodologies, and understandings.” Research is viewed as a method of using systematic techniques to increase information in a particular field of study (Tranfield *et al.*, 2003:207). This research was conducted systematically, implementing all the research processes and ethical observations.

Figure 3-1 illustrates the research onion, a multi-layer model that shows six layers of design considerations (Saunders et al., 2019). According to Abdelhakim (2021), the research onion has many layers of description that are crucial to formulating an effective design tool from which methodology arises. This study followed the research onion to formulate an effective design tool whereby the research onion model informs the design.

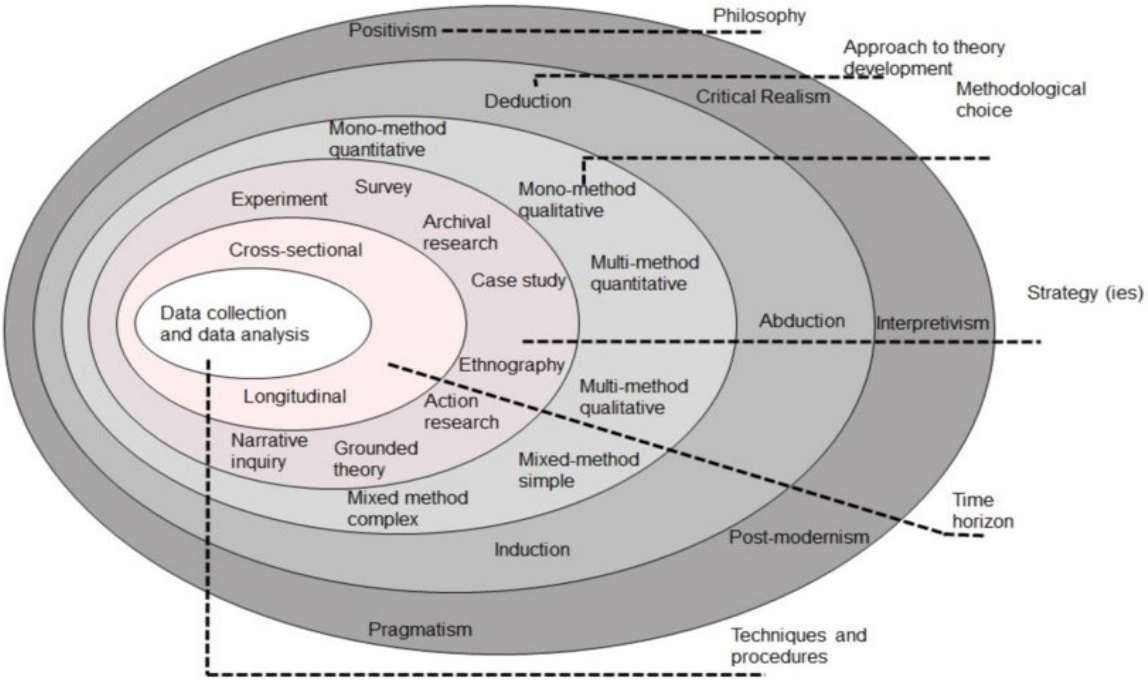


Figure 3-1 The Research Onion (Saunders et al., 2019:108)

3.2 Research Design

Research design can be defined in many ways. Welman et al. (2005:52) defined research design as “the plan according to which research participants are obtained and information is collected from them.” Kothari (2004:31) defines it as the conceptual design where research is undertaken, and it outlines the plan for the data collection, how it will be measured, and how it will be analysed. The design of this study was guided by the six layers of research onion from (Saunders *et al.*, 2019. This study navigated through the layers of the research onion to make informed design decisions, shaping the overall methodology and approach. The research philosophy, research approach, methodological choice, strategies, time horizon, and techniques and procedures are discussed in this chapter. The research design outlines the methods for data collection, the tools utilised, and the procedures for analysing the collected data (Business Dictionary.com, 2015).

An exploratory research design guided the study to meet the set objectives. The exploratory research design was deployed using a qualitative approach. Researchers such as Saunders *et al.* (2012) and Mohajan (2018) articulate that an exploratory research design gives the researcher knowledge of the study's problem and ideas based on the participants' answers to the research questions. Therefore, this helped the researcher understand the topic in-depth (Saunders *et al.*, 2012).

The research onion, proposed by Saunders et al. (2019), provides a structured and comprehensive framework for designing research, guiding researchers through each layer of methodological decisions, from the outermost layer (philosophical positioning) to the innermost layer (data collection techniques). The metaphor of the onion represents the sequential layers of decisions that need to be made in developing a coherent research design. Each layer influences the next, helping researchers clarify the key elements of their study and ensuring alignment between research questions, methodology, and analysis. In this study, the research onion framework was instrumental in guiding decisions across multiple dimensions, ensuring that the research design was systematic and well-considered.

How the Research Onion Informed this Study

The research onion was instrumental in structuring this study's entire research design. It provided a clear pathway, guiding decisions at every stage of the research process. The framework helped align the research philosophy with the chosen methodology, ensuring coherence between the research question and the approach taken.

Philosophy: The constructivist philosophy guided the focus on participants' subjective experiences with immersive technologies.

Approach: The inductive reasoning aligned to generate new insights rather than testing pre-existing hypotheses.

Strategy: The case study method was suitable for the detailed examination of the specific institutional context.

Choice: The mono-method (qualitative) approach ensured in-depth, focused data collection on institutional readiness.

Time Horizon: A cross-sectional design was appropriate for capturing a snapshot of the current state of institutional readiness.

Techniques: Semi-structured interviews and thematic analysis provided the necessary flexibility to explore participants' insights while ensuring consistency in data analysis.

By following the research onion, this study was able to systematically approach the complex issue of immersive technology adoption in higher education, ensuring all methodological elements were carefully considered and aligned.

3.2.1 Research Philosophy

Research philosophy is the outermost layer of the research onion. It relates to research philosophy, which refers to the set of beliefs regarding the nature of knowledge and how it should be acquired. According to Cresswell (2014), In this study, research philosophy is used interchangeably with research paradigm, as both refer to the foundational set of assumptions about reality, knowledge, and the methods through which knowledge is obtained (Saunders *et al.,* 2019). A research paradigm, such as constructivism, shapes the researcher's approach to inquiry, influencing decisions related to methodology, data collection, and analysis (William, 2024). The constructivism paradigm focuses on multiple realities and getting in-depth facts about individuals' feelings, experiences, and opinions regarding a specific topic. It can be noted that constructivism deals with the findings that are subjective and relevant to the research. For this study, a constructivist philosophy was adopted. Constructivism posits that reality is socially constructed, meaning individuals create meaning through their experiences and interactions with the world (Lincoln & Guba, 1985). This philosophical stance is appropriate for this research because the study seeks to explore participants' subjective experiences and perspectives on immersive technology adoption within higher education

institutions. The constructivist approach underpinned the qualitative nature of the study, focusing on the detailed understanding of institutional readiness as shaped by the participants' insights.

This research paradigm is mostly relevant to be used in a qualitative study as it allows the researcher to construct the knowledge and results from the individuals' factual experiences and existing literature. On the other hand, positivism is believed to have real, hard, and external reality (Cohen *et al.*, 2000; Kamal, 2019). Positivism is mostly relevant to quantitative study because it is used to measure, control, and generalise results using surveys and experimental methods.

Advantages of Using the Constructivist Paradigm in this study

Rich, In-Depth Understanding: Constructivism allowed the researcher to gain a deep, nuanced understanding of participants' experiences. By focusing on individual interpretations, I uncovered insights that are not readily available through objective, quantitative methods. The constructivist paradigm is particularly useful for investigating complex social phenomena, where multiple perspectives and experiences contribute to the overall understanding of the issue (Acharya, 2024). This is ideal when researching areas such as organisational change, learning processes, and technology adoption.

The paradigm allows for flexibility in data collection and analysis, which enables the researcher to explore participants' experiences in an open-ended way. This flexibility is beneficial for capturing unexpected findings and developing new theories from the data. Constructivist research emphasises giving voice to participants, ensuring that their perspectives and experiences are at the centre of the study. This is valuable for understanding how individuals experience phenomena within their unique contexts.

Relevance of Constructivism to this Study

In the context of this study, which explored the factors that could influence the adoption of immersive technologies, the constructivist paradigm was particularly appropriate for several reasons, such as the readiness of an institution to adopt new technologies, which was shaped by the perceptions and experiences of key stakeholders, faculty staff, and students. By using the constructivist paradigm, the research was able to capture the diverse perspectives on technological readiness, which varied based on individual roles, experiences, and expectations. This study aimed to understand how different stakeholders within a higher education institution perceive and experience the process of adopting immersive technologies.

Constructivism enabled the research to delve into the subjective meanings and interpretations that participants ascribe to the adoption process, providing a holistic view of the institution's readiness. The adoption of immersive technologies is influenced by the specific context of the institution, including its technological infrastructure, organisational culture, and leadership. Constructivism allows for the exploration of how these contextual factors shape stakeholders' experiences and readiness for adoption. The researcher engaged with participants through semi-structured interviews, and the researcher and participants co-constructed knowledge on the topic. This process of interaction aligns with the constructivist paradigm, as the researcher sought to understand the participants' constructed realities regarding the factors that could influence the adoption of immersive technologies, including the institution's readiness.

The constructivist paradigm is well-suited for exploring the complex, subjective, and context-dependent nature of institutional readiness for adopting immersive technologies (Acharya, 2024). Its emphasis on understanding participants' perceptions and the context-specific factors influencing adoption makes it a valuable framework for this study. By using a constructivist approach, the research can generate rich insights into how different stakeholders within the institution experience and interpret the factors that affect readiness for technological change.

3.2.2 Research Approach

Research approaches typically distinguish between deductive and inductive reasoning. There are two approaches in research, namely inductive and deductive approaches. According to Armat et al. (2018), the inductive approach is used when there is inadequate literature on the existing research findings. The scholars further elaborate that during the researcher's analysis, innovative ideas and theories will be discovered inductively. This approach is used to create new knowledge and theories from the data collection. The deductive approach has been defined by Creswell and Clark (2007) as carrying out the work from the top down and from a theory to a hypothesis. Differently, an inductive researcher carries out work from the "bottom-up, using the participants' views to build broader themes and generate a theory interconnecting the themes" Soiferman (2010:3).

In this study, an inductive approach was adopted. The inductive approach is appropriate for qualitative research because it allows the researcher to develop theories and patterns based on the data collected rather than testing pre-existing hypotheses (Bryman, 2016). For this study, the inductive approach enabled the researcher to generate insights and theories regarding factors that could influence the institution to adopt immersive technology based on

the participants' views and experiences. Figure 3-2 illustrates inductive reasoning as it allowed the researcher to get specific observations and discover patterns from the data collection.

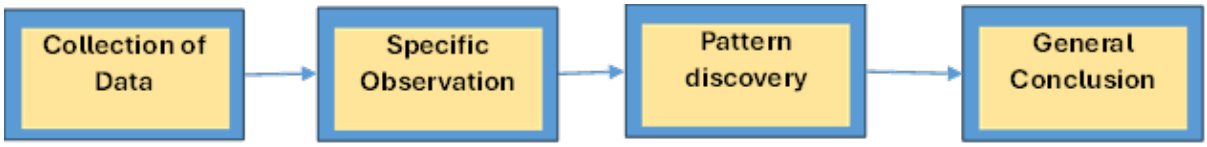


Figure 3-2 Inductive Reasoning (Authors construct adapted from Bhandari, 2023)

In this study, this is how inductive reasoning was applied.

1. Collection of Data

Literature on the adoption of immersive technologies in institutes of higher learning from a South African context is limited. Therefore, following an inductive approach data, empirical data needed to be collected to understand the phenomenon under study better, as introduced in Chapter One. Thus, in this qualitative study, data was collected by gathering detailed information from participants through a semi-structured survey administered through scheduled one-on-one online interviews. Questions related to the adoption of immersive technologies in the institute of higher learning and the perceived benefits after that were asked to gain an understanding of the current research problem.

2. Specific Observation

After collecting the data, the researcher engaged in a specific observation by carefully examining the data to identify significant details, patterns, or recurring themes. This stage involved a close reading, listening to the interview, recording data, and transcribing the data, allowing the researcher to observe phenomena and behaviours that emerge directly from the data without imposing any prior theories. In this current study, it was interesting to observe that the participants were optimistic about the benefits emanating from adopting the immersive technologies in the institute of higher education that was used for this study.

3. Pattern Discovery

As the researcher continued to analyse the data, patterns began to emerge. These patterns included common themes, trends, relationships, and behaviours observed across the data set. Pattern discovery is a critical phase in the inductive approach, as it moves the researcher from specific observations to broader insights (Azungah,2018). The researcher continuously compared different pieces of data to identify these patterns, which are grounded in the

empirical evidence collected. This process is called thematic analysis, whereby patterns, themes, and relationships emerge (Leavy, 2017). In this study, the most dominant pattern discovered is the importance of organisational readiness and organisational culture as key factors influencing the adoption of immersive technologies in higher education. Organisational readiness encompasses several aspects, including the institution's technological infrastructure, leadership support, and the preparedness of faculty and staff to integrate these technologies into their teaching practices.

4. General Conclusion

Finally, the researcher synthesised the identified patterns into a general conclusion. This conclusion was drawn inductively, meaning it was based on the accumulated observations and patterns discovered during the analysis. The general conclusion represented the overarching themes or theories that have emerged from the data, providing new insights and understanding of the research topic. Unlike deductive approaches, where conclusions are derived from testing hypotheses, inductive conclusions are derived from the data itself (Creswell & Clark, 2007).

Conclusion of Inductive Application in this Study

In applying the inductive approach in a qualitative study, the researcher started by collecting open-ended data from participants without any specific expectations. The study was about the adoption of immersive technologies in higher education; the researcher conducted interviews with IT staff and students to gather their experiences and perspectives. As the researcher observed the data, they noticed 1000 themes, for instance, such as concerns about the technical infrastructure, costs, uncertainty, and the influence of organisational culture on the adoption. Over time, patterns emerged, such as recurring mentions of technical challenges and the need for professional training. These patterns lead the researcher to form general conclusions about the factors influencing the adoption of immersive technologies in higher education. The conclusions were drawn directly from the observed data, making them a grounded and evidence-based understanding of the research problem. This inductive approach allows the researcher to build theories or models that are closely tied to the real-world experiences of the participants (Armat *et al*.,2018).

3.2.3 Research Methodology

The choices layer refers to how researchers select between mono-methods, mixed-methods, or multi-method approaches. This study used a mono-method approach, specifically

qualitative research methods. A single qualitative method was deemed appropriate to gather detailed and context-specific data from participants through semi-structured interviews. Research methodology has been defined by Kothari (2004) as assistance in solving the research problem. Research methodology is a systematic method whereby the researcher identifies the process of how the research will be carried out from the beginning till the end (Singh, 2010). Furthermore, Singh (2010) elaborated on the term research methodology by articulating that it includes things like problem identification, literature review, and identifying how data analysis will be done as well as how the results will be interpreted and conclusions drawn from the results. This section discusses information on the methods of collecting data and research methods related to the answering of the research questions.

There are two main types of research methods: quantitative and qualitative methods. George (2011) defines quantitative research as a systematic inquiry that collects measurable data and presents numbers based on the facts collected from individuals. Alternatively, Pong (1998:305) defined qualitative research as “a multi-method in focus, involving an interpretive, naturalistic approach to its subject matter”. It entails a detailed description of situations, events, people, and thoughts. In addition, Hancock (1998) postulated that qualitative data refers to creating descriptions of an observable fact.

Two main types of research methods have been explained above. However, this study focused on collecting non-numerical data, which is a mono-method qualitative research approach. This method assisted the researcher in determining students’ behaviour and thoughts on immersive technologies at CPUT. This study aimed to explore the adoption of immersive technologies in higher education in depth; hence, the qualitative method is the most appropriate for answering the research questions and achieving the aim of the research. The qualitative method was best suited for this study as it gives details and allows a greater understanding of people’s experiences and opinions.

Table 3-1 illustrates the comparison of quantitative and qualitative methodologies.

Table 3-1 Comparison of Quantitative and Qualitative Methodologies (Farghaly, 2018)

Quantitative	**Qualitative**
Focuses on numerical data and believes in a single reality	Understand individuals’ feelings, opinions, and situations, beliefs on **multiple realities**
Generate theories that can be generalisable on the results	**Generalisation** of theories is not a priority in qualitative research

Quantitative research focuses on designs such as experimental, quasi-experimental, and non-experimental designs.	Qualitative research focuses on designs such as historical research, **case study**, ethnography, narrative research, grounded theory, and action research.
Applies the deductive approach formulated from an existing theory, and the hypothesis is tested by data collection.	Applies the **inductive approach** to explore the observed data for patterns and relationships.

Multiple realities: Semi-structured interviews were used for data collection in this study. This allowed the researcher to explore realities constructed by participants' facts and opinions. The researcher embraced the diverse perspectives and experiences of participants. Recognised that each participant brings their subjective reality to the study, shaped by factors such as knowledge, background, and personal beliefs. The researcher used methods such as in-depth interviews to explore these multiple realities and understand how they influence participants' perceptions and interpretations of the phenomenon in the study.

Generalisation: Generalisation is defined "as the degree to which the findings can be generalised from the study sample to the entire population" (Polit & Hungler, 1991:645). This study used a qualitative method, so generalising theories was not a priority.

Case Study: According to Yin (2018), a case study is appropriate for studying a phenomenon in a real-life setting, whereby it provides in-depth, relevant data to the environment of the case. When designing a case, it is crucial to identify the level of the study's analysis and whether the whole organisation is part of the study or only a set of individuals in the organisation (Törnebohm, 2019). For this study, a set of individuals from the IT department at CPUT were selected as a case study.

Inductive approach: This approach was applied in the study for data analysis purposes whereby the researcher explored the observed data for patterns and relationships using thematic analysis.

Pilot Study

A pilot study is defined by Arain *et al.* (2010) as a small feasibility study to trial whether the components/ methods of the investigation can be successful. A pilot study is carried out on a small scale to identify whether the researcher can continue with the data collection or not. Moreover, the use of a pilot study is crucial in assisting with the quality and appropriateness of the study (Lowe, 2019). A pilot study was conducted with four participants (two staff

members and two students) from the CPUT IT department. This pilot study aimed to improve the data collection instrument (Interview Guide Appendix B). The pilot study served several purposes in this study, including to:

- Identify any mistakes in the questions.
- Determine whether the questions were clear and relevant in answering the research questions of the study.
- Assist in validating the interview questions before data collection.
- Provide significant input in restructuring the questions to meet the objectives of the study, whereby a few questions were amended.
- Ensure the quality of the questions asked.

The researcher conducted the pilot study with two senior lecturers and two postgraduate students in the IT department who had vast knowledge of research. Their honest contribution to the pilot process assisted the researcher in removing questions that were not relevant to students but only applied to staff. This helped the researcher to determine whether the interview questions would collect relevant data to answer the research questions or not. The pilot study data collection was not included in the main study as it was only used to strengthen the interview guide. Its results enhanced the clarity of the interview guide. They validated the use of online platforms for data collection, ensuring that the main study proceeded smoothly and produced reliable, actionable insights.

Population and Sampling

The population is defined as the bigger group of individuals from which a sample is to be drawn (Kothari, 2004:41). Convenience sampling is a sampling technique in which a sample is chosen because it is easily accessible to the researcher (Emerson, 2015). The purposive also known as the judgmental sampling technique, refers to a technique in which a researcher uses their wisdom to choose a sample that is the most suitable to acquire the necessary information for the research questions of the study (Etikan *et al.*, 2016). In this study, the population consisted of key stakeholders within the higher education institution, including IT faculty members and postgraduate students. A purposive sampling strategy was used to select participants who had relevant experience and insights into the institution's readiness for adopting these technologies.

Non-probability sampling

Teddlie and Yu (2007) state that non-probability sampling allows the researcher to select certain groups intentionally in a non-random way, and it does not guarantee that all selected

populations will have an equal chance of participation. Qualitative study normally applies the non-probability sampling method. Findings cannot be generalised to the entire population (McCombes, 2019). A non-probability sampling method was applied to select a minimum number of participants until data saturation was achieved. This study used a purposive convenience sampling method to collect data from the participants at an institution of higher education to participate in the study. In this study, the population comprised 7 IT staff and seven students who attended classes at the Cape Town campus.

A sample is defined as a smaller group of individuals or items that are drawn from the population for measurement purposes. In this study, the sample was conducted from fourteen participants who were in the Information Technology (IT) department, staff, and students at CPUT. Ahmad and Talaei (2012:112) postulate that "sample size is often justified by interviewing participants until data saturation is reached." The author further defines data saturation as a situation when no new themes or information is produced. In this study, data saturation was reached at fourteen participants, and no new themes on the adoption of immersive technologies were produced from the interviews.

Participant Selection Process

The identified target population for the study consisted of faculty members in the IT faculty who are involved in the adoption or decision-making processes related to immersive technologies at CPUT and postgraduate students. The inclusion criteria used in the study ensured that only participants who had direct knowledge and experience related to the adoption of immersive technologies in higher education were selected for the research. Criteria included Faculty members teaching courses in disciplines suitable for immersive technology integration (For example, STEM and multimedia).

To capture a diverse range of perspectives and experiences, efforts were made to include participants from various disciplines, senior lecturers, top management and postgraduate students, and students with different levels of experience at the university. Participants were recruited through targeted outreach efforts to the academic IT Department by sending emails to faculty members and postgraduate students. Interested individuals were screened based on the established inclusion criteria. Those who were available and convenient to the researcher were invited to participate in the study. They received detailed information about the study objectives, procedures, and their rights as participants (Consent Form).

Participants were interviewed using purposive and convenience sampling, whereby the persons suitable for the study, who were available and willing to participate in the study, were

chosen. Participants who expressed willingness to participate and provided informed consent were included in the study. Efforts were made to ensure that the final participant sample represents a diverse range of perspectives and experiences relevant to the research topic. Fourteen participants who were convenient to the researcher were interviewed online via Teams. The chosen participants are experts in the IT department, such as senior lecturers. Therefore, they know of technologies.

Profile of the Participants

To better understand how participants were anonymised, the researcher described participants' profiles in a table format (Table 4-2). The researcher interviewed fourteen conveniently selected participants at the Cape Peninsula University of Technology (CPUT) Cape Town campus. The researcher interviewed two senior management (SM1 – SM2), four senior lecturers (SL1 – SL4), one lecturer (L1), and seven postgraduate students (PG1 – PG7) in the faculty of informatics and design. The participants were anonymised by using codes. Table 4-2 illustrates the participant's position, the number of years at the institution, and the percentage of each participant's position level. Column one indicates the encoding of participant names and identities to meet anonymity and confidentiality requirements.

3.2.4 Research Strategy

The research strategy includes various methods, such as experiments, surveys, case studies, and ethnography. A case study strategy was selected for this study. A case study focuses on an in-depth examination of a specific context, in this case, a higher education institution, to explore the factors influencing the adoption of immersive technologies. The case study strategy was well-suited to exploring the complex dynamics of technological adoption within an academic institution, providing rich qualitative data from key stakeholders.

A case study has been defined by Brinkmann *et al.* (2014) as a method with focused characteristics aimed at the transferability of discoveries between multiple research units while remaining focused on a particular unit. However, as Li and Zhang (2022) point out, the case study strategy does not certainly mean "transferability- whereby the results from one setting can be generalised", and when examining intricate methods, a satisfactory level of transferability is achieved. Bhattacherjee (2012) defines transferability in research as the extent to which findings can be applied to different contexts or settings. Conversely, Barnes *et al.* (2005) emphasise that transferability in case studies involves readers making connections between the study's elements and their own experiences. Furthermore, Donmoyer (2000) states that the concept of transferability can solve the problem of complexity.

However, it still assumes that results from one setting can generalise to another only if the setting contexts are very comparable. The IT department at CPUT was selected as a case study because it is convenient for the researcher to conduct data collection and acquire ethical clearance.

This study aimed to identify the factors that could influence the adoption of immersive technologies. Therefore, the IT department at CPUT was convenient for the researcher to use as a case study. Eisenhardt (1989) noted that case study research focuses on understanding the existing dynamics within a single setting. Thus, this study used IT department participants to identify the factors that could influence the adoption of immersive technologies at CPUT.

3.2.5 Time Horizon

The time horizon refers to the period within which a research project is intended to be completed (Saunders et al., 2019). For this study, the project is intended to be completed by December 2024. According to the research onion model, there are two primary types of time horizons: cross-sectional and longitudinal. Cross-sectional time horizons involve collecting data at a single point in time (Bryman, 2016). They are typically employed when the research aims to understand a phenomenon, experience, or process as it exists at a specific moment. Cross-sectional studies are particularly suitable for exploring the current state of an issue or comparing distinct groups at a single time point (Creswell & Creswell, 2017).

Given the objectives of this study, which are to explore and understand the current experiences, perceptions, and attitudes of the institution regarding factors influencing the adoption of immersive technologies at CPUT, a cross-sectional time horizon was selected. This approach is well-suited to capturing these elements as they exist at the time of the study. A cross-sectional time horizon was adopted for this research, meaning data was collected at a single point in time, specifically over four months, from August to November 2023. The cross-sectional design was chosen due to the study's focus on understanding the current experiences, perceptions, and attitudes toward immersive technologies within the institution. This approach allowed the researcher to capture a snapshot of the institution's readiness and factors affecting adoption at a specific moment in time.

In line with the cross-sectional time horizon, data collection was designed to gather in-depth insights from participants at a single point in time. The methods employed included semi-structured interviews conducted with 14 participants to explore their current experiences and perspectives. The semi-structured format allowed for flexibility in probing specific areas of interest while maintaining a consistent structure across interviews. Cross-sectional studies are

conducted within a specific period, capturing data at a single point in time (Bryman, 2016). In qualitative research, cross-sectional studies are often used to explore phenomena as they exist within a particular context (Creswell & Poth, 2016). For example, in this study, a cross-sectional approach was used to examine the experiences of staff and students during interviews and to explore their perceptions of a new technology adoption policy.

The choice of a cross-sectional time horizon in this qualitative study aligns with the research objectives, resource availability, and the nature of the phenomenon under investigation. This approach enables a focused and detailed exploration of the participants' current experiences and perspectives, providing a comprehensive understanding of the topic at a specific point in time.

3.2.6 Data Collection and Data Analysis

The final layer involves techniques and procedures which detail how the data is collected and analysed. In this study, semi-structured interviews were the primary data collection technique. These interviews allowed for flexible conversations with participants while still ensuring consistency in addressing the main themes of interest, such as organisational culture, faculty preparedness, and management support. The interviews were transcribed and analysed using thematic analysis, which is a method for identifying and reporting patterns (themes) within qualitative data (Braun & Clarke, 2006).

Data Collection

Data collection occurred in August 2023, using online platforms such as Microsoft Teams. Each interview lasted between 30 and 50 minutes and was conducted with participants who provided informed consent. The interviews were recorded with permission and transcribed using Microsoft Teams. The transcriptions were then exported as Microsoft Word documents, ensuring accuracy by aligning them with the original audio recordings. Semi-structured interviews were chosen over other methods like questionnaires due to their capacity to yield rich, detailed data on participants' experiences and insights. While questionnaires may require substantial resources and time for data analysis (George, 2011), semi-structured interviews offer a more adaptable approach, making them suitable for exploring complex topics in depth.

Data Analysis

Thematic analysis was utilised to analyse the transcribed data. This method, as described by Braun and Clarke (2006), involves identifying and reporting patterns (themes) within

qualitative data. The thematic analysis process followed the (Saunders *et al.,* 2016) framework whereby the researcher began with reading and cleaning up the data, combining similar data from the transcripts, grouping the themes and patterns, and coding the data, where the researcher organised the data into meaningful segments. Following coding, themes, patterns, and relationships among the codes were examined and grouped to provide a structured interpretation of the data (Leavy, 2017). To ensure accuracy, the transcriptions were meticulously cleaned and validated against the recorded interviews. Thematic analysis was employed to generate new insights and concepts from the data, facilitating a deeper understanding of the factors influencing immersive technology adoption.

The data analysis was supported by *ATLAS.ti* 2023 software, which assisted in managing and analysing the qualitative data. This software provided tools for organising, coding, and visualising the data, enhancing the robustness and reliability of the analysis process.

In summary, the data collection methods employed in this study, which were semi-structured interviews and thematic analysis, provided a comprehensive approach to understanding the adoption of immersive technologies. By leveraging these methods, the study generated valuable insights into the factors influencing the adoption of technology integration.

3.3 Research Data Quality

According to Awan *et al.* (2023), the quality, validity, and evaluation of the process are crucial in a qualitative study. This helped the researcher to determine whether she collected valid data. In this study, the quality and validity of the data were enhanced through piloting the study whereby the pilot study (Section 3.2.3) defined participants contributed to strengthening the interview guide instrument (Appendix B). Moreover, the participants selected in this study needed to confirm whether the research questions were relevant and easy to understand. This is the reason they must have been involved in working in the IT division or studying toward an IT degree. The scholars further define validity as the degree to which qualitative data accurately display what the researcher is determining to portray. Guba and Lincoln (1994) developed a framework to assess the trustworthiness and credibility of qualitative data. Table 3-3 below illustrates four contexts that can be used to determine the quality of the qualitative data.

Table 3-3 Quality Standards for Qualitative Research (Lincoln & Guba,1985)

Criteria	Description	How It was Applied in the Study
Credibility	Accurate findings and valid interpretation of participants' views	To ensure credibility in this study, the researcher conducted briefing sessions with supervisors to learn more about the research protocol. Pilot interviews were conducted to improve the interview process, and time per session was managed. Transcribed data was cleaned, and the researcher ensured that the transcription was accurate according to the interviewee's words.
Transferability	The results of the study can be applied to other settings	A purposive sampling technique was used to ensure the selected participants were from the selected setting and could be applied to other settings if needed.
Dependability	Refers to the consistency of the results and the assurance of the findings discovered from data collection regardless of the changes	The researcher developed detailed notes of the study protocol and data collection process throughout the study.
Confirmability	Other researchers could validate the findings of the study	The researcher took note of possible ethical issues that could potentially affect the data analysis and discussed them with other researchers and supervisors to confirm the validity of the findings.

3.3 Research Ethics

Data collection was conducted at CPUT; therefore, it was important to acquire ethical clearance (Appendix A) from the department before data collection. IT staff and students were interviewed to get their opinion based on the research questions. Before the interview session, the researcher emailed the consent form (Appendix C) to the participants to sign as a confirmation for the researcher to use the information provided. Each participant was made aware of the voluntary participation and was ensured that they would remain anonymous. The information provided by the participants will not be disclosed to anyone who is not part of this research.

The ethical clearance approval and consent forms are attached in Appendixes A and C in the Appendices section. The research objectives were detailed so that participants could answer the questions. The researcher made the participants aware of their voluntary participation, as they could withdraw from the interview process if they wanted.

3.4 Summary of the Chapter

This chapter discussed the research design and methodology used to collect data for the study. It also outlined the methods and tools used to collect data, as well as the population and sampling procedure and data analysis software (Atlas. ti). The next chapter presents the study's data analysis and findings.

4 CHAPTER 4: DATA ANALYSIS AND INTERPRETATIONS

4.1 Introduction

This chapter presents the data collected from fourteen participants at Cape Peninsula University of Technology. As mentioned in the research methodology chapter (Chapter 3), the semi-structured interviews were administered by the interviewer via *Microsoft Teams*®, an online platform. The respondents were briefed before the interview could take place that their participation was voluntary. Several scholars (Kumar, 2002; Flick, 2015; Barry & Zikmund, 2015) emphasised that data analysis is one of the most fundamental facets of research. Bryman (2016) defines the process of data analysis and interpretation as the process which involves systematically examining, organising, and making sense of raw data to derive meaningful insights, draw conclusions, and make informed decisions. Kumar (2002) adds that data analysis is incomplete without interpretation. The Pilot study findings are described below.

4.2 Pilot Study

Introduction

The pilot study aimed to improve the data collection instrument (Interview Guide Appendix B) and to identify how the responses align with the research objectives. Therefore, the pilot study identified a few changes that the researcher made to the interview guide before data collection. Qualitative data was collected with four participants (two SLs and two PGs) from the IT department. Purposive convenience sampling was used to select the participants for the pilot study.

Purpose of the Pilot Study

The pilot study served several purposes in this study, including to:

- Identify mistakes in the questions.
- Determine whether the questions were clear and relevant in answering the research questions of the study.
- Assist in validating the interview questions before data collection.
- Provide significant input in restructuring the questions to meet the objectives of the study, whereby a few questions were amended.
- To ensure the quality of the questions asked.

The pilot study collected data from participants via online interviews via teams. Overall, the chosen methods demonstrated a prominent level of feasibility and effectiveness in capturing the necessary information.

4.2.1 Pilot Results

The following section presents the results of the pilot study.

4.2.1.1 Engagement Enhancement

Participants expressed that immersive technologies, such as virtual reality (VR) and augmented reality (AR), have the potential to enhance student engagement by providing interactive and immersive learning experiences. They noted that these technologies could make complex concepts more tangible and facilitate active participation in the learning process.

4.2.1.2 Experiential Learning Opportunities

All participants highlighted the value of immersive technologies in offering experiential learning opportunities that simulate real-world scenarios. They emphasised the potential for students to gain practical skills, develop critical thinking abilities, and enhance their understanding of course content through hands-on experiences facilitated by VR and AR applications.

4.2.1.3 Technological Infrastructure and Support – Accessibility and Affordability

Participants raised concerns about the accessibility and affordability of immersive technologies, citing issues such as the cost of equipment, compatibility with existing infrastructure, and availability of technical support. They emphasised the need for institutions to invest in resources and infrastructure to ensure equitable access to these technologies for all students.

4.2.1.4 Technical Expertise and Training

Participants identified a lack of technical expertise and training as potential barriers to the adoption of immersive technologies in higher education. They highlighted the importance of providing faculty members with training and professional development opportunities to build their skills in integrating VR and AR tools into their teaching practices effectively.

4.2.1.5 Impact of Organisational Culture

Organisational culture played a significant role in shaping employees' and students' perceptions of encouraging innovation at the university. Participants described environments that prioritise employee and students' well-being and offer supportive policies and initiatives as conducive to achieving balance. Conversely, organisations with rigid structures and expectations were perceived as barriers to maintaining a healthy equilibrium.

4.2.2 Implications for the Main Study

4.2.2.1 Challenges Encountered - Data Collection Logistics

Coordination related to data collection posed challenges during the pilot study. Scheduling interviews with participants proved to be time-consuming, and coordinating online sessions presented logistical hurdles. The researcher had to send emails and messages to the convenient participants to request their participation. Participants would take a long to respond to the researcher. Additionally, technological issues, such as internet connectivity problems during online sessions, affected data collection efficiency.

Learning from the logistical challenges faced during data collection in the pilot study, efforts were made to streamline data collection processes for the main study. Utilising scheduling tools, providing clear instructions, and leveraging technology to facilitate data collection enhanced efficiency and minimise disruptions.

4.2.2.2 Sample Size Considerations

Given the limitations in sample size observed in the pilot study, the sample size determination for the main study was carefully considered. Efforts were made to ensure adequate representation across relevant participants and contextual variables to enhance the robustness of the findings.

4.2.2.3 Study Design

The findings and insights gained from the pilot study informed an approach to the design and implementation of the main study. Feedback from participants and lessons learned from overcoming challenges were integrated into the refinement of research protocols, methodologies, and strategies for the main study to enhance its effectiveness and success.

4.2.3 Conclusion

The pilot study provided valuable insights into the researched topic, demonstrating the feasibility of the research methods and offering preliminary findings that will guide the development of the main study.

4.3 Main Study

Based on the outcomes of the pilot study, the researcher designed a main study, where the interviewer collected data from staff and students at CPUT's main campus in Cape Town using Microsoft Teams®. Data from the pilot study was not included in the main study as it was only used to improve the data collection instrument. The researcher deployed a convenience sampling method whereby staff and students who confirmed their availability and willingness to participate completed the interview process. The researcher was aware of the process of collecting data and understood the ethics that bound the study.

Data analysis via *Atlas.ti* version 23 elicited themes and codes. Additionally, after merging similar codes, the grouping of themes eased the analysis process. This process established an understanding of the factors that could influence the adoption of immersive technology within CPUT higher education contexts. Section 4.2 presents the results from the data that was collected from CPUT students and staff at the Cape Town campus.

4.3.1 Profile of the Participants

To understand the findings clearly, the researcher illustrated the participants' profiles. Table 4-1 below illustrates the participant's position, the number of years at the institution, and the percentage of each participant's position level. Column one indicates the encoding of participant names and identities to meet anonymity and confidentiality requirements.

Table 4-1 Participants by Position Level

#	Position Level	Number of Participants	Number of years at the institution	Participants percentage
SM1 – SM2	Senior Management (Previous HOD & Dean)	2	More than 15 years	14%
SL1 – SL4	Senior lecturers Including the program coordinator	4	More than 10 years	29%
L1	Lecturer	1	More than 2 Years	7%
PG1 – PG7	Postgraduate Students	7	More than 5 years	50%
	Total Number of Participants	14		100%

An interview guide (Appendix B) with semi-structured interview questions for students and one for management (senior management and senior lecturers) was used. The interview guide for students and management had some related questions; however, only a few questions were different, which only management could answer, and were not relevant for students. They were removed from students' questionnaires. The research questions were guided by the TOE framework, which has three contexts: Technology, Organisation, and Environment. Twenty questions were asked of the students and 22 of the management to get their views on the factors that could influence the adoption of immersive technologies at CPUT. Participants responded to all the questions; therefore, the researcher acquired a 100% response rate.

Table 4-2 below highlights the research questions that link with the interview questions posed to the participants.

Table 4-2 Research Questions Linked to Interview Questions

Research Questions	Interview Questions
MRQ: What are the factors that could influence the adoption of immersive technologies in higher education institutions?	• What do you think are the key benefits of immersive technology adoption? (Relative advantage) • Do you have any other factors you think can be added to influence the adoption?
SQ1: What effect does an institution's technical infrastructure have on the adoption of immersive technologies in higher education?	• Do you think technical infrastructure is important in the adoption process of immersive technologies, and why? • What is your experience with the current institutions' technical infrastructure?
SQ2: How does an institution's organisational culture influence the adoption of immersive technologies in higher education?	• In your opinion, please discuss the institutions' culture and how things are done within the organisation in terms of decision-making or in general. • In your opinion, do you think the culture of the organisation can influence the decision to adopt immersive technology? How so?
SQ3: How do an institution's external factors influence the adoption of immersive technologies in higher education?	External factors examples: Customer pressure, Competitor pressure, Government support • In your view, do you think the factors mentioned above are important in the adoption process, and why? • Do you have any other external factors that could lead to a decision to adopt?

The TOE framework developed by Tornatzky and Fleischer (1990) was used to guide the study of the existing factors and previous literature. Sections 4.3.2 to 4.3.4 explore aspects of the TOE framework, respectively, addressing feedback associated with the technology context (Section 4.3.2), the organisation context (Section 4.3.3), and the environment context (Section 4.3.4).

4.3.2 Technology Context

The below context highlights the technology context from the TOE framework. It answers the following research sub-question.

SQ1 What effect does an institution's technical infrastructure have on the adoption of immersive technologies in higher education?

Technical Infrastructure

The researcher collected data on the institution's technical infrastructure and the adoption of immersive technologies. In doing so, the researcher inquired about the institution's technical infrastructure, challenges, and the impact these factors have on the adoption of new technologies. Pan *et al.* (2021) articulated that the effect of technical infrastructure is deemed to be crucial in the adoption of new technologies. Moreover, this means that the investment in the technological infrastructure could have a substantial influence on technological innovation. Subsequently, Pan *et al.* (2021) state that technology infrastructure has a crucial role in ensuring successful technological innovation.

The results from the study revealed that CPUT does not have proper technical infrastructure. Participants identified the challenges they encounter daily on campus. PG2 identified that *Some of the computers that we have are quite old and some of them are outdated. There is a need for this new equipment* system *[PG2]*. They felt that due to poor infrastructure on campus, it could be a tremendous challenge to adopt immersive technologies. While SL4 agrees with PG2 on the lack of proper infrastructure, the participant stated that you look at its lecturers going to classes and dragging laptops, and they want to install them in there, and some of these computers *do not have power. So, how are you able to go digital? How are you able to put these systems in place? So, there is a need to develop the university's infrastructure so that it can embrace the system and equipment that can be used for immersive technologies [SL4].*

Participants believe that these challenges could be a hindrance in the adoption process as they complained about non-functional, old, and outdated infrastructures on campus. PG3 adds on the challenges by stating that:

> *The challenges that I have with the institutions, mostly when you visit them, are that some of the resources that you need around the institution are not sufficient. Sometimes, they do not work, like your printers. Yes, there is a bit of a connectivity issue with the computer lab due to the load shedding around. Those are some of the challenges, especially technical infrastructure [PG3].*

The effect of technical infrastructure on the adoption of new technology at CPUT can be identified as a hindrance to the adoption process. The technical infrastructure is the considerable influence of adopting immersive technology at higher institutions of learning (Defitri *et al.*,2020). PG4 agrees with the statement made by (Defitri *et al.*, 2020) by stating *technical infrastructure is the most pertinent part of adopting this technology for the full experience. Things like being able to access immersive settings or immersive environments. You're going to need immersive technology. You know you are going to need the Aptic glove, you are going to need the VR headset* [PG4].

Additionally, for the users to have a fully immersive experience, the technical infrastructure needs to be up to standard. All Participants identified that technology infrastructure is the most vital part of adopting new technology. Below are some of the responses from participants emphasising the importance of technical infrastructure.

Participants responded:

> *So, if the infrastructure is down for any reason or if it is not available or accessible to students, then they are not going to be able to use it. So, it is important that those specs, too, are considered and that the actual infrastructure is maintained and supported. This at least prevents or limits the risk of the infrastructure going down [PG5].*

> *It is the most important thing because if we do not have the infrastructure and the infrastructure is the computers, the labs, electricity, and the infrastructure is also trained staff, need to go on training to understand how these things work so that we can teach these things. This is the most important thing. And unfortunately, this is one of the biggest challenges of CPUT because it does again come down to financial considerations and how money is spent and where it is spent and where it is prioritised. [SM2].*

One participant (*SM1*) agrees that technical infrastructure is important in the adoption process; however, it is not a prohibiting factor for the institution not to adopt the technology as it is straightforward. Furthermore, the participant continues to state that immersive technologies are cheap and easily available.

> *Technical infrastructure is important for everything, but immersive technologies are so cheap and easily available that it is not a huge infrastructure. It is not a prohibiting factor [SM1].*

Nonetheless, the rest of the participants do not share the same sentiments. They believe that the adoption of immersive technologies, including the required resources such as 3D glasses,

goggles, VR headsets, modulators, etc., is quite an expensive process. Most of the participants anticipated that technical infrastructure could be a challenge for the institution in adopting new technologies due to the costs involved in improving the infrastructure to accommodate the adoption of immersive technologies. Below is the view of one of the participants.

> *A lot of these things are quite expensive, and that could be one of the things holding the institution back. Things are potentially quite expensive or hard to configure, and that is why they are not that widely used [PG2].*

The factors below come from the TOE framework and the data collection; therefore, the participants were asked about the relative advantage of the adoption of immersive technology at CPUT. The question asked was: “What do you think are the key benefits of the adoption of immersive technologies? What are your roles?”

Relative advantage

The data collected from participants in this study highlights several key benefits associated with the use of immersive technologies in educational settings.

Improve engagement

Immersive learning improves students’ engagement in the classroom. This type of learning encourages students to want to learn more, as it is perceived to be fun to use. This study confirms the statement made by Shen et al. (2022) in the literature that immersive technologies improve student engagement. Most participants highlighted that there is a high chance for students to get better results in their modules. The benefit of immersive training simulation is that it also eliminates threats to real-life situations.

A participant said:

> *So, the implementation of immersive technologies and the university adopting the immersive technologies means that as a student, I can move with time, and it equips me as a student. It enhances my engagement within the classroom. So, as a student, it can help me with that, and it can encourage me to learn even more using this platform because we are always on the Internet using our digital mobiles. [PG6]*

Allow students to gain practical experience and knowledge.

Immersive learning allows students to explore the subject and gain knowledge of not only theory but also practical aspects (Southgate, 2019). Students can have unlimited practical sessions whenever they want to practice (Jantjies et al. (2018)). This benefit collaborates with

the claim made by (Jantjies *et al.,* 2018) in their study. Additionally, it allows users to make errors without real-life consequences. Participant stated:

> *If training simulations are forced, let us say, for instance, an aerospace technical job or a bomb simulation in which you use Matic gloves and immersive environments to interact with how training is conducted. That also eliminates real-life situations where the threat is potentially higher, but you could do the simulation in a virtual setting [SL4].*

Enhanced Memory Retention

Immersive learning offers a unique opportunity to engage with educational content in several ways, which can enhance memory retention (Scavarelli et al., 2021). Different individuals experience memory retention through different modalities; for instance, some learners prefer reading and writing, while others benefit more from auditory and visual stimuli. According to Participant (PG2), one of the significant benefits of immersive learning is its impact on memory retention. Participants expressed that they find it challenging to grasp theoretical concepts through traditional methods but believe that visual experiments will make it easier for them to remember and understand the material.

> *Memory retention is also one of the benefits. As I have said, it is difficult to grasp content. Therefore, VR assists in keeping the memory you have learned [PG2].*

The data analysis suggests that immersive technologies offer substantial benefits that can improve students' learning in education. By improving memory retention, increasing engagement, and promoting practical experiments, these benefits present a compelling case for broader adoption in educational settings. However, it is also important to consider the potential barriers to implementation, such as cost, accessibility, and the need for technical expertise.

Technology Compatibility

Compatibility is vital in the adoption process of new technology. It allows the organisation to identify whether the proposed new technology is compatible with the existing systems (Malik *et al.*, 2021). Therefore, the organisation needs to identify the compatibility of the old and new systems. PG1 agrees with the compatibility of the new technology within the organisation by stating that: *Yes, but if your infrastructure is not capable of handling that kind of technology, or resources do not have the capabilities to support the adoption, it will not be useful [PG1].*

According to Amini and Jahanbakhsh (2023), compatibility with technology innovation is one of the factors that influence the rate of technology adoption in an organisation. Participants were asked: "*Do you think technology compatibility is important in the adoption process of immersive technologies, and why do you think so*?" All participants agreed on the importance of technology compatibility before technology adoption in an organisation. Participants articulated that before any technology adoption, the experts need to be involved to examine the compatibility of the new technology with the existing systems. Some of the views from the participants:

> *Yes, if this infrastructure falls over for whatever reason, whether it cannot handle the load or does not have sufficient processing power or something like that, it is going to erode the user's or student's experience. It just takes one or two students who have a terrible experience, and then it spreads by word of mouth, and it could taint the implementation of it. So that is why you must have a good and strong infrastructure [PG5].*

> *Yes, so the departments and the faculty can work together, but especially the departments themselves must be able to synthesise existing content with new technology and existing teaching and learning methods with new technologies [SM2].*

Technology Competency

Technology competency has been highlighted as one of the factors that could influence technology adoption. A substantial technical infrastructure is required in an organisation for the success of new technology. Users of the technology also need to be competent in using it. Due to executing highly interactive elements, memory retention is higher in terms of reading or listening in comparison to immersive technology, which has a high interactivity ratio.

Therefore, the users need to be competent with the technology. Based on the literature, the researcher reckons that memory retention for interaction with products or with academic material would lead to higher pass rates within the campus. It would lead to more competent students and students absorbing information and academic material. Even dissemination of information on the campus could be put in these sorts of environments where students can access different points within a space, like an information office that has embedded information points on everything that you would need throughout the campus without being there, but also being interactive. So, memory retention or what an individual is interacting with is quite clear and concise, and one will retain that information easier than if you read it in an e-mail. All participants shared the same sentiments about the importance of technology competency. For instance, a participant said:

You need to be competent in the technology that you are using primarily. This is not technology, becoming a full-stack developer, or being able to utilise every single device on the tech platform. But if you are speaking about immersive technology specifically, being competent in utilising the headset or glove, navigating through immersive environments, and using smartphones, tablets, and PCs is vital to being effective. So, without these technical competencies, it will be like winking in the dock [PG7].

4.3.3 Organisation Context

The below context highlights the organisational context from the TOE framework. It answers the following research sub-question.

SQ2 How does an institution's organisational culture influence the adoption of immersive technologies in higher education?

Organisational Culture

Organisational culture is one of the factors in a TOE framework that is used for technology adoption by researchers. Participants were asked to identify the institutions' culture and elaborate on whether the culture of the institution can influence the adoption of immersive technologies. Question asked: "*In your opinion, do you think the culture of the organisation can influence the decision to adopt immersive technologies? How so*? "All participants believe that organisational culture can influence the decision to adopt. These are the views from PG2, PG4, and SM2; the participants believe that the institution does encourage the adoption of modern technologies and innovation. PG2 stated:

My understanding of organisational culture within the university and how things are done is that the university is more or less using a top-down approach, whereby the top management makes decisions about how they want the university to be run. I believe the culture can influence the decision to adopt, as top management makes decisions and is looking forward to implementing new technologies [PG2].

Participants share the same sentiments that the culture of the organisation can influence the decision to adopt immersive technologies by encouraging lecturers to be innovative in the classroom. SM2 articulated that CPUT encourages lecturers to be creative. We can adopt new technologies. We are encouraged to be creative. We are constantly being offered workshops on modern technologies. We have champions such as Professor ….., who is embracing AI in architectural research and especially in research and design. So, we have champions that are

> *championing this, and the culture is one where we are allowed to experiment, and we are encouraged to be innovative [SM2].*

While PG4 adds on the culture of not having a sense of urgency for resolving issues, the participant believes that this culture could encourage CPUT to replace the culture of walking around with student cards with an immersive technology system. PG4 stated:

> *Absolutely, the culture can influence the adoption. So, for instance, the culture that I mentioned earlier, you know, of not having a sense of urgency for access or a culture of punishment for not having your card, immersive technologies could replace an entire library. You could physically enter the space within the comfort of your own home, and you could eliminate all of those barriers that I just mentioned [PG4].*

Participants PG2, PG3, PG6, SM2, and L1 share the same view that there is a culture of delays in terms of making decisions, a lack of communication, and a lack of sense of urgency within the department or institution at CPUT. Therefore, PG6 highlight the importance of culture by stating that: *I mean the culture runs everything the culture filtrates into the decision-making and down to the ground of the people working with us now, the students. So, if the culture of top people is not communicating down, how are we going to know what is happening? [PG6].*

The participants highlighted the factors above that could hinder the process of adopting innovative technologies. Therefore, CPUT must address and resolve the delays in decision-making, improve communication on what is happening within the department, and respond to requests or matters with a sense of urgency. PG3 and L1 state the following challenges in the culture: *There are always some kinds of challenges, like delays, when it comes to decision-making. Some of the things will go through, and some might not go through due to the challenges, the obstacles, and then maybe the finances around the decision-making [PG3].*

> *There is a huge dedication to students even though academics are treated so extremely poorly. The institution shows a distinct culture of fear. Everybody is afraid of everybody else, and there is a huge fear of audit findings. And so, what you find is that it could take a month to get simple things such as a plane ticket to Johannesburg approved through all the systems because nobody wants to go outside of their understanding of what goes on [L1].*

Top Management Support

Sayginer and Ercan (2020) state that top management involvement is crucial in the adoption process of new technology. Therefore, participants were asked about the importance of top

management support in the adoption of new technologies. Only one participant amongst 14 participants believed that top management support is not necessarily important in the adoption of immersive technologies. The participant conveyed that it is easy and cheap to adopt immersive technologies; hence, it is not necessary to involve management in introducing these technologies in class. Furthermore, the participant elaborated that management is focusing on what is happening on top rather than the bottom.

> *Not really, because it is such a low-level thing; it is just making individual lecturers excited about it. No, because what I am saying is things are as easy as Google Glass, which is a piece of cardboard that you put in front of your phone, and you can get software on your phone to make 3D fully immersive things with your phone. So, nothing is stopping me from giving an architecture student instruction. Take your cell phone and make a 3D model of this thing, put it on glasses, and show it to the rest of the class. I do not need management to give input on that [SM1].*

The rest of the participants stated the importance of management support in the adoption process. Management support is part of the TOE factor used in previous literature and has been identified as playing a crucial role in technology adoption (Oliveira et al., 2019). SL1 believes that management must make every decision; therefore, their support is crucial.

> *Yes, anything that is done within an organisation, be it an institution of higher learning like CPUT, must be approved by the top management, and should the top management be reluctant and not knowledgeable about these technologies. You may find out that the investment will be dragging its feet in implementing these technologies [SL2].*

Organisational Readiness

Organisational readiness has been deemed to be crucial in the adoption of new technologies (Ghaleb *et al.*,2021). The question posed to the participants was whether *CPUT was ready to adopt or not.* The organisation needs to identify whether they are ready to adopt new technologies or not. The majority shared the same sentiments that CPUT is ready to adopt immersive technologies, whereby PG4 said: "*They are prepared. You see, the thing is, like I said, one of the main deterrents or things that prevent organisations from taking up new technology, in my opinion, is the cost of the technology*." The cost of the technology can be high, which could delay the adoption of new technologies within the organisation.

Technical infrastructure and financial resources need to be available for the organisation to be ready to adopt. The importance of technical infrastructure and financial resources has been identified in this study. The participants expressed their concerns about the technical

infrastructure and financial capabilities of CPUT. However, out of 14 participants, 10 participants agreed that despite all the challenges CPUT has, they are prepared and capable of adopting immersive technologies. Some of the views from the participants:

> *They are prepared. Yeah, I am not 100% sure about that. You see, as I said, one of the main deterrents or things that prevent organizations from taking up new technology, in my opinion, is the cost of the technology [PG4].*

> *They are prepared in principle. These technologies are often expensive because you must pay for licenses. So, financially, it would be a challenge. We would have to be clever in the way we decide how many students get access. Do we have machines to run it? I think psychologically, the institution, if I might say so, is prepared, keen, and willing. Our Vice-Chancellor is remarkable in his idea and his dream for the institution [SL4].*

Four participants disagree on the readiness of the institution. They believe that the institution is not ready financially and that the infrastructure they currently have is old. It can be noted that the institution needs to improve its infrastructure and get sponsors to assist financially in giving students an immersive learning experience. Some views from participants:

> *I do not think so because of the excessive cost that it would be in terms just in terms of an OK, most of statistically most of our people, our students have mobile technology. But to effectively utilise immersive technology, you need things like haptic gloves, you know, in terms of really interacting with the environment and its elements. [PG5].*

> *I do not think that they will be able to implement that anytime soon due to financial issues. I can tell you this much: We are the IT department, and the machines in our labs are something like five or six years old, you know, yes, yes, like the RAM needs to get replaced [SL1].*

In conclusion, CPUT appears to be foundational and ready for adopting immersive technologies, but practical challenges related to financial resources and outdated infrastructure must be overcome first. Addressing these issues will be essential for the institution to move from a state of readiness to an effective implementation.

Financial Capacity

The financial capacity of the institution is important in adopting immersive technologies. One of the managers has stated that from the department's perspective, they get funding. *SM1: "As a department, we have been getting a lot of funding from …. as well. So, there has been some funding*

that's coming in from …., but because I'm not part of that, I can't tell you what the funding has been given and for what has it been allowing us to do things that we want to or is there restriction on the money." Therefore, the interviewee further highlighted that the department is ready financially to adopt immersive technologies. Lecturers and students are eager to start utilising VR/AR for teaching and learning. Most of the participants felt uneasy with CPUT's financial capacity; hence, they recommended that the institution get financial support from business partners. Participants could not answer whether there is funding from the government as it goes to the VC and DVC. Below are some views from the participants:

> *If I am not mistaken, they have been trying to source outside funding to create such a lab. So, the Dean is for it, and I think most of our senior management—can I call it our senior management—in our faculty [SM2].*

> *That is a bit of a difficult one to answer because if there is any government support, it will go to our VC and our DVC [SL3].*

4.3.4 Environment Context

The context below highlights the environmental context from the TOE framework. It addresses the following research sub-question.

SQ3 How do an institution's external factors influence the adoption of immersive technologies in higher education?

External Factors

The external factors that have been identified in the proposed framework used in the study are the regulatory environment and competitive pressure. The researcher asked the participants about the external factors that they think could influence the adoption of immersive technologies at Cape Peninsula University of Technology (CPUT) and how these factors influence the decision to adopt immersive technologies. Participants identified three external factors that could influence the adoption: Industry partnerships, Global pandemic, and Pricing factors. 5 out of 14 participants had their views on how the external factors influence the adoption. They mentioned a few factors and elaborated on how they are influencing the adoption of immersive technology.

4.3.3.1 Field Experts & Qualified Personnel

For instance, three participants had their views on the institution's external factors. Participants identified that partnering with outside industries and specialists (Qualified Personnel) from

around the world could influence the adoption of new technologies. *PG3 said, "I think outside the institution will be different organisations or industries that are offering services to other institutions or that are developing the technologies for different reasons that CPUT could collaborate with."* Additionally, they believe that meeting other experts in the field of immersive technologies could bring knowledge, sharing of ideas, and inspiration to CPUT. It can be denoted that connecting with other individuals who have experience with the technology could be beneficial and easier for the institution to learn.

For instance, SM2 stated that it could be useful to create a conference and get inspiration from other competitors who have adopted the strategy.

> *Well, I think if we are proactive and can create a conference and get sponsors, my main thing would be for us to spread our wings and connect with specialists in teaching and learning by adopting immersive technologies. We must connect with them overseas. The people who are doing this and doing this well, and we academics must go to conferences, they must learn [SM2].*

The results from Garcia and Prasolova-Førland (2023) conform with the results from this study as they show the value of having an expert who will effectively communicate the available resources and provide training on immersive technologies. Thus, participants highlighted the need for training and field experts.

4.3.3.2 Global Pandemic

PG4 indicated that the global pandemic could be a factor influencing the decision to adopt immersive technologies. In 2020, the COVID-19 pandemic caused institutions of learning to change to remote learning instead of traditional learning. Therefore, the pandemic forced everyone to introduce new ways of learning.

> *Yes, well, if there is another pandemic, a global pandemic, that will influence the adoption of immersive tech. Yes, as you said, if the students are motivated as to why they would need it, if competitors' pass rates are scoring higher because of memory retention, utilising immersive tech would be one [PG4].*

4.3.3.3 Regulatory Environment

Regulatory support refers to the government authority's support by encouraging the adoption of innovation. Some laws and regulations govern technology innovation, and these laws can influence or prevent the adoption of new technologies. For instance, South African law "No. 26 of 2008: Technology Innovation Act, 2008". The act provides for the encouragement of the

development and exploitation in the public interest of innovations and improvements, in addition to the intention *to begin the Technology Innovation Agency (South Africa, 2008:2). Participants were asked, "Do you think the government supports higher institutions with this kind of initiative? If yes, are you aware of any institution that received support?."* Most participants believe the government provides funding for technology innovation. The management agreed that the government supports this kind of initiative; however, the institution will need to apply for funding. Some of the views:

> *I think they would. I do not think they would necessarily dictate or specify which technologies, but I think they would support or encourage the use of technologies [PG5].*

> *Well, if you write a proposal and ask the government to give you money to buy something, they will, of course. But that is not the key driver. People must have the will to do it, and then they can ask the government for support, and the government will give it [SM1].*

Competitive Pressure

The pressure from competitors has been identified to be crucial in the adoption of new technologies by participants in the study. The pressure felt by the customers from their competitors can influence the organisation to adopt technological innovation (Kumar and Krishnamoorthy, 2020). All participants agreed that external factors can influence the adoption of immersive technologies at higher institutions. They articulated that immersive technologies could be beneficial for their learning. Therefore, students felt that they were the voice to encourage the institution to adopt immersive technologies. SL3 identified that students do want to experience immersive learning. The participant said: *"So what I am saying, yes, there are lots of people that are interested in a lot of these things, and they are inquiring about it because a lot of the students are asking us to have what I would call a short-course".* It can be noted that students are the customers at CPUT; therefore, they feel the pressure to be at the same level as other neighbouring institutions that have virtual labs for their learning.

> *So, the competitive pressure will be able to influence us to adopt as well because if they have already done something similar, we could get the benefits from them. We can see from what UCT has done, this competitive pressure and we will be embarrassed and look like fools if we are calling ourselves a University of Technology and are not at the forefront of using AI and immersive technologies [SL1].*

We are, we are important in the adoption process. I mean we, as students, and if we wait to say we are customers, we want to keep up. We want to keep up with our peers out there. You know, we are paying fees. So of course, We need to put pressure on us to get what we want [PG6].

Industrial Partners

The participants mentioned this factor during the interview process. Most participants stated that CPUT could get assistance from industrial partners. The institution could collaborate with business associations that work with immersive technologies. By doing so, the institution will reduce costs when adopting immersive technologies. The researcher discovered that CPUT attends business associations for new technologies and receives funds from the department. However, there is no motivation or drive from the institution to start the adoption of immersive technologies.

Participants' views:

Industry, if the industry comes to us and says to us, unless your students can make 3D programs, if students or multimedia students can make 3D things, immersive programs, then we cannot work with them. So, if industry demands it, or if industry demands certain levels of safety that we can only do if we give immersive technology and engineering where they say to us, we want your students to be certified that they can go up high buildings, then we'll have to buy a program like that to test them for instance [SL4].

As such, I think from the student perspective, we also need to be very aware of what our industry is in this area. And if I talk about this area, what is the industry in the Western Cape, what is important inside the Western Cape And having that understanding, we both from there as a department, we have been getting a lot of funding [PG7].

Pricing Factor

Participants mentioned that the pricing factor is a hindrance to the adoption of immersive technologies due to their being expensive. This statement collaborates with the literature where Matsika and Zhou (2021) assert that immersive technology tools are expensive. However, one participant identified pricing reduction as the factor that could influence the adoption. Furthermore, the participant believes that reducing the costs of immersive technology resources will have a high adoption rate.

I think from a technological perspective, if you add access to these sorts of technologies at a lower price that will have a higher adoption [PG3].

4.4 Adoption

The theme of Adoption emerged from the researcher's data collection. Participants had an interest in the adoption of immersive technologies. The adoption theme assisted the researcher in getting participants' views and factors that could influence the institution to adopt or not adopt. Additionally, it provides the factors such as challenges and risks that could assist the organisation in looking out for before the implementation of new technology.

4.4.1 Understanding of Immersive Technologies

In trying to identify the participants' understanding, the researcher asked the participants questions below to identify whether they understood the researched technology and get their views on the adoption of immersive technologies: "What is your understanding of immersive technologies? What experiences do you have with immersive technologies, for instance, as a decision-maker, implementer, or user?" The findings from data collection identified the participants' understanding and experiences of immersive technologies in terms of virtual and augmented reality.

It can be identified that all the participants have a good understanding of immersive technologies, as they all managed to provide their understanding of immersive technologies. Below is one of the responses from the participants:

> *Immersive technologies are like a practical environment where individuals can be in an immersed environment without physically being there [PG1].*
>
> *My understanding is that it is a kind of technology that is used mostly in gaming and I know it can be used in learning for practical purposes, it blends visual content with the physical environment [SL2].*
>
> *I understand as usually as putting googles on your face and be in a virtual environment, the other one you can simply put your cell phone in to and it gives you some sort of three-dimensional experience [SM1].*

However, they lack experience in using technology. Only 3 out of 14 participants have used the technology. For instance, Participant 4 has explained their experience with VR PG4:

> *I have experience, so I have developed a 3D walkthrough of a retail store in Cape Town where we embedded active digital elements for virtual reality, for augmented reality where it would be accessible through mobile phones, tablets, computers. I have done virtual walkthroughs for real estate. In the past, I have done virtual walkthroughs where I am a potential consumer or interested in a place for things*

> *like museums as well. I recently in the Netherlands had experience with haptic gloves and how it is utilized for training simulations for edit technologies where you cut out the risk of tangible items [PG4].*

From the researcher's data collection, it has been identified that most participants, such as management, senior lecturers, and students, lack experience in using the technology. However, they would want the institution to adopt the technology. The participants felt that the adoption of virtual reality would be a pleasant experience for students, especially for simulation purposes.

4.4.2 Adoption Challenges and Risks

Despite the benefits of immersive technologies, these technologies have challenges. Question 14 from Appendix B question that was asked to the participants regarding adoption challenges and risks: "*What challenges can you think of that CPUT will have to adopt an Immersive learning tool?".*13 participants raised several issues regarding the adoption of immersive technologies at CPUT. Challenges that participants deemed could be a hindrance in the adoption process were lack of technical infrastructure on campus, such as old computers, slow internet connection, non-functional plugs in the classroom, non-existing virtual labs, and more. It can be noted that there is a lack of infrastructure in developing countries. Therefore, this deters the growth of technological innovation in developing countries such as South Africa. The major challenge discovered was a lack of funds to acquire proper resources, as the resources are expensive.

Participants' view:

> *Yes, I am in support of it, but I am also in support of infrastructure. So once infrastructures are in place, I do not have a problem with immersive technology. [SL1].*

One of the participants raised the high-cost challenge that could cause a delay for the organisation in adopting immersive technologies. Participants said: *Excessive cost for the campus and for the student time investment in terms of training students and staff. If they are going the technology route, it will* be a high cost of technology purchase. You know, they pretend they would need developers, so there would be more employees who would need to be improved within the campus, specifically in terms of technology and software [PG5].

Resistance to Change

50% of participants identified that resistance to change is a major issue within teaching and learning environments. In particular, lecturers become reluctant to adopt new technologies. PG6 agree that there is a possibility of reluctance in terms of adapting to new uses of technology: *"Sometimes people can be a bit resistant to change. Not everyone is the same obviously, but you may have some people that struggle to take on something new."* It can be implied that technophobia is an issue in the education industry due to a lack of awareness and training in new technologies. Lecturers would rather choose to teach face-to-face than change to new ways of learning, such as virtual learning.

Below is the view of the participant who is reluctant to adopt immersive technologies. The participant believes that there is a need to have proper facilities and training before implementing immersive technologies. Thus, it will assist those who have technophobia.

> *I would rather choose a face-to-face classroom because it is stressless. I just go to class; I teach and then go. But then if you are proposing that we all move on to online learning, you must provide us the facilities to be able to conduct online learning. There must be an ongoing developmental plan to incorporate every lecturer into immersive use of technology and it also goes with training as well. As much as we propose the immersive use of technologies, many people are technophobic [SL3].*

SL3 Highlight the importance of ongoing development in terms of training users on immersive technologies. It will keep users updated with technological advancements, maximising the effectiveness of the tools, enhancing user satisfaction, fostering innovation, and aligning with institutional goals. It ensures that users can fully leverage the capabilities of immersive technologies and adapt to changing needs and opportunities.

Hard to Grasp Material

One participant identified the intriguing challenge they are facing with traditional learning. The researcher learned that the participant found it hard to grasp the material and theory of the modules. Immersive learning could be the solution to this challenge as it allows students to be in the environment they are learning about virtually.

> *Well, I guess so I mean for my purposes I mean it has mostly been obviously from attending classes and so forth and taking in the materials that they have been lecturing on some of the things are a bit hard to grasp [PG2].*

Participants identified the various risks in terms of the adoption of immersive technologies on campus. Risks identified were vandalism, theft, and security and maintenance around the

hardware and software of immersive technologies resources. Due to the student strikes that happened before on campus, students caused havoc and vandalised the infrastructure. It has led to participants being afraid of vandalism and theft on campus infrastructure. One participant mentioned that there is a possibility of CPUT academia becoming late adopters in terms of adoption of innovation. It can be noted that this could reduce the standard of education at CPUT as academic competitors are moving with time in terms of adopting immersive technologies.

Vandalism & Theft

> *Some challenges also take place like the vandalism, stealing of property, which can be a drawback to the implementation of these immersive technologies because the systems and equipment that are required, some of them might not be present [PG3].*

> *And I fear if we do not adopt these technologies that we will become redundant as academics, we will stagnate, and we will not get promoted and we will not be employable at other universities [L1].*

4.4.3 Decision-making of Adoption

In trying to identify top management's views, the researcher asked participants (Management)" What *do you believe is top management's view of immersive technologies adoption in the institution?* "Management has raised their interest in developing technological innovation on campus. Participants believe that CPUT is a university of technology and, therefore, needs to stay relevant to the new uses of technology. The researcher discovered that the higher institution is in the process of developing smart labs for its vision 2030. Therefore, it can be noted that decision-making regarding the adoption of technology innovation at CPUT is currently in the pipeline. Participants views:

> *Well management is keen. And so, I haven't heard the rest of the management talk about it explicitly, but I have served on councils and senates and I can tell you the university as a whole and this is with our Champion VC at the front of the ship is very keen to be technologically innovative and at the front of its game. So, as a whole university is keen [SM2].*

> *And we are also a program leader, we are encouraged to benchmark our curriculum, which means we are supposed to compare to other courses to see to what extent are we living up to what is happening in terms of global trends and how can we improve to help push the boundaries [SL3].*

Well, I think as lecturers we also feel that we need to grow and to stay current. So, we must be able to adopt the latest innovative technologies in our teaching, to stay current without teaching, but also with our research [SL2],

4.4.4 Views on Adoption

Participants were asked about their views on the adoption of immersive technologies at CPUT. Question asked*: "What do you think about the adoption of immersive technologies in CPUT?."* All participants showed interest in the adoption of virtual learning at CPUT. The participants believe that immersive technologies should be adopted in higher education. SL4:" *We are in support of the technology and would want to adopt it in our institution*". By doing so, it will allow students to experience learning in a virtual environment simulation. We are living in a digital world whereby everything is done through digital technologies, immersive technologies, and 4IR. Thus, higher institutes of learning should adapt to the new uses of technologies moreover in education.

In general, what I think about the adoption of Immersive technologies at CPUT is that CPUT is an institution of technology it must invest in technology, and it aspires to be the best in Africa. I believe they should. I strongly believe that the university should adopt immersive technologies [PG3].

I think as the faculty, the faculty is very, I would say progressive in that thinking. We are looking at creating a couple of smart can I call it Smart Labs where we want them to do a lot of testing and a lot of experimenting on a lot of these things [SM1].

Main RQ: What are the factors that could influence the adoption of immersive technologies in higher education institutions?

This section discusses additional emergent factors identified by the participants.

An interview question asked:

- Do you have any other factors you think can be added to influence the adoption?

Some factors have been identified in the proposed framework used in the study (TOE), such as relative advantage, technical infrastructure, technology competency/compatibility, top management support, organisational culture, regulatory environment, and competitive pressure. The researcher asked the participants the factors that they think could influence the adoption of immersive technologies at Cape Peninsula University of Technology (CPUT). Participants identified additional key factors that could influence the adoption, such as leadership style, Organisational readiness, Industry partnerships, Qualified personnel,

Training, Institution's financial capacity, Pricing reduction factor, Relevance, Global pandemic, and stakeholder involvement.

Participants PG1, PG3 & SL2 identified leadership style as *leadership, leadership of the management also I think can also play a role in adoption of the technology that will influence the adoption of the technology around the institution. [PG3]*

> *Our top management Style as well. It will be great for our Deans, HODs, and other management from different departments to meet and discuss the adoption of immersive technologies in our institution. And not just the solutions in their respective roles. I think that would improve our culture, technical infrastructure, and students; experience [SL2].*

Relevance and curiosity about new technology have a vital influence on the adoption of immersive technologies. It is of paramount importance for the institution to identify the relevance of wanting to adopt new technologies. This will be able to assist in discovering whether the technology will be used or if it will be obsolete or not being used at all. The user of the technology needs to understand immersive technologies for it to be used effectively. The participant's view:

> *So, one you need to look at relevance. So, looking at what the university offers and what the virtual reality scenarios are that relate to the university's context in terms of content knowledge. So, are there existing educational virtual reality scenarios that relate to the content that is being taught by the lecturers? Otherwise, what happens is that institutions buy the technology, but it never gets used because lecturers do not see the value [SM2].*

> *All right, why I say you can have all the wonderful things out there, but unless there is an interest, unless there is a curiosity factor, nothing will work. So, staff must be curious about it and staff should be wanting to learn more about it [SL4].*

Subsequently, this is where training comes in place. Training provided to users will give them more knowledge, confidence, drive, and enthusiasm for using virtual and augmented reality in education. PG7 identified the training factor by stating: There must be training for users, and there must be an ongoing developmental plan to incorporate every lecturer into immersive use of technology, and it also goes with training *[PG7].*

Participants PG1, PG2, PG3 & SL3 emphasised the financial capacity of the institution for instance PG2 said "*Perhaps we can talk about the financial means of the university which could not be necessarily an external factor, maybe it's an internal one because we're looking at does the university*

have the capacity in terms of money to do that and implement it. So, it could be one of the factors. And, we can also talk about the, you know the qualified personnel, it is one of the aspects factors that should also be considered as a factor when you want to adopt or not to adopt."

It can be noted that the financial capacity of the institution is crucial in the adoption process. This will determine whether the institution can adopt the technology or not. One of the participants mentioned that the buying price of this technology, such as headsets, goggles, 3d screens, and hiring qualified personnel, can be very expensive. Therefore, the institution needs to be financially stable or get sponsors from industry partnerships. *PG4: "So, that is one factor as the buying purchase of the technology can be quite high. I think from a technological perspective, if you add access to these sorts of technologies at a lower price that will have a higher adoption. I think from a socioeconomic perspective as well where people are seen as a higher social status, having access to immersive technologies like your headsets could drive enthusiasm for adoption*."

One of the participants stated that stakeholders, such as students, staff, and management, and everyone around the campus must be involved for the adoption to be successful. *We involve students, staff, and everyone in campus to be involved in promoting immersive technologies at out campus. [PG1]* while Management also highlighted the cruciality of partnering with industries to be able to give students an immersive technology experience. The participants believe that pressure from the industry can influence the adoption of new technologies.

> *SM1: "The only thing that could lead to a decision to adopt is if what I can say we send our students out for internship at the end of their third year. in our feedback, we also receive responses from the excessively big key industry players. in their feedback to us, they also emphasize the fact that these adoptions are required. I think that would lead to us taking notice and adopting it more rapidly."*

The below pie chart identifies the internal factors mentioned by the participants. It highlights the number of participants who identified the factors that could influence the adoption of immersive technologies. From the chart below, it can be noted that most participants 42% of the participants believe that the financial capacity of the institution is crucial as it will identify the readiness of the organisation in terms of the adoption of new technologies. 33% of participants identified the Relevance & curiosity factor as they believe that the institution needs to identify how the technology is relevant to the organisation. The stakeholders need to be interested in the adoption for it to be successful.

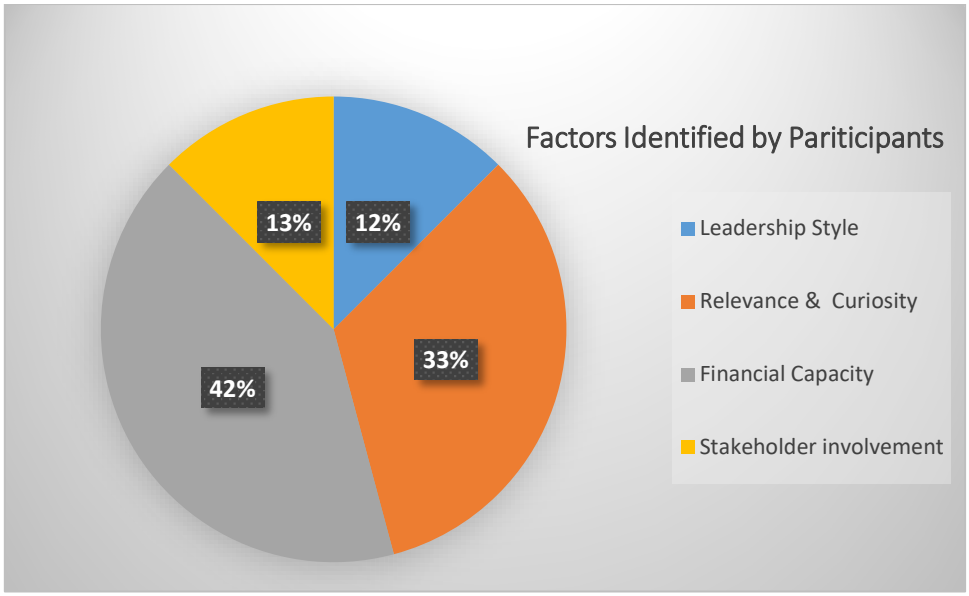


Figure 4-1 Internal Factors Identified by Participant

Three major themes were identified from the framework, namely, Technology, Organisation, and Environment and a new adoption theme was identified from the data collection. The themes in Table 4-3 link back to the research questions and objectives based on the TOE framework. The themes were coded, and patterns and similarities were discovered from the participants' interviews. The themes emanating from data analysis were used to group similar data codes, and the TOE framework guided the process of answering the research questions of the study. The total number of initial codes generated during the open coding phase was more than 1000. Appendix G shows a snapshot of Atlas ti codes(Example of data coding extract: Source: Atlas.ti V23). The criteria used to refine codes, such as merging similar codes and removing those not aligned with the TOE domains. A breakdown of how the codes were grouped into categories under each domain of the TOE framework, and how themes emerged from these categories. Table 4-3 summarises themes that were identified. The analysis began by generating more than 1000 initial codes from the data, grounded in the TOE framework (Technology, Organization, Environment). These codes were refined by merging similar ones and discarding those that were less relevant to the research questions. For example, codes related to "IT infrastructure" and "technical support" were combined, while infrequent, unrelated codes were removed.

The refined codes were then grouped into categories under each TOE domain. In the Technology domain, for instance, "infrastructure inadequacy" and "Infrastructure costs" were categorised under "technical infrastructure." In the Organisation domain, codes like "leadership support" were grouped under "Top management support."

Themes were developed by identifying patterns across these categories. For instance, the Technology domain led to the theme of technical infrastructure as a driver for immersive technology adoption. This process ensured that the analysis was both data-driven and aligned with the TOE framework.

Table 4-3 Themes, Concepts, and Sources Mapped to Categories Technology, Organisation, Environment and Adoption

	Themes	**Associated Concepts**	**Quotes**
Adoption	• Decision-Making Challenges • Risks • Benefits • Views • Security	• Management Decision Challenges • Advantages • Views • Uncertainty	• "The potential risks associated with the technology include **high costs** and **uncertainty** returns on investment." (Source: Data collection, interviews)
Technology	• Relative advantage • Technical infrastructure • Technology Compatibility	• Advantages • Technology Adoption • Innovation • Infrastructure • Compatibility	• "The immersive technologies have significant **enhancements in learning outcomes and engagement (Benefits)**." (Source: Data collection, interviews)
Organisation	• Top Management • Culture • Finances • Organisational readiness • Training • Relevance • Leadership style • Stakeholder involvement • Qualified Personnel	• Management skills Budget • Org Readiness • Frustrations • Factors	• "Stakeholders expressed varied views on the usefulness of the technology, highlighting both its **innovative potential** and the **challenges** it poses." (Source: Data collection, interviews) • "**Organisational readiness**, including **training** and **infrastructure**, is a determining factor in the technology's adoption." (Source: data collection)

Environment	• Competitor pressure • Pricing factor • Industry partnerships	• Competition, influence • Budget • Collaboration	• "There is **significant pressure from competitors (Competitor Pressure)** who had already adopted similar technologies, driving our own adoption efforts." (Source: interviews)

TOE framework for this study

The researcher added factors that were derived from the interviews on the TOE framework for this study. This study followed a case study strategy; therefore, the researcher used Cape Peninsula University of Technology as the case study. Participants added the factors that they believe could influence the adoption of immersive technologies at higher institutions. These factors were added to the existing factors from the literature. Qualified Personnel, Technology Training, Financial Capabilities, Organisational Readiness, Stakeholder Involvement, Relevance, industry partners, Interest or curiosity, and Pricing Reduction factors were added. Figure 4-1 below sets out the enhanced TOE framework.

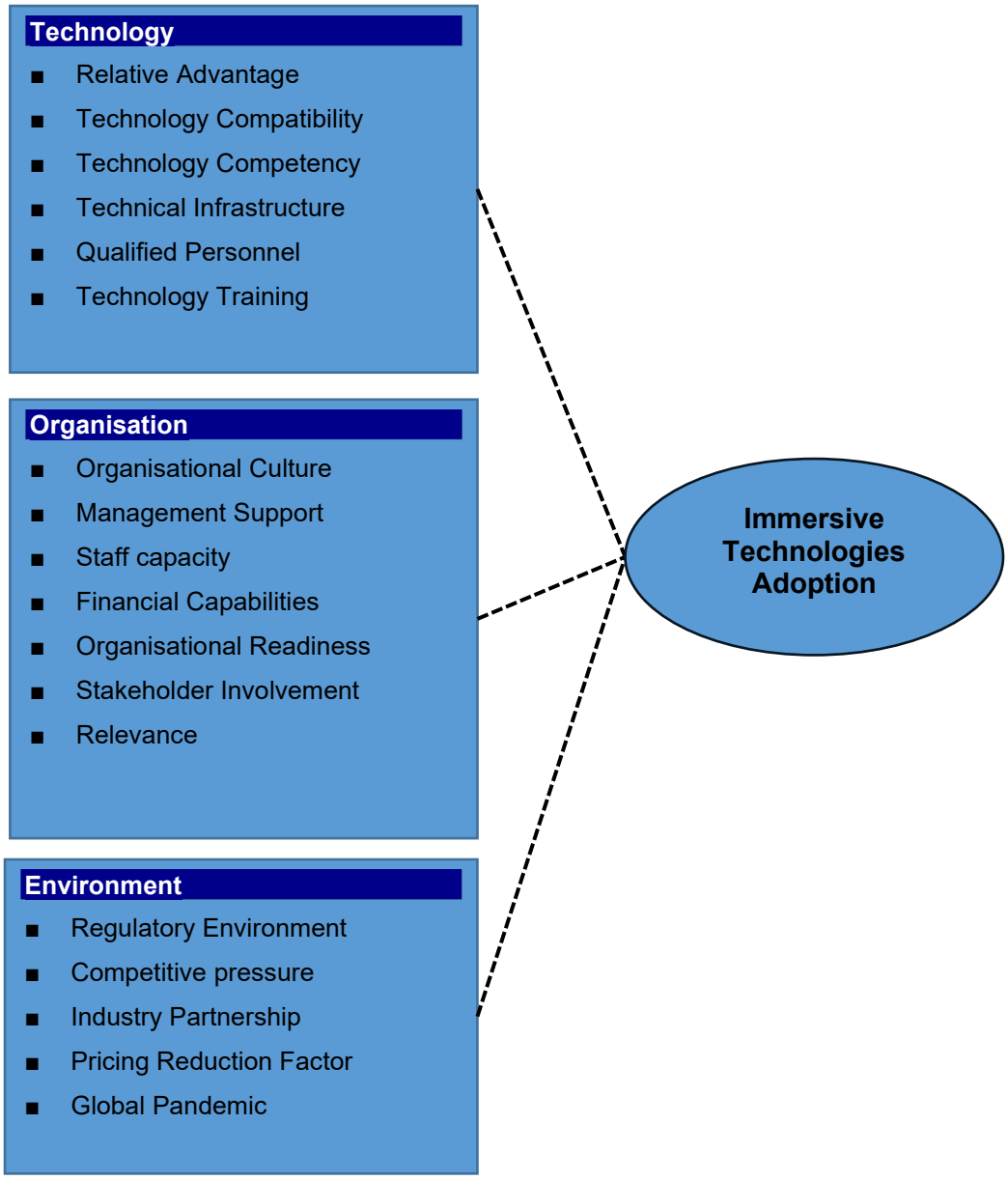


Figure 4-2 Final TOE Framework for Factors that Could Influence the Adoption of Immersive Technologies at CPUT(Source:Author)

4.5 Summary of the Chapter

In summary, the researcher presented the results from the data collection conducted with fourteen participants at the Cape Peninsula University of Technology. These findings were analysed and interpreted to answer the study's research questions. Additionally, the factors that were discovered from the findings were added to the existing TOE framework of this research despite all the adoption challenges that have been identified. The relative advantages of immersive technologies could be beneficial for the institution. The faculty, students and lecturers are eager to utilise immersive learning for their courses. It has been noted that the management of CPUT has introduced smart labs to their vision for 2030. Therefore, students are looking forward to having virtual/augmented reality as part of the smart labs in 2030. The improvement of technical infrastructure and development of innovation in the institution could attract more students to join CPUT. In the next chapter, the researcher will conclude and provide recommendations.

5 CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The study investigated the factors influencing the adoption of immersive technologies in higher education, with a focus on identifying the factors that could influence the adoption of immersive technologies and institutional readiness as a factor. By applying the Technology-Organization-Environment (TOE) framework, the research aimed to investigate the factors that could influence the adoption of immersive technologies in higher education institutions in South Africa and to understand how technical infrastructure, organizational culture, and readiness impact the adoption process at higher education institutions.

5.1.1 Background & Research Problem

Immersive technologies, such as virtual reality (VR) and augmented reality (AR), have the potential to transform higher education by enhancing learning experiences. However, the adoption of these technologies requires a thorough examination of institutional factors that may affect their integration.

The primary problem addressed was how institutions' technical infrastructure, organisational culture, external factors, and readiness impact the adoption of immersive technologies. The study sought to identify specific challenges and opportunities associated with adopting these technologies in higher education settings.

5.1.2 Research Objectives

Each objective was reviewed following the results from the data analysis.

Objective 1: To examine how an institution's technical infrastructure influences the adoption of immersive technologies in higher education.

The institution’s technical infrastructure was identified, and challenges and recommendations were provided to improve it. All participants agreed that good, compatible, and stable technical infrastructure will influence the adoption of immersive technologies at CPUT.

Objective 2: To identify how an institution's organisational culture influences the adoption of immersive technologies in higher education.

The participants identified the institution's organisational culture. They shared the same sentiments about how the institution is conducted and how the culture of the institution could

influence the adoption of immersive technologies. Additionally, some participants raised the idea that there is a culture of innovation in the organisation, as lecturers are encouraged to be creative and innovative in their teaching. Some participants mentioned the smart lab development for Vision 2030, which management is encouraging. Therefore, the culture mentioned above does influence the adoption of immersive technologies.

Objective 3: To identify how an institution's external factors influence the adoption of immersive technologies in higher education.

The participants mentioned external factors such as competitors' pressure, pricing reduction on immersive technology resources, global pandemic, and industrial partnerships. These factors were identified as influencing the institution to adopt immersive learning. For instance, the pressure from competitors is the driving force that influences adoption, as students want what other institutions close by have and do not want to be left behind.

5.1.3 Research Design to answer the research questions

The research employed a qualitative approach, including interviews with IT staff and students at the institution. Data collection focused on technical infrastructure, organisational culture, external factors, and readiness to adopt immersive technologies. The TOE framework was used to guide the research questions and objectives. Due to the qualitative nature of the study, thematic analysis was used to identify key themes, patterns, factors, and insights related to the research questions.

5.1.4 Findings

Technical Infrastructure: The study found that inadequate technical infrastructure is a significant barrier to the adoption of immersive technologies. Participants highlighted issues such as outdated equipment and insufficient resources, which could hinder the integration of new technologies.

Organisational Culture: The research revealed that organisational culture plays a crucial role in technology adoption. A culture that encourages innovation and supports new technologies can facilitate the adoption process. Conversely, a lack of urgency and poor communication can impede it.

Readiness: The institution's readiness to adopt immersive technologies was mixed. Some participants felt that the institution was ready, while others highlighted that CPUT needs to improve its infrastructure before the adoption. While there is a willingness and enthusiasm for new technologies, financial constraints and outdated infrastructure pose challenges.

5.2 Discussion

The findings underscore the importance of aligning technical infrastructure and organisational culture with the goals of adopting immersive technologies. Institutions must address infrastructure deficiencies and foster a supportive culture to enhance the adoption process. The study aligns with existing literature that emphasises the role of technical infrastructure and organisational factors such as costs, training, and readiness in technology adoption.

Relation to Previously Known Work

This research corroborates previous studies that highlight the factors of immersive technologies. It extends the understanding of these factors in the context of immersive technologies, contributing new insights into the specific challenges faced by higher education institutions. This research corroborates existing studies that underscore the importance of technical infrastructure, Management support, external factors, and organisational culture in the adoption of new technologies. The findings align with several key contributions in the literature, such as:

Technical Infrastructure: Pan et al. (2021) emphasise that the robustness of technical infrastructure is crucial for the successful adoption of new technologies. Their research highlights how investments in infrastructure can significantly influence technological innovation, a finding echoed in this study's discovery of infrastructure challenges at the institution. Similarly, Defitri et al. (2020) argue that inadequate technical infrastructure is a substantial barrier to technology adoption, which was consistent with the participants' experiences at CPUT.

Organisational Culture: The role of organisational culture in technology adoption is well-documented. Sayginer and Ercan (2020) discuss how top management support and a culture conducive to innovation are vital for successful technology implementation. This study supports their findings by revealing that a culture promoting creativity and innovation can facilitate the adoption of immersive technologies. Conversely, the research also reflects the challenges posed by a culture of delays and poor communication, aligning with earlier critiques of institutional culture's impact on technology adoption (Ghaleb et al., 2021).

Readiness for Adoption: The concept of organisational readiness is central to technology adoption studies. Oliveira et al. (2019) highlight that readiness, encompassing both technical and financial aspects, is a critical factor in the successful adoption of new technologies. This

study's mixed findings on CPUT's readiness for immersive technologies echo Oliveira et al.'s emphasis on the need for both technical preparedness and financial resources.

Technology Compatibility: Malik et al. (2021) and Amini and Jahanbakhsh (2023) stress the importance of technology compatibility in the adoption process. This study's focus on how the compatibility of new technologies with existing systems influences adoption supports their conclusions, reinforcing the need for institutions to ensure that new technologies align with their current infrastructure.

Overall, this research extends the understanding of these factors by providing specific insights into how they interact in the context of immersive technologies within higher education. It contributes new perspectives on the practical challenges institutions face and offers empirical evidence that supports and expands upon existing theoretical frameworks.

5.3 Recommendations

Technological Aspect

For low-cost implementation, the institution could first provide education on immersive learning. Then, they could look at utilising readily available resources, like a smartphone. Accessing virtual environments or immersive environments can be done with a smartphone. For instance, using an avatar or just utilising touch throughout the application. Additionally, get an alternative option like a VR card box where students could be taught how to make their own, slide the phone in there, and be completely immersed. So, that is one way to mitigate the challenge of finance, adaptation, and access. Starting at a small scale to see the results could be an influence on the institution to see the benefits of the technology.

The institution could get an expert who is knowledgeable in the subject to assist and handle the implementation of this technology from start to finish and train users. All staff in different departments need to collaborate to encourage all senior management from the top to buy into the idea of immersive technologies, as individuals at the bottom do not have the power.

Organisational Aspect

Institutions should prioritise professional development programs for faculty and staff to build expertise in using immersive technologies. Training should focus not only on the technical aspects but also on pedagogical strategies for integrating these technologies into the curriculum. Continuous professional development will help ensure that educators are well-equipped to utilise immersive technologies effectively. To encourage the adoption of

immersive technologies, institutions should cultivate a culture that embraces innovation and experimentation. This includes providing opportunities for faculty to pilot new technologies, share best practices, and collaborate on innovative projects. Recognising and rewarding innovative efforts can also motivate faculty to explore and adopt new technologies.

Environmental Aspect

Institutions should be mindful of regulatory and ethical considerations when adopting immersive technologies. This includes ensuring data privacy and security, addressing accessibility concerns, and complying with relevant regulations. Developing policies and guidelines to address these issues can help mitigate risks and ensure the responsible use of technology.

5.4 Possible Future Research

Based on the findings presented in the study, potential future research should also focus on the effect of technical infrastructure on technology adoption innovation in developing countries. A quantitative study on a similar topic could be done to identify the findings of this study and to research the motivation from other universities that have adopted and discuss what encouraged them to adopt immersive learning. Additionally, it is important to find out why the adoption would be required by the institution (CPUT) from an academic perspective and why it might not be feasible for the institution.

This study was delimited to a single faculty at one institution. It is recommended that similar initiatives be considered across other faculties within the same university, as well as at traditional academic institutions more broadly. The experiences and outcomes observed in the Faculty of Informatics and Design (FID) at Cape Peninsula University of Technology (CPUT) may differ significantly from those in other faculties, such as the science faculty. Therefore, further empirical research is needed to explore in-depth organisational readiness and understand students' experiences with immersive technologies across diverse academic disciplines.

5.5 Limitations of the Study

This study is limited to factors that could influence the adoption of immersive technologies at higher education institutions in South Africa. It is restricted to Informatics and design students and staff studying at Cape Peninsula University of Technology only. The TOE framework guided the study's research questions. It will not cover any other university in the Western

Cape except CPUT. Additionally, only qualitative methodology was used in the study to assist in the data collection process. Furthermore, time constraints were a limitation in the sense that the study had to be completed within the period specified by the institution. There was a challenge in getting the participants, especially staff at CPUT, and it took a long time to finish the data collection.

5.6 Significance of the Study

The application of the tenets of the TOE framework to the field of immersive technology indicates that *a significant theoretical contribution* is made to the body of knowledge. The TOE framework assisted the study in identifying how the adoption of technology should be carried out at a higher education institution. This theoretical framework assisted the researcher in identifying the factors that could influence stakeholders and decision-makers on whether to adopt immersive technology or not. The study offers *methodological significance* by juxtaposing the qualitative outcomes of the pilot study with those of the main study. From *a practical standpoint*, the outcome of this study will assist higher institutes in improving their organisational culture and technical infrastructure. It will inform policy-making in terms of decision-makers at higher education institutions to consider the adoption of immersive technologies.

5.7 Conclusion

In conclusion, this empirical study offers critical insights that can guide decision-makers at the Cape Peninsula University of Technology (CPUT) in navigating the adoption of immersive technologies. Through a detailed case study focusing on CPUT in Cape Town, South Africa, the research has illuminated key factors affecting the integration of such technologies within higher education institutions. The study employed qualitative methods, including semi-structured interviews with Informatics and Design staff and students, to explore the factors influencing the adoption of immersive technologies. The data collection utilised interview guide questionnaires, informed by the Technology-Organization-Environment (TOE) framework, which provided a structured approach to understanding the adoption dynamics.

The research identified several crucial factors impacting the adoption process, including leadership style, organisational readiness, industry partnerships, qualified personnel, technology training, financial capacity, pricing, relevance, the global pandemic, and stakeholder involvement. Despite the various challenges faced by CPUT, such as outdated infrastructure and financial constraints, the study underscores that the benefits of immersive

technologies, particularly in enhancing virtual learning, continue to be a significant driver for innovation. Immersive technologies offer substantial benefits, including improved engagement, practical experience, and enhanced learning outcomes. These benefits highlight the potential of immersive learning to transform educational practices and justify continued efforts toward overcoming the existing barriers. By addressing the challenges identified in this study and leveraging the documented benefits, CPUT can better strategise its approach to adopting immersive technologies.

Overall, this research provides a comprehensive understanding of the factors influencing technology adoption in higher education and emphasises the need for strategic planning and investment to harness immersive technologies' full potential.

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Appendix A: Ethics Approval

PO Box 1906, Bellville,7535 Symphony Way, Bellville, Cape Town, South Africa
+ 27 (0)21 959 6767 www.facebook.com/cput.ac.za info@cput.ac.za www.cput.ac.za

Office of the Research Ethics Committee
Faculty of Informatics and Design
Room 2.09
80 Roeland Street
Cape Town
Tel: 021-469 1012
Email: ndedem@cput.ac.za
Secretary: Mziyanda Ndede

06 July 2023

Ms Olivia Kgosiejang
c/o Department of Information Technology
CPUT

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Project title: Factors for the Adoption of Immersive Technologies in Higher Education in South Africa

Approval period: 06 July 2023 – 31 December 2024

This is to certify that the Faculty of Informatics and Design Research Ethics Committee of the Cape Peninsula University of Technology approved the methodology and ethics of Ms Olivia Kgosiejang (214224376) for MICT: IT (Magister Technologiae: Information and Communication Technology).

Any amendments, extension or other modifications to the protocol must be submitted to the Research Ethics Committee for approval.

The Committee must be informed of any serious adverse event and/or termination of the study.

Prof Lincoln John Theo
Research Ethics Committee Rep
Faculty of Informatics and Design
Cape Peninsula University of Technology

Appendix B: Interview Guide

Factors Influencing the Adoption of Immersive Technologies in Higher Education

Name of the Researcher: Olivia Kgosiejang

Interview Guide

This interview addresses aspects pertaining to the factors influencing the adoption of immersive technologies in a South African institution in Cape Town. Written consent will be provided to the participants to sign that they are voluntarily taking part in the interviews. The interview will be recorded for data analysis purposes. It consists of 22 Questions and should last for 40 min or less.

1. Can you please introduce yourself?

- Tell me about the institution.
- How long have you been with the institution?
- What are your roles and responsibilities within the department?

2. Who are the key stakeholders (top management), and what are their responsibilities?

3. What is your understanding of immersive technologies? Tech Relative advantage

Immersive technologies are referred to as “virtual content with the physical environment” so that the end users interact naturally with combined reality.

4. What experiences do you have with immersive technologies, for instance, as a decision-maker, implementer, or user? Tech

5. In your opinion, please discuss the institution’s culture and how things are done within the organisation in terms of decision-making or in general.

- In your opinion, do you think the culture of the organisation can influence the decision to adopt immersive technology? How so?

6. Discuss the high-level organisational structure (Management level) in terms of decision-making. Organisation

7. What could the institution do to encourage the adoption of immersive technologies? Adoption

8. How is your department involved in technology adoption-related decisions and initiatives? Tech

9. What do you think about the adoption of immersive technologies in CPUT? Tech adoption

- Do you think the institution is prepared to adopt? If not, what are the obstacles, and what could be done to remove them?

10. How do you think immersive technologies could influence or enhance teaching and learning?

11. In your opinion,

- Do you think technical infrastructure is important in the adoption process of immersive technologies, and why?
- Do you think technology compatibility is important in the adoption process of immersive technologies?
- Do you think management support is important in the adoption process of immersive technologies? (Why do you say so) Organisation-Top management support.

12. What is your experience with the current institutions' technical infrastructure?

13. In your opinion, what are the critical key aspects to consider before any technology adoption? Adoption

14. What challenges do you think CPUT will have in adopting an immersive learning tool? Adoption

- Do you think there is a risk in terms of the adoption? If yes, what are the risks?

15. What do you believe is top management's view of immersive tech adoption in the institution? Tech/org

16. How will the institution ensure that the immersive technology's adoption is compatible with the existing systems? Tech Compatibility

17. What do you think are the key benefits of immersive tech adoption in your role as a manager and lecturer? Tech relative advantage

18. Are you aware of any institutions that have been adopted? (Environment)

- If yes, is CPUT able to do something similar with other institutions?

19. External factors examples: Customer pressure, Competitors pressure, Government support

In your view, do you think the factors mentioned above are important in the adoption process? If so, do you have any other external factors that could lead to a decision to adopt or not adopt? (Environment)

20. Does CPUT participate in business associations (such as EON Reality) that promote immersive technology adoption? If so, please share the key notes of the conversation.

21. Do you think the government supports higher institutions with this kind of initiative? If yes, are you aware of any institution that received support? (Environment)

22. Do you have any other factors you think can be added to influence the adoption? (Adoption)

Appendix C: Individual Consent for Research Participation

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FID/REC/ICv0.1

FACULTY OF INFORMATICS AND DESIGN

Individual Consent for Research Participation

Title of the study:	**Factors Influencing the Adoption of Immersive Technologies in Higher Education**	
Name of researcher:	Olivia Kgosiejang	
Contact details:	email: keneilwekgosiejang@gmail.com	Phone: 073 061 5811
Name of supervisor:	Dr Errol Francke	
Contact details:	email: FranckeE@cput.ac.za	Phone: 082 494 7851

Purpose of the Study: The purpose of this study is to investigate the factors that could influence the adoption of immersive technologies in higher education institutions in South Africa. The eruption of global crises such as the COVID-19 pandemic has forced everyone to work remotely and digitally. The higher institutes of learning are also not spared. Therefore, it is of paramount significance for institutions of higher learning to adopt learning systems that enhance teaching and learning remotely without too many interruptions. Immersive technologies could be the solution to this problem as they facilitate easy interactive learning and engagement between students and the learning material.

Participation: This study will use semi-structured interviews to collect data from participants. It is limited to collecting the views, ideas, preferences, and opinions of the research participants using open-ended questions. Participation in the study will be voluntary, and the participants will be anonymous.

Confidentiality: The identities, personal information, and data collected by the participants will be safeguarded against unauthorised access. Strict confidentiality will be observed.

Anonymity: The data collected will be aggregated for the study, and all participants will remain anonymous. The identities, personal information, and data collected of the participants will be safeguarded against unauthorised access.

Conservation of data: The data collected for the study will be safeguarded against unauthorised access. In lieu of the POPI Act, the data will only be used for the purposes explained to research participants and only kept for the duration required.

Voluntary Participation: Participation in the study will be voluntary, and participants will be afforded an opportunity to withdraw at any stage.

Additional consent: I make the following stipulations (please tick as appropriate):

	In thesis	In research publications	Both	Neither
My image may be used:				X
My name may be used:			X	
My exact words may be used:			X	
Any other (stipulate):				

Acceptance: I, (print name)

agree to participate in the above research study conducted by Olivia Kgosiejang of the Faculty of Informatics and Design in the Department of Information Technology at the Cape Peninsula University of Technology, whose research is under the supervision of Dr Errol Francke.

If I have any questions about the study, I may contact the researcher or the supervisor. If I have any questions regarding the ethical conduct of this study, I may contact the Secretary of the Faculty Research Ethics Committee at 021 469 1012 or email naidoove@cput.ac.za.

Participant's signature: _____ Date: 07.09.2023

Researcher's signature: K. Kgosiejang Date: 07.09.23

Appendix D: Interview Transcript Template

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Factors Influencing the Adoption of Immersive Technologies in Higher Education

	Participant: XXX Interviewer: Olivia Kgosiejang Date of Interview: ddmmyyyy Time: hh. mm Online interview via Teams
Interviewer	
Participant	
Interviewer	
Participant	
Interviewer	
Participant	
Interviewer	
Participant	
Interviewer	
Participant	

Appendix E: Site Permission

Cape Peninsula University of Technology

Office of the Deputy Vice-Chancellor: Research, Technology Innovation & Partnerships
Bellville Campus
P O Box 1906
Bellville 7535
Tel: 021-959 6242

11 July 2023

Ms Olivia Kgosiejang
Student No: 214224376
MICT: IT (MTech: Information and Communication Technology)
Department of Informatics and Design
Cape Peninsula University of Technology

Dear Ms Kgosiejang

RE: SITE PERMISSION TO CONDUCT RESEARCH AT CPUT

Based on the recommendation of APPROVAL from the Faculty of Informatics and Design Research Ethics Committee I am pleased to support your research study "*Factors for the Adoption of Immersive Technologies in Higher Education in South Africa*". Your request to access the Cape Peninsula University of Technology as a research or recruitment site, is granted.

The research study will include investigating the factors that could influence the adoption of immersive technologies in higher education institutions suing semi-structured interviews. Purposive convenience sampling method will be used to collect data from CPUT Cape Town campus Information Technology (IT) staff and students.

This site permission covers the time-period of 16 July 2023 to 17 July 2024.

The CPUT site permission is contingent on research ethics approval as well as adhering to all the relevant CPUT policies and regulations.

The following information has relevance:
Research Ethics Approval Date: 6 July 2023
Research Ethics Approval valid until: 31 December 2024
Research Ethics Approval Reference No: 214224376/2023/12

Permission is herewith granted for you to do research at the Cape Peninsula University of Technology.

Wishing you the best in your study.

Sincerely

Prof Dina Burger
Director: Directorate Research Development
Cape Peninsula University of Technology

Appendix F Editing Certificate

DR PATRICIA HARPUR

B.Sc Information Systems Software Engineering, B.Sc Information Systems (Hons)
M.Sc Information Systems, D.Technology Information Technology

Editing Certificate

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19 Keerweder Street Vredelust Bellville7945

083 7308540

doc@getthatresearchdone.com

To Whom It May Concern

This document certifies I have copy-edited the following thesis by Olivia Keneilwe Kgosiejang

FACTORS INFLUENCING THE ADOPTION OF IMMERSIVE TECHNOLOGIES IN HIGHER EDUCATION

Please note this does not cover any content, conceptual organisation, or textual changes made after the editing process.

Best regards

Dr Patricia Harpur

20 April 2024

Appendix G Atlas.ti Snippet (Example of data coding extract: Source: Atlas.ti V23)