UNIVERSITY OF KWAZULU-NATAL

Factors that influence the adoption of teledentistry by dental professionals in South Africa

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DECLARATION

I Ismaeel Mahomed, declare that

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In memory of our beloved cat Cheeto (2022/08/29).

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ABSTRACT

The emergence of the fourth industrial revolution has introduced many capabilities for the healthcare sector. The concept of telehealth, or "healthcare at a distance" has been studied extensively in various domains such as medicine, dentistry, cardiology, radiology, and mental health. South Africa, a country marked by a high prevalence of oral health disease and a lack of dental professionals to cater to the public and rural sectors, can benefit from the capabilities of teledentistry. Despite the promising capabilities of teledentistry, telehealth has not thrived in South Africa, and the successful adoption of teledentistry has not been investigated amongst South African dental professionals. Furthermore, technological innovations are susceptible to cyber-attacks, and given South Africa's vulnerable standing to cybercrime, it is crucial to study trust and perceived risks that pertain to teledentistry. There exists a gap in the literature that identifies the factors influencing the adoption of teledentistry amongst South African dental professionals, and how cyber security risks influence teledentistry adoption as well. This study aimed to address the above, by utilizing a conceptual model based on the UTAUT and added constructs of trust and perceived risk. Online questionnaires were distributed to dental professionals on social media platforms such as LinkedIn and WhatsApp. A sample of 146 respondents was utilized in the study through convenience and snowball sampling. The study was predominantly quantitative and data was analyzed through descriptive and inferential statistics (one sample t-tests, Pearson correlation, and regression). The study’s questionnaire did include a section that elicited an open-ended response that was analysed from a phenomenological perspective. Performance expectancy, effort expectancy, social influence, facilitating conditions, trust, and perceived risk all had significant positive correlations with behavioral intention to adopt teledentistry. The construct of performance expectancy exhibited the strongest correlation with behavioural intention and facilitating conditions the lowest. The main theme derived from the open-ended section was that teledentistry would be used in a supplementary manner to to enhance dentistry by increasing the capacity for quick patient consultations rather than become a fully fledged replacement for dentistry. The study provides a concise identification of factors that will enhance the use of teledenistry within the dentistry sector of South Africa thereby ensuring greater access to dental expertise at a cost that is economically viable.

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LIST OF ABBREVIATIONS

AIC	Akaike Information Criterion
AGFI	Adjusted Goodness of Fit Index
ANOVA	Analysis of Variance
BI	Behavioral Intention
BIC	Bayesian Information Criterion
CB-SEM	Covariance Based Structural Equation Modeling
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
DOI	Diffusion of Innovation Theory
EE	Effort Expectancy
FC	Facilitating Conditions
GFI	Goodness of Fit Index
HIPAA	Health Insurance Portability and Accountability Act
HPCSA	The Health Professions Council of South Africa
HIS	Health Information Systems
ICT	Information and Communications Technology
IDT	Innovation Diffusion Theory
M-HEALTH	Mobile Health
MPCU	Model of PC Utilization
NFI	Normal Fit Index
PBC	Perceived Behavioural Control
PE	Performance Expectancy
PEOU	Perceived Ease of Use
PGFI	Parsimoneous Goodness of Fit Index
PHC	Primary Health Care
POPIA	Protection of Personal Information Act, 2013
PR	Perceived Risk
PU	Perceived Usefulness
RMSEA	Root Mean Square Error of Approximation
SCT	Social Cognitive Theory
SI	Social Influence
SRMR	Standardized Root Mean Square Residual

STDDEV	Standard Deviation
TAM	Technology Acceptance Model
TLI	Tucker-Lewis Index
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
USA	United States of America
UTAUT	Unified Theory of Acceptance and Use of Technology
WHO	World Health Organization
4IR	Fourth Industrial Revolution

CHAPTER ONE - INTRODUCTION

1.1 Introduction

This research project investigates the factors influencing the adoption of teledentistry amongst South African dental professionals, using a predominantly quantitative approach with the distribution of an online questionnaire. This chapter provides an overview of the project, including the background for the study (Section 1.2), the problem statement (Section 1.3), the research questions and objectives (Sections 1.4 & 1.5), the research design and methodology (Section 1.6), significance (Section 1.7), justification (Section 1.8), and limitations (Section 1.9) of the study. The chapter concludes with an outline of the dissertation (Section 1.10).

1.2 Background of the study

The Information and Communications Technology (ICT) sector is constantly evolving, providing innovative approaches to fields such as the healthcare sector. While healthcare is being revolutionized by the inception of the Fourth Industrial Revolution, Dentistry 4.0 is driving oral health by providing new opportunities in the manufacturing, automation, and data exchange fields. Dentistry 4.0 collectively involves technologies like teledentistry, Artificial Intelligence, Internet of Things, Augmented and Virtual Reality, Computer-Aided Design, 5G and robotics, 3D printing, and cybersecurity.

Among these fields, teledentistry and cybersecurity are the most prominent research fields in recent years, owing to the COVID-19 pandemic. Teledentistry was introduced in 1997 by Cook, who proposed that dental professionals can use video conferencing technologies to solve the problem of consulting or offering advice to patients over a distance (Alsharif & Al-harbi, 2020). This technology has evolved to include many devices and technologies, such as phone calls or SMS technologies, to promote the treatment of patients over long distances.

One of the major concerns with new technologies is the element of cybersecurity. Patients' confidential data must be protected when transferred from one medium to another. According to Kruse *et al*. (2017), cybersecurity within the healthcare sector has always been a concern and lacks certain aspects. Firstly, limited IT resources and the inability of organizations to spend adequately on information technology (IT) infrastructure. There is still a notable dependence on legacy systems such as Windows XP. Secondly, fragmented governance is lacking in healthcare, which refers to accountability and responsibility over the IT domain. Lastly, cultural habits such as sharing of passwords to promote patient care first has become an issue (Martin *et al*., 2017).

Furthermore, low and middle-income positioned countries such as South Africa have exhibited the highest disease burden globally, accounting for 25% of the world's disease burden, while being under-resourced in terms of human labour and financial resources (Fortuin & Naidoo, 2015). This study investigates the factors influencing the adoption of teledentistry in South Africa, with an added focus on Cybersecurity trust and perceived risk, given South Africa's current vulnerable standing on cyber-attacks.

Teledentistry, which falls under the umbrella of telemedicine, pertains to delivering oral health care over distances using technology that substitutes face-to-face interaction. Services such as telediagnosis, teletriage, telemonitoring, and telereferrals can all be done without a nearby dentist. Teledentistry has been a popular topic worldwide since the inception of COVID-19. Dental services had to resume while curbing the spread of infection. Research on teledentistry's attitudes, behaviour, and knowledge has been extensively covered in Saudi Arabia, Pakistan, Brazil, the USA, and India (Nayar, McFarland, Chandak, & Gupta, 2017; Alsharif & Al-harbi, 2020; Mathivanan *et al*., 2020; Raucci-Neto *et al*., 2021; Chaudhary *et al*., 2022). Key findings from these regions are positive attitudes toward adopting this technology. At the same time, dental professionals lack the critical knowledge of teledentistry and how to use it effectively. Most studies do not account for other technology adoption factors, found in comprehensive technology adoption frameworks like UTAUT.

The lack of focus or reliance on teledentistry in South Africa has been identified as an urgent area that needs to be addressed. This issue has been flagged by Fortuin and Naidoo (2015), where they assert that telemedicine has not thrived in South Africa, as it should have, given the constant evolution of technology. In a subsequent study, Bissessur and Naidoo (2019) observed that the use of ICTs in South Africa has been identified as a national governmental strategy to improve access to general healthcare. However, teledentistry has not been included as part of this strategy. Since 1998, the National Strategy for telemedicine has looked into developing this field by introducing the Telemedicine Lead Programme and ensuring that necessary research is conducted. However, as Bissessur and Naidoo (2019) indicated, teledentistry is a glaring omission from the strategy to include ICTs in the healthcare domain to obviate the racial and economic healthcare disparities in South Africa.

Despite teledentistry being an essential tool in providing oral health care, developing countries still lack knowledge and experience in the use of teledentistry. The current intended research investigates the factors that influence the adoption of teledentistry in South Africa. The study’s scope extends to include the dimension of cybersecurity. The rationale for this extension is the researcher’s contention that any meaningful ICT engagement must include a cybersecurity component.

1.3 Research problem

The prevalence of oral disease in low and middle-income countries is high, leading to the vital need for dental professionals (Peres *et al*., 2019). However, there is an insufficient number of professionals available and accessible to the population of these countries (Watt *et al*., 2019). This is further emphasized by South Africa's imbalanced healthcare system, where 71% of the population depends on state-funded healthcare (Rensburg, 2021). Teledentistry can aid in overcoming these geographical and societal issues regarding oral healthcare in South Africa. Country-wide adoption of such a technology would have several benefits, including increasing access to oral health information and tools, allowing diagnosis, and promoting oral health education and training (Fortuin & Naidoo, 2015).

While teledentistry is an essential technological tool in promoting oral health care, telehealth adoption in South Africa has failed for various reasons that have not been investigated. Of the 88% of initiatives the National Department of Health introduced, only teleradiology and teledermatology are still being utilized in select provinces (Fortuin & Naidoo, 2015). This indicates that teledentistry (which is a domain within telehealth) is not among the successful adoption of telehealth initiatives in South Africa. Furthermore, the challenge is the willingness of dental professionals to adopt teledentistry, which has shown promise globally (Adenuga, Iahad, & Miskon, 2017).

1.4 Research questions

The main research question is stated as: **What is the behavioural intention of dental professionals in South Africa to adopt teledentistry?**

- What are the factors influencing the adoption of teledentistry amongst dental professionals in South Africa?
- What roles do trust and perceived risk play amongst South African dental professionals in the adoption of teledentistry?
- How can the adoption of teledentistry be enhanced in South Africa?

1.4.1 Research hypotheses

Following the research questions above, the study seeks to test the below hypotheses:

$H1_0$: *Performance expectancy has no influence on the behavioural intention to adopt teledentistry in South Africa*

$H2_0$: *Effort expectancy has no influence on the behavioural intention to adopt teledentistry in South Africa*

$H3_0$: *Social influence has no influence on the behavioural intention to adopt teledentistry in South Africa*

$H4_0$: *Facilitating conditions has no influence on the behavioural intention to adopt teledentistry in South Africa*

$H5_0$: *Trust has no influence on the behavioural intention to adopt teledentistry in South Africa*

$H6_0$: *Perceived risk has no influence on the behavioural intention to adopt teledentistry in South Africa*

1.5 Research objectives

The main aim is stated as: **To determine the behavioural intention of dental professionals in South Africa to adopt teledentistry**

- To determine the factors influencing the adoption of teledentistry amongst dental professionals in South Africa.
- To determine the roles that trust and perceived risk play amongst South African dental professionals in the adoption of teledentistry.
- To determine how the adoption of teledentistry can be enhanced in South Africa

1.6 Research Design and Methodology

The research methods utilized in this study are of a descriptive and pragmatic approach. A quantitative research design is employed through an online questionnaire distributed on the Lime Survey and Google Forms platforms. Participants are South African dentists and dental specialists sought after via social media platforms such as LinkedIn, Instagram, and WhatsApp. The sample is obtained with convenience and respondent-driven sampling primarily through LinkedIn's connections functionality. Thereafter, the data obtained through these platforms are subjected to descriptive and inferential statistics. Particularly the tests carried out in this study are Cronbach's alpha, confirmatory factor analysis (CFA), and covariance-based structural equation modelling (CB-SEM) to assess the reliability and validity of the research instrument, respectively. The demographics of the study and an aggregate view of the responses to the individual items in the questionnaire are discussed through visual aspects such as bar graphs. Before presenting the inferential statistics, tests of normality and a justification for choosing inferential statistics are given. The inferential statistics assist in answering aims and objectives of the study. These tests are the one sample t-test, bi-variate Pearson correlation, and multiple regression. Lastly, the study questionnaire consists of an open-ended component that is assessed through phenomenology, identifying the prominent meaning units and grouping these into themes.

1.7 Significance of the study

Oral health comprises many dimensions, including social, economic, environmental, and cultural problems. Consequently, addressing oral health problems by implementing and promoting innovations in the field would benefit one's health overall (Huang & Wang, 2021). Even though oral health is not part of the Sustainable Development Goals, Oral Health is strongly linked with one's general health, emphasizing the need to protect and drive this domain forward (Huang & Wang, 2021). Considering these statements, teledentistry is a technological innovation that can aid oral healthcare delivery. Both dental professionals and patients can benefit from such a study as it looks into the factors influencing teledentistry adoption amongst dental professionals who are the implementers of the technology. Furthermore, no studies have been conducted on the topic in a South African context, addressing literature gaps. Lastly, the study may form a basis for future research, such as investigating teledentistry from a patient or public health adoption point of view.

1.8 Justification of the study

The key issue regarding oral healthcare in South Africa is that many individuals do not have access to healthcare providers or private healthcare due to a dire shortage of dentists in the country. Teledentistry offers a solution to these disparities by allowing individuals in remote or rural areas to access oral health services using alternate communication methods. Most importantly, society was vulnerable to the COVID-19 pandemic, and teledentistry limits the spread of the virus by promoting pre-consultation with a dental professional. While the above statements are promising, the factors influencing the adoption of teledentistry amongst South African dental professionals have not been investigated. Furthermore, if the study is not conducted, factors affecting the adoption of teledentistry in South Africa will not be known, which will inhibit the country’s 4IR effectiveness.

1.9 Limitations

The study may produce limited outcomes owing to the research design (surveys) employed. Respondents are mainly limited to close-ended questions. The open-ended component of the questionnaire addresses this should respondents have further opinions. Quantitative studies also require extensive statistical analysis, which this study needed to employ to achieve the desired outcomes. The researcher needed to acquaint themselves adequately with such methods. Lastly, the study utilizes non-probability sampling, which lacks credibility compared to probability sampling. This introduces the risk of bias; however, this is addressed by obtaining participants

who graduated from different universities working in all nine provinces. The exact population size of dental professionals was also unknown in 2022; however, an equation is utilized to determine the required sample size under these conditions.

1.10 Thesis Outline

This dissertation comprises six chapters. Chapter 2 reviews prior research on the factors influencing teledentistry adoption amongst South African dental professionals with an added view of cybersecurity concerns in this domain. The chapter reviews the concept of oral health in South Africa and provides an overview of telehealth, introduction to teledentistry, factors influencing teledentistry, trust in teledentistry, and perceived risk in teledentistry. Theoretical evidence and justification for the conceptual model are synthesized from prior research studies and are also indicated in this chapter. The chapter concludes by noting that teledentistry and telehealth have been studied extensively in various countries, but there is a lack of research in this domain given a South African context, thus supporting the need for this research study.

Chapter 3 explains the choice and justification for the chosen research methods, and describes in detail how the data collection and analysis methods are implemented. Chapter 4 presents the results of the data collected. The results are discussed in Chapter 5 within the context of this study's research question, aims, and objectives, and the results are reflected in the context of existing studies. Chapter 6 concludes the dissertation by summarizing how this study contributes to existing knowledge. Implications for practice are identified. Limitations of the study are acknowledged, and suggestions for future research are proposed based on the limitations and results of this research. In the next chapter, a review of the prior research on the concept of teledentistry, perceived risk, and trust is presented.

CHAPTER TWO - LITERATURE REVIEW

2.1 Introduction

The following chapter begins by reviewing the literature on the landscape of oral health in South Africa. Thereafter, the concept of telehealth is introduced with a focus on the study's topic, teledentistry, and the factors influencing this concept amongst South African dental professionals. Lastly, a review on the concepts of trust and perceived risk and their roles in long-distance healthcare services will be discussed. This chapter also discusses theoretical frameworks in the technology field and the conceptual framework adopted in the study.

2.2 Oral health in South Africa

2.2.1 Definitions

The world has changed drastically with the inception of the fourth industrial revolution. Dentistry 4.0 refers to the fourth dental revolution, which utilizes modern and innovative technological advancements to provide oral health care more efficiently (Haleem, Javaid, Singh, & Suman, 2021). Dental professionals are the drivers of Dentistry 4.0. A dental professional refers to a broad group of professionals involved in dentistry, including dentists, dental assistants, educators, students, and technicians (Ozkan Ata & Ozkan, 2009). However, Bhayat and Chikte (2019) point out that dental professionals can be divided into clinical and non-clinical groups. The clinical group entails oral hygienists, dental therapists, dentists, and specialists. Non-clinical personnel involve receptionists, dental assistants, dental technicians, cleaning, and admin staff. The following study focused on clinical personnel, particularly dentists and dental specialists. Dentists and dental specialists also have the capabilities of oral hygienists and therapists (Bhayat & Chikte, 2019). Thus, it was deemed appropriate to focus the study on dentists and dental specialists.

2.2.2 Current position of oral health care in South Africa

Global disparities exist regarding oral health care, particularly in the disadvantaged parts of the world (Petersen, Bourgeois, Ogawa, Estupinan-Day, Ndiaye, 2005). South Africa is notably concordant with this statement as the country deals with inadequate numbers of oral health professionals and facilities and unequal distributions of public and private oral healthcare workers (Bhayat & Chikte, 2019). Highlighting these disparities is the stark contrast in dentist-to-population ratios. Developed countries have a ratio of 1:2000, while developing countries

have a ratio of 1:150000 (WHO, 2019). Furthermore, South African dentists tend to relocate to developed countries, increasing these disparities (Gallagher & Hutchinson, 2018).

The South African Health Sector comprises public and private healthcare. The public sector lacks dental professionals, as only 16% of the population is treated by the private sector, with 90% of dentists employed in the private sector. This would imply that teledentistry services would be most needed in the public healthcare sector. The public sector is divided into three tiers, mainly offering primary, secondary, and tertiary services (outlined in the table below). Primary Health Care (PHC) facilities could utilize teledentistry services, as patients are referred to district hospitals (secondary services) if there is a lack of qualified professionals or facilities. Furthermore, PHC facilities and district hospitals can reach dental specialists in academic hospitals through teledentistry.

Table 2-1 Summary of dentistry tiers in South Africa

Tier	Location	Dental Professionals	Services Offered
Primary	Primary healthcare facilities	Dental therapists and oral hygienists	Radiographs, oral examinations, prescription of antibiotics, extractions, and restorations
Secondary	District hospitals	Dentists and dental therapists	Impacted teeth extractions, removable dentures, and orthodontics
Tertiary	Academic hospitals	Dentists, dental specialists, registrars	Endodontics, prosthodontics, orthodontics

The importance of oral health education to parents of children aged three to six years old is emphasized by Bhayat and Chikte (2019). Children should regularly receive dental screenings and education on oral hygiene (Kannellis, Damiano, & Momany, 2000). This is an opportunity for teledentistry technologies to be utilized. Health knowledge can be passed on via video or

phone calls. South African oral healthcare is based on curative care instead of oral health promotion and prevention. Curative care may require the services of experts in the oral health field; however, it reduces the costs of resources and equipment needed. Lastly, it is essential to take heed of the above disparities in oral healthcare in South Africa. Teledentistry is a technology that has not been studied extensively in South Africa to address such issues, and the factors that prevent using this technology have not been adequately established amongst South African dental professionals (Fortuin & Naidoo, 2015).

2.3 Overview of Telehealth

2.3.1 Definition

The World Health Organization (WHO) defines telehealth as exchanging valid information over distances using information and communication technologies to provide health care services (Doraiswamy, Abraham, Mamtani, & Cheema, 2020). These healthcare services are generally defined in the literature as diagnosing and treating patients, preventing injury and disease, and continuing education among healthcare providers (Doraiswamy *et al*., 2020; Mannochia, 2020).

2.3.2 A Critique of long-distance healthcare services

The concept of telehealth is not new (Mannochia, 2020). Cushing (2022) corroborates that healthcare has utilized telehealth for over 30 years. This field has been widely adopted in various forms, including Teleradiology, Teledermatology, Telepharmacy, Tele-forensics, legal medicine, Artificial Intelligence, and Telemedicine (Perrone, Zerbo, Bilotta, Malta, & Argo, 2020). There is a general agreement in the literature that telehealth is most efficient in the monitoring and continuity of chronic and non-communicable diseases such as hypertension and diabetes (Beheshti, Kalankesh, Doshmangir, & Farahbakhsh, 2022; Perrone *et al*., 2022).

Telehealth comprises two primary forms: Asynchronous (store-and-forward) and synchronous. Asynchronous telehealth involves storing patients' information on the system and reviewing it later, whereas synchronous telehealth is a live consultation between the patient and practitioner. Shigekawa, Fix, Corbett, Roby, and Coffman (2018), and Beheshti *et al*. (2022) highlight that synchronous telehealth has held dominance over asynchronous telehealth as it has higher diagnostic capabilities and offers a stronger sense of communication between the patient and practitioner. However, Snoswell *et al*. (2020) argue that asynchronous telehealth would reduce administrative overheads and funding associated with organizing telehealth consults, indicating that both forms of telehealth hold positive traits. Telehealth can be carried out via a simple phone or video call and does not relate to a specific technological platform (Poppas, Rumsfeld,

& Wessler, 2020). While Poppas *et al*. (2020) point out the value in the simplicity of phone and video calls, Beheshti *et al*. (2020) established that Skype and email were the most popular tools used during telehealth visits.

The COVID-19 pandemic has placed a greater dependence on adopting remote healthcare services. Almallah and Doyle (2020) point out that physical visits relating to non-emergency cases were kept to a minimum, which marked increased levels of telehealth adoption. The key strengths of telehealth include reducing commute times to appointments, improving no-show rates, and reducing costs (Almallah & Doyle, 2020). Conversely, barriers to telehealth adoption include prioritizing convenience over the quality of healthcare delivered, privacy, clinician burnout resulting from the overuse of technology, and ensuring adequate support and education for both patient and clinician. Telehealth is centered around the use of technology, and the digital divide that may form because of telehealth adoption is discussed below. Smith and Raskin (2020), Dhaliwal *et al*. (2021), and Barnett *et al*. (2022), and corroborated and identified that telehealth may further the divide between healthcare access and the rural community. Rural areas suffer from little to no technical support and lower budgets, hindering the capacity to adopt technology quickly (Beheshti *et al*., 2022).

In adopting telehealth services, it is vital to consider the digital divide between high- and low-income groups, such as Internet access (Smith & Raskin, 2020). Barnett *et al*. (2022) further argue that this digital divide is defined as “digital redlining” and comprises two more critical elements – individuals' digital fluency and the patient's capacity to be their own health advocates. Schmid (2020) further corroborates this by maintaining that transitioning to telehealth would require three key factors: broadband access, adequate technology literacy, and a device capable of accessing the internet. Interestingly, telehealth services have evolved to include devices such as wearable sensors that can be used both by clinicians and patients (Poppas *et al*., 2020). This poses the question of whether adopting more advanced technologies to promote telehealth further increases disparities between those who can afford or quickly adapt to technological innovations and those who cannot.

There has been debate about whether telehealth services would last beyond the COVID-19 pandemic. Poppas *et al*. (2020) assert that telehealth services can last, and must, through its ability to remove barriers to healthcare access and indicating that healthcare workers have the necessary technological means. However, Almallah and Doyle (2020) argue that telehealth requires considerable support from both clinicians and patients to ensure its success and future adoption.

The intended research study looks to address these gaps. Much research exists on telehealth services, its role during COVID-19 amongst patients, and the importance of addressing digital disparities amongst users. However, there has been a lack of extensive research in teledentistry, particularly in a South African context amongst dental professionals, and the key factors influencing South African dental professionals to use this form of healthcare during and beyond the COVID-19 pandemic.

2.4 Introduction to Teledentistry

2.4.1 Definition

The definition of teledentistry has evolved with its precursor, telemedicine, defined as using communication networks to deliver healthcare services and education to various locations (Sood *et al*., 2007). This is done to address the inadequate distribution and shortage of healthcare professionals (Sood *et al*., 2007). The first definition of teledentistry was established in 1997 as utilizing videoconferencing to carry out diagnosis and treatment advice over distances (N. Chhabra, A. Chhabra, Jain, Kaur, & Bansal, 2011). However, according to Kopycka-Kedzierawski and Billings (2006), this definition has changed recently. It is now termed as improving oral health by transmitting dental information from one place to another. Furthermore, Schleyer, Thyvalikakath, Spallek, Dziabiak, and Johnson (2012) give a more comprehensive definition of teledentisry, mentioning that teledentistry is a multi-faceted ICT domain, including dental records, dental information systems, education development, and oral health promotion.

2.4.2 Modalities of Teledentistry

Teledentistry can be carried out in three primary ways (Islam *et al*., 2022). The first method involves communication between a dentist and a specialist dentist to share information such as photos and records, allowing the dentist and specialist to review and develop treatment plans. The second method, known as “synchronous” teledentistry, involves real-time communication between a dentist and a dental specialist or patient. This is usually carried out by a video call or video conferencing. The third method relates to remote patient monitoring. Data is collected in real-time and sent to dentists in remote locations (Talla, Levin, Glogauer, Cable, & Allison, 2020).

It is evident that dentists and dental specialists prefer using synchronous teledentistry over asynchronous forms (Flores *et al*., 2020). Numerous studies indicate the importance of real-time video consultations and their advantages over simple mobile consultations. As a result,

real-time communication is the most authentic way to conduct teledentistry. Furthermore, Poirier, Jensen, and Sethi (2022) identified through their scoping review of teledentistry that before the COVID-19 pandemic, the literature focused on asynchronous teledentistry as opposed to post-COVID-19 pandemic, where the focus was mainly on synchronous teledentistry.

2.4.3 Benefits and potential applications of Teledentistry

2.4.3.1 Benefits

Teledentistry has broadened the capabilities of both clinicians and patients and offers numerous benefits. The most common benefit is increased access to dental services and care during the COVID-19 pandemic and remote communities (Mariño *et al*., 2015). Teledentistry also reduces costs associated with in-person consultations, such as transport and waiting times. Estai, Bun, Kanagasingam, and Tennant (2018) extend this finding to children in that they miss fewer days of school due to dental visits. Dentists can reduce chair time and see more patients. Poirier, Jensen, and Sethi (2022) highlight that less burden is placed on resources as the availability of dental professionals increases, and patients have lower stress levels as they can deal with environments and staff they are familiar with. Other advantages include contacting specialists in remote locations and having access to dental care in emergencies.

2.4.3.2 Potential Applications

Teledentistry has numerous applications within dentistry. The most common branches of dentistry and their applications are given in the table below.

Table 2-2 Branches of dentistry and teledentistry applications

Branch of dentistry	Applications
Restorative Dentistry	At home administration of 38% Silver Diamine Fluoride solution for treatment of small carious lesions. This can be monitored by remote follow-ups (Crystal & Niederman, 2019). Remote diagnosis of periapical lesions of anterior teeth.
Orthodontics	Teleorthodontics is a low-cost way to manage orthodontic treatment, such as reducing the costs of directly transferring the dentist to a specialist. It also helps screen and refer potential candidates for orthodontic treatment (Squires, Michelogiannakis, Rossouw, & Javed, 2021).

	Teleorthodontics can utilize imaging technology with a smartphone device and help the patient autonomously progress through aligner trays (Maspero *et al*., 2020).
Paediatric Dentistry	Teledentistry can be used to promote better oral hygiene habits (Shetty, Yamamoto, & Yale, 2018; Mallineni *et al*., 2020). Telephonic conversations and email can be used to deliver preventative counseling and distribute dietary charts (Islam *et al*., 2022). High-strength sodium fluoride can also be prescribed using online channels (Islam *et al*., 2022). Delayed tooth eruption, shedding of deciduous teeth, eruption cysts, and neo-natal or natal teeth can all be monitored using Teledentistry (Wallace, Schofield, Burbridge, & O'Donnell, 2021)
Endodontics	Root canal orifices can be recognized from a distance using teledentistry, which suggests that highly trained endodontists can give guidance to general dentists over the telephone regarding the recognition of root canal orifices (Brüllmann, Schmidtmann, Warzecha, & d'Hoedt, 2011)
TMJ Disorders	Store-and-forward teledentistry systems were compared with traditional examinations in patients with TMJD. The same reliability was found with in-person consultations, reducing working time in patients (Salazar-Fernandez, Herce, Garcia-Palma, Dekgado, & Jose Felix Martin, 2012). Furthermore, coupled with this, photobiomodulation can treat TMJD at home (Fornaini, Pelosi, Queirolo, Vescovi, & Merigo, 2015).
Maxillofacial and Oral Surgery	Effective in consultation, assessment, treatment planning, and follow-up care of conditions such as TMJ and salivary gland disorders, orthognathic, and head and neck cancer (Roccia, Spada, Milani, & Berrone, 2005; Aziz & Ziccardi, 2009; Wells, Roked, Moore, & Sivarajasingam, 2016)

2.4.3.3 Potential drawback and barriers to teledentistry

While teledentistry holds numerous advantages, there are also disadvantages associated with it. The common disadvantages gathered from the literature are difficulties experienced with technology, accessibility of the internet in rural areas, and the quality associated with images and videos. Islam *et al*. (2020) points out that the disadvantage of reduced image quality can be overcome by combining asynchronous forms of teledentistry with live consultations. Furthermore, Islam *et al*. (2020) assert that the most important drawback is difficulty assessing the posterior oral cavity and its associated dentition and soft tissues. This is further corroborated by Suetenkov, Popkova, and Kiselev (2020), who confirmed the inability of teledentistry to address orthodontic emergencies, broken prosthodontics, grossly carious teeth, and lesions and swellings of the intraoral and extraoral cavity. Lastly the provision of adequate training for the adoption of teledentistry has also been a concern amongst dental practitioners (Islam *et al*., 2022). It has been established numerous times in the literature that teledentistry is not a replacement for routine dentistry but an enabler (Poirier, Jensen, & Sethi, 2022).

Fornaini and Rocca (2022) suggest that some barriers to teledentistry may be overcome by ensuring clinical mailboxes are maintained and user-friendly, saving as much time on manual processes by creating email templates that can personalized with hyperlinks unique to each patient. Specific tools, such as the DentalMonitoring scanbox, have used smartphones to send clinicians images (Minervini *et al*., 2022).

2.5 Factors influencing Teledentistry

2.5.1 Teledentistry in developed and developing countries

Teledentistry has been broadly and significantly covered in countries worldwide, such as Brazil, India, Pakistan, Saudi Arabia, Rwanda, and the United States. Several articles have been produced during the COVID-19 pandemic, with Mahdavi, Atlasi, and Naemi (2022) establishing through scientometric analysis that the United Kingdom, United States, and Italy have been the most active in producing research on the topic. Furthermore, most citations on this topic are related to Chinese papers (Mahdavi *et al*., 2022).

Through their systematic review, Lin *et al*. (2022) established that generally, dental professionals have high awareness and a positive attitude toward teledentistry but lack knowledge and adoption of it. These findings correlate with a study done in Rwanda, where attitude levels were positive, but the actual adoption of teledentistry was low (Murererehe *et al*., 2017). However, Subhan *et al*. (2021) highlight that dentists' knowledge levels regarding

teledentistry have increased due to COVID-19. Similarly, Plaza-Ruíz, Barbosa-Liz, and Agudelo-Suárez (2021) corroborate that knowledge, practices, and expectations of dentists regarding teledentistry have increased post-COVID-19 indicating that the pandemic has brought more awareness to the field as distance had become an important aspect of everyone's lives. Late adopters are not aware of the benefits of teledentistry, and the drawbacks tend to cloud one's judgment, as opposed to early adopters who have knowledge and inclination towards the benefits. One of the main concerns of late adopters is that the level of care would not be the same as in-person care (Tiwari, 2022)

Giraudeau, Bauer, Tramini, Inquimbert, and Toupenay (2022), highlight that even though some dentists implement teledentistry, only 1.5% of them have had training related to it, and 1.3% are aware of telemedicine regulations which is a vital indicator that training, and regulations need to be a priority. Furthermore, Giraudeau *et al*. (2022) suggest that the major concern regarding teledentistry adoption lies in digital forgery and technical incompatibilities. This is further emphasized by Khokar *et al*. (2022) where it was established that dentists were foremost concerned with digital forgery (90%), followed by patient confidentiality (84%), and hardware or technical issues (80%).

The above information is summarized in the table and pie chart below, where research studies from the years of 2017 to 2022 were analyzed regarding the factors studied in teledentistry adoption. It is evident that South Africa was not amongst these countries, and the UTAUT model has not been utilized to investigate teledentistry in a South African context. This highlights the research gap in the literature.

Table 2-3 Teledentistry constructs covered

Year	Author	Knowledge	Perception	Experience	Awareness	Attitude	Practice	Usefulness	Challenges	Review	Case Location	Framework
2018	Nayar *et al.*						X				USA	Unspecified
2020	Mathivanan *et al.*	X				X	X				India	Unspecified
2020	Alsharif & Al-harbi										Saudi Arabia	Teledentistry Survey (TDS)
2020	Al-Khalifa & Alsheikh				X			X			Saudi Arabia	Unspecified
2020	Almazrooa *et al.*		X	X		X					Saudi Arabia	Unspecified

2021	Raucci-Neto *et al.*	X	X	X							Brazil	Unspecified
2021	George *et al.*	X			X	X					India	Unspecified
2021	Subhan *et al.*	X			X	X					Pakistan	Unspecified
2022	Chaudhary *et al.*				X			X	X		Saudi Arabia and Pakistan	Unspecified
2022	Tiwari, Diep, Tranby, Thakkar-Samtani, & Frantsve-Hawley										USA	Unspecified
2022	Giraudeau, Bauer, Tramini, Inquimbert, & Toupenay	X				X	X				France	Unspecified
2022	Soegyanto, Wimardhani, Maharani, & Tenant		X								Indonesia	Unspecified
2022	Khokhar *et al*		X								Malaysia	Unspecified,
2022	Kui *et al*									X	Global	Integrative Review
2022	Mahdavi, Atlasi, & Naemi									X	Global	Scientometric and content analysis

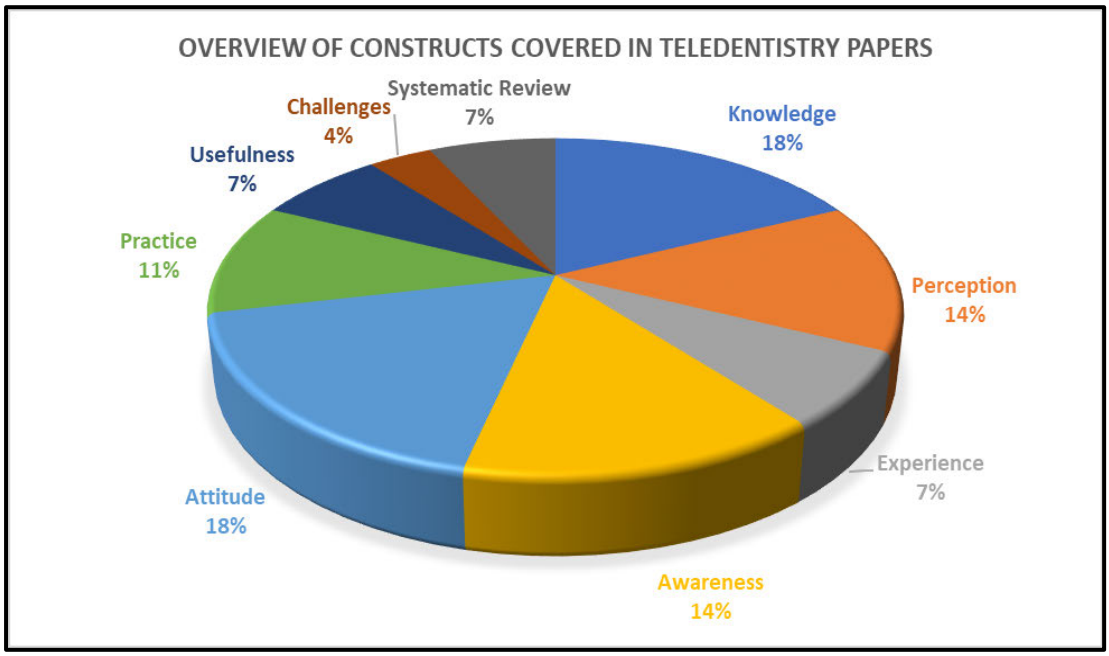

Figure 2-1 Overview of constructs covered in teledentistry papers

2.5.2 Teledentistry in South Africa

The Health Professions Council of South Africa (HPCSA) and the national health regulatory body have established guidelines for telemedicine in South Africa. Initially, these guidelines had been applied to medical professionals only, and online consultations held by these

professionals (Tantawi *et al*., 2023). These guidelines were then applied to teledentistry adoption before the COVID-19 pandemic (Fortuin & Naidoo, 2015). Even though the COVID-19 pandemic reintroduced interest in this field, there is an indication that it was not utilized (Aladbullah & Daniel, 2018; Estai *et al*., 2018). The Oral Health Centre of South Africa will prioritize teledentistry in its agenda and look to include it in the national oral health policy by introducing it at a tertiary level and in the public and private domains (Tantawi *et al*., 2023).

Teledentistry has been a recently investigated field in South Africa, primarily explored by researchers (Fortuin & Naidoo, 2015; Bissessur & Naidoo, 2019). Teledentistry falls under telemedicine, first brought to South Africa in 1998 by the National Strategy for Telemedicine. Even though telemedicine lacks credibility, technology has evolved, and academics, government officials, and health ICT researchers have learned from previous projects and improved (Fortuin & Naidoo, 2015). This was evident with South Africa's first successful ICT initiative, MomConnect. The most significant challenges to oral healthcare lie in undiagnosed diseases and inaccessibility to dental services, mainly among school learners, the elderly, and physically and mentally impaired individuals (Petersen, Bourgeois, Bratthall, & Ogawa, 2005; Sheiham, 2005; Buddiga *et al*., 2014). Barriers to Teledentistry in South Africa include legal, ethical, confidentiality, and security issues. Furthermore, the relationship between funders, service providers, and users in developing remuneration models has also been a concern (Estai *et al*., 2018; Alabdullah & Daniel, 2018).

Bissessur and Naidoo (2019) assessed teledentistry screening against traditional screening. They found a 95-98% concordance rate implying that teledentistry is an effective tool in screening school learners in rural areas of KwaZulu-Natal. The findings of Bissessur and Naidoo (2019) hold significant value for the intended research project. Bissessur and Naidoo (2019) established that the two dental professionals who tested out manual dental screening against teledentistry had similar clinical expertise and explained that this may have led to promising levels of diagnosis using teledentistry. However, the factors influencing the adoption of teledentistry in South Africa have not been fully established, which is what the current study will aim to do.

Technology adoption has been traditionally studied via theoretical models such as the Technology Acceptance Model (Davis, 1989). TAM2 (Venkatesh & Davis, 2000) and the Unified Theory of Acceptance and Use of Technology (Venkatesh, Morris, Davis, & Davis, 2003). It has been shown by Venkatesh *et al*. (2003) that the UTAUT model explains at least 70% of the variance in data pertaining to acceptance of technology. This is the highest

performing model in predicting acceptance and adoption of technology. However, UTAUT has not been used in a comprehensive empirical study to understand the acceptance and adoption of teledentistry in South Africa. This study obviates this gap in the body of knowledge by providing an empirical basis for understanding teledentistry acceptance and adoption in South Africa.

2.6 Trust in Teledentistry

2.6.1 Definition of trust

The construct of trust has evolved over the years regarding technology adoption. Trust has been defined numerously regarding the adoption of m-health applications (Zhang & Zhu, 2022; Cao, Kurata, Lim, Sengoku, & Kodama, 2022). Zhang and Zhu (2022) established that a critical factor in adopting health information systems is the ability of m-health platforms to ensure that reliable, safe, and accurate information is provided. Furthermore Arfi, Nasr, Kondrateva, and Hikkerova (2021) extend that trust involves an element of confidence one would have in these information systems.

2.6.2 Trust in technology and healthcare

Trust has been found to influence the behavior of users in technology adoption, most notably in the e-commerce and information system fields (Amoako-Gyampah & Salam, 2004; Ha & Stoel, 2009). However, Berry and Bendapudi (2007) argue that healthcare is a more personal and vital commodity to a consumer. Trust compromises numerous components, including user-friendliness of technologies such as m-health, healthcare professional competence, the role of data, and related accuracy and security measures regarding this data (Arfi *et al*., 2021; Jokinen, Stolt, & Suhonen, 2021; Zhang & Zhu, 2022). Jokinen *et al*. (2021) corroborate this statement by offering further insight into the importance of data and trust during an integrative review regarding e-health. Concerns arise from the inadequate, incorrect, and inaccurate data handling amongst healthcare divisions. Telehealth may utilize the capabilities of smart devices. Arfi *et al*. (2021) assert that this may raise trust and privacy issues as these devices collect, store, and manage sensitive information.

Lastly, Liu, Chen, Kuo, and Lin (2022) point out the importance of the reliability of technology. Users become frustrated with unreliable technology and the need to depend on previous experience with older technologies and adopting new technologies, which impacts trust (Aborg & Billing, 2003; Ayyagari, Grover, & Purvis, 2011). Similarly, Zhang *et al*. (2022) established that users who could not use m-health comfortably became frustrated and perceived it as unreliable.

2.6.3 Trust in patient-provider relationships

Patient-clinician relationships are built on trust that develops during in-person interactions. Yee, Bajaj, and Standford (2022) point out that the lack of connection introduced by telehealth systems may have a negative impact on trust, and that it is vital not to neglect the humanistic factor when utilizing telehealth systems. Furthermore, Jokinen *et al*. (2020) emphasize that individuals want services like teledentistry to improve healthcare and not replace in-person care, which is the primary means to build trust between patients and providers.

Many studies have indicated the strong impact trust has on behavioral intention (Pavlou, 2003; Egea and Gonz´alez, 2011; Jang *et al*., 2016; Papa *et al*., 2020;), while Zhang *et al*. (2022) further highlight that competence of health professionals is related to trust and the impact this trust would have on behavioural intention. Considering this and the literature mentioned above, this study intends to address the research gap of trust's impact on behavioral intention to adopt Teledentistry amongst South African dental professionals. Trust has been explored in various domains of healthcare and technology. However, there is a lack of research on how it impacts the field of Teledentistry amongst South African dental professionals.

2.7 Perceived risk in Teledentistry

2.7.1 Definition of perceived risk

The literature initially defined perceived risk only regarding fraud and product quality (Arfi *et al*., 2021). Peter and Ryan (1976) indicated this by defining perceived risk as the expectation of loss because of purchases and inhibits purchase behavior. The definition of perceived risk has changed today as it is defined in terms of e-service and the uncertainty surrounding the outcomes of pursuing acts in this field (Featherman & Pavlou, 2003). There is a possibility of suffering a loss from using technologies.

2.7.2 The relationship between perceived risk and technology adoption in the healthcare sector

Perceived risk has been studied in numerous e-health fields, such as m-health and telemedicine. Telehealth is governed by an impersonal relationship between healthcare worker and patient (Bahanan & Alsharif, 2022). As a result, fear and risk arise from the possibility of losing contact or being subjected to misdiagnosis or misinterpreted information (Biancone, Secinaro, Marseglia, & Calandra, 2021). Interestingly, Alhajri et al. (2021) found that physicians who were previously exposed to telemedicine had lower levels of perceived risk and increased confidence levels when using this technology.

Kamal *et al*. (2020) point out that developing countries like Pakistan lack health resources, creating a sense of risk when adopting new technologies like telemedicine. This is coupled with the existing digital divide and technical incompetencies. Furthermore, Rho, Yoon, Kim, and Choi (2014) claim that individuals in the public healthcare sector had higher levels of perceived risk when compared to individuals in private healthcare. However, it is important that both private and public healthcare workers take note of the role of privacy in risk, as it was found to hinder telemedicine adoption in studies (Rho *et al*., 2014). Generally, individuals are concerned about how data is collected, stored, and maintained, and the network and devices used for these processes (Schnall, Higgins, Brown, Carballo-Diguez, & Bakken, 2015). Many studies have established that an increase in perceived risk has a negative impact on behavioural intention (Arfi *et al*., 2020; Kamal *et al*., 2020; Bahanan & Alsharif, 2023; Upadhyay, Kamble, Navare, 2023; Zhu *et al*., 2023).

2.7.3 Types of perceived risk

Perceived risk can be divided into various facets. There is a general agreement in the literature that perceived risk comprises six components: performance risk, social risk, psychological risk, financial risk, safety risk, and opportunity/time risk (Kamal, Shafiq, & Kakria, 2020; Bahanan & Alsharif, 2022). Some studies have focused on psychological, performance, and financial risks (Kamal *et al*., 2020; Bahanan & Alsharif, 2022). Conversely, when investigating medical practitioners, and telemedicine, Bakshi and Tandon (2021) determined that financial risk does not influence behavioural intention because it outweighs other risks. Similarly, Hsieh (2014) asserts that physicians aren't subject to financial and time losses. Instead, the importance of security and privacy risk and their evident role in behavioral intention were emphasized. This research study fills the literature gap in that no studies have been done on investigating the influence perceived risk has on Teledentistry adoption amongst South African dental professionals. Considering that no studies have been done on this construct when investigating teledentistry adoption by South African dental professionals, all six subcategories of perceived risk are integrated into the study.

2.8 Conceptual Framework

2.8.1.1 Discussion on theoretical frameworks

The introduction of new technological innovations to society has necessitated various theoretical models to explain users' technology use and acceptance. These models are the Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), TAM and TPB combined (c-TAM-TPB), Innovation Diffusion Theory (IDT),

Model of PC Utilization (MPCU) and Social Cognitive Theory (SCT), all of which have their backgrounds in social sciences (Kijsanayotin, Pannarunothai, & Speedie, 2008).

2.8.1.2 Technology Acceptance Model (TAM)

The technology acceptance model (TAM) was developed in the late 1980s by Fred D.Davis as a way to analyze user acceptance of technology (Davis, 1985; Davis, 1989). User acceptance is a vital concept to determine how technologies are successfully adopted (Davis, 1993). The TAM model hypothesizes five main constructs are involved in user acceptance of technology. Perceived usefulness and perceived ease of use influence one's attitude, which in turn affects their behavioral intention. This behavioral intention results in actual use.

Ammenwerth (2019) highlights the TAM model holds considerably high value in predicting variance in Behavioural Intention to use (30-70%). Similarly, Adenuga *et al*. (2017) point out that TAM has great potential in healthcare and has gained popularity. However, Davis (1989) contends that despite its general popularity in assessing user acceptance of technology, it is rarely used in healthcare without being extended with other variables due to the complex nature of some concepts, such as telehealth. For this purpose, the TAM model was not seen as an appropriate model for this study.

2.8.1.3 Technology Acceptance Model 2 and 3 (TAM 2 & 3)

The Technology Acceptance Model 2 and 3 were created to address the shortcomings of the original TAM (Venkatesh & Davis, 2000), mainly the low explanatory power (R^2). TAM2 contains added determinants to the perceived usefulness (PU) and usage intention constructs. Changes are monitored in determinants when increases are seen (Venkatesh & Davis, 2000). The determinants that are added to PU are social influences and cognitive instrumental processes. Social influences include image, experience, voluntariness, and subjective norm. Cognitive instrumental processes include result demonstrability, job relevance, category, and output quality (Lindsay, Jackson, & Cooke, 2011).

TAM3 has added determinants for the perceive ease of use and usage intention constructs (Venkatesh & Bala, 2008). The determinants that are added to PEOU are anchors and adjustments. Anchors refer to beliefs an individual has regarding a technology and include computer self-efficacy, computer anxiety and playfulness, and perception of external control. Adjustments refer to how one's beliefs are shaped through the experience with the system and include objective usability and perceived enjoyment. According to a bibliometric analysis conducted by Sebastian, Guede, and Antonovica (2022) the UTAUT model has exhibited more presence or importance over the TAM (TAM, TAM2, and TAM3) in recent years. The UTAUT

model holds a greater number of publications, citations, and emerging themes over the TAM. As a result it was found to be more prevalent to conduct a study utilizing the UTAUT model.

2.8.1.4 Theory of Reasoned Action (TRA)

The Theory of Reasoned Action developed by Azjen and Fishbein (1980) is a social psychology theory that explains the role attitude has in actual behavior. Intention acts as a mediating factor between attitude and behavior. Subjective norms also influence intention, which in turn affects behavior. TRA has been used primarily for researching health behaviors such as addiction. The drawbacks of this model relate to having to determine an individual's beliefs before analyzing their behavior, as the model does not specify the individual's beliefs (Davis *et al*., 1989). Sheppard, Hartwick, and Washaw (1988) have also highlighted that the model deals with behaviors within individuals' control. Some situations need to be studied where behaviors are not within an individual's control, such as having resources to perform the behavior. As such, the Theory of Planned Behaviour (TPB) was introduced, which includes "Perceived Behavioural Control" as a variable.

2.8.1.5 Theory of Planned Behaviour (TPB)

The Theory of Planned Behavior is an extension of the Theory of Reasoned Action. This model addresses the weakness of the Theory of Reasoned Action in that TRA only considers volitional behaviors instead of considering behaviors that require resources, skills, and opportunity (Fishbein, 1993). The model includes an additional variable known as "Perceived Behavioural Control" to address non-volitional behaviors. Perceived Behavioural Control refers to the extent to which the individual believes the behavior is easy or hard to perform (Azjen, 1991). Individuals favour performing behaviours they have control over. If one's intentions are constant, increasing PBC would increase the likelihood of performing the behavior (Conner & Armitage, 1998).

Conner and Armitage (1998) point out that the Theory of Planned Behaviors sufficiency has been considered numerous times (Eagly & Chaiken, 1995). It is suggested that the TPB can be extended further with more constructs. Azjen (1991) has indicated that the model is open to adding further constructs if it can be ascertained they add to the variance in behavior or intention. Lastly, Sniehotta, Presseau, & Araújo-Soares (2014) assert that TPB has limited predictive validity and that the constructs in the model do not accurately explain the validity of behavior. Taking the above into consideration, the Theory of Reasoned Action and Theory of Planned Behavior were not utilized in this study.

2.8.1.6 Diffusion of Innovations Theory (DOI)

Rogers (1995) developed the Diffusion of Innovation theory to explain innovation acceptance and adoption. Innovation refers to technology, ideas, or processes that are new to an individual within a specific society (Zhang, Yu, Yan, & Spil, 2015). Diffusion refers to the process in which innovations are discussed between members of a society (Rogers, 1995). Innovations can be discussed in different ways between members of a society such as interpersonal communication and mass media.

The Innovation Adoption Curve was developed by Rogers (1995) to explain five categories of individuals (innovators, early adopters, early majority, late majority, and laggards). These categories are determined through different stages an individual goes through, such as understanding, persuasion, decision, implementation, and confirmation. Innovators and early adopters make up 16% of the curve. Innovators are those individuals who have substantial knowledge and background in innovation. In contrast, early adopters also have a good understanding of innovation but have a more robust social integration. The early and late majority adopters make up 68% of the curve, and lastly, the laggards are those who are resistant to innovations due to a lack of knowledge and resources (Zhang *et al*., 2015). Taherdoost (2018) points out that the DOI theory lacks explanatory power and the ability to predict outcomes when compared to other adoption models. As a result, utilizing this model for the study was not seen as appropriate.

2.8.1.7 Social Cognitive Theory (SCT)

The Social Cognitive Theory was developed by Bandura (1986) to explain behavior. Bandura (1986) highlights that behaviour is shaped by personal cognition and the environments one is exposed to. An individual's perception, beliefs, and expectations will determine their behavior (Benight & Bandura, 2004). The environment an individual is exposed to may refer to the physical environment governed by objects or the social interactions the individual may have with the external world. Thirdly, the model also accounts for behavior as a construct like the TRA and TPB. Behavior refers to how one acts under certain situations and could include technological innovations (LaRose & Eastin, 2004; Ratten & Ratten, 2007).

Behavior, personal factors, and environment share a triadic relationship, with behavior being influenced by personal factors and environment, and environment sharing a connection with personal factors (Carillo, 2015). Zhou and Brown (2015) assert that the Social Cognitive theory is not a unified theory and has many components that aren’t fully understood and connected, such as observational learning and self-efficacy. Frameworks such as UTAUT address these

shortcomings by unifying previous technology adoption models into one coherent model that can be easily understood through clear connections between variables.

2.8.2 Discussion of UTAUT

This study's theoretical model of choice is the Unified Theory of Acceptance and Use of Technology (UTAUT) with an extension of trust and perceived risk relating to Information Security. The UTAUT model was proposed by Venkatesh *et al*. (2003) and formed a unification of the eight prominent technology use and acceptance models mentioned above. Selecting one of the models above over the other limits one to particular scenarios or conditions. Hence, unifying the above models allows one to embrace different variables and study different contexts (Marikyan & Papagiannidis, 2023).

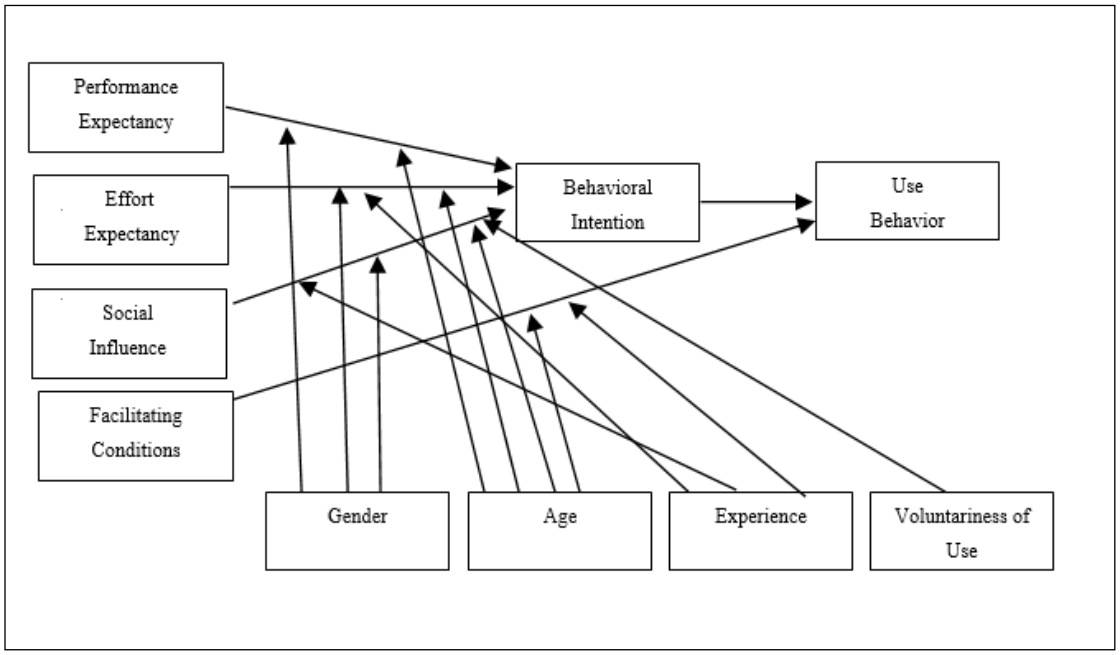

Figure 2-2 UTAUT model

The UTAUT model has gained popularity in the health information system field, as it is a comprehensive model that addresses all of the previous technology adoption models. Numerous researchers have utilized this model in the context of Health Information Systems. Kamal *et al*. (2020) extended TAM, including variables of UTAUT and perceived trust and risk to investigate the acceptance of telemedicine in Pakistan. Dental students' behavioral intention to use teledentistry was investigated using UTAUT in the United States of America (USA) (Alabdullah, Van Lunen, Claiborne, Daniel, & Yen, 2020). UTAUT emanated from the USA and was mainly used in the finance, entertainment, and telecommunications sectors (Venkatesh *et al*., 2003). The model comprises three main variables: performance, effort, and societal influence impacting behavioral intention. Facilitating conditions are said to have a direct effect on use behavior. All of the above variables are moderated by age, gender, and experience.

Table 2-4 UTAUT constructs

Construct	Definition
Performance Expectancy (PE)	"Degree to which an individual believes that using the system will help him or her to attain gains in job performance" (Venkatesh *et al*., 2003).
Effort Expectancy (EE)	"Degree of ease associated with the use of the system" (Venkatesh *et al*., 2003).
Social Influence (SI)	"Degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh *et al*., 2003).
Facilitating Conditions (FC)	"Degree to which an individual believes that an organisation's and technical infrastructure exists to support the use of the system" (Venkatesh *et al*., 2003).
Behavioral Intention (BI)	The subjective probability an individual has to perform a certain behaviour (Fishbein & Azjen, 1975).

Performance Expectancy

Performance expectancy is the degree of trust an individual has that he or she can overcome obstacles and achieve a desired goal using that technology (Venkatesh *et al*., 2003). If benefits are attained from the system, adopting services would increase (Tojib & Tsarenko, 2012). Generally, health studies have found positive relationships between performance expectancy and behavioural intention. Performance expectancy impacts general health information by positively affecting users' intentions to utilize new e-health systems (Gagnon *et al*., 2016). In the context of teledentistry, performance expectancy of teledentistry adoption amongst fourth year dental students were investigated and was found to have the strongest relationship with behavioural intention (Alabdullah *et al*., 2020). Other studies have also indicated that performance expectancy holds the most substantial relationship with behavioural intention (Sharifan, Askarian, Nematolahi, & Farhadi, 2014; Liu *et al*., 2015). Conversely, Gu *et al*. (2021) investigated e-health adoption in the context of a developing country (Pakistan) and found no relationship between performance expectancy and behavioral intention. Gu *et al*. (2021) attributed this finding to individuals in Pakistan not having knowledge on e-health and

particularly the benefits derived from it. Furthermore, developing countries have a lack of ICT infrastructure, knowledge, skills, and insufficient numbers of quality healthcare facilities.

Effort Expectancy

Effort expectancy is the ease associated with using the system (Venkatesh *et al*., 2003). The construct loses explanatory value the more an individual uses the system, as they would eventually get used to it (Chauhan & Jaiswel, 2016). Bawack and Kamdjoug (2018) investigated health information systems using UTAUT in a developing country context (Cameroon). It was established that more effort is required from older participants to utilize HIS. Generally, effort expectancy has a positive relationship with behavioural intention (Alabdullah *et al*., 2020; Gu *et al*., 2021; Shiferaw *et al*., 2021), and systems that are easier to use, beneficial, and valuable would result in increased use of that system.

Social Influence

Social influence is the perception one has that important individuals in their lives believe they should use new systems (Venkatesh *et al*., 2003). Individuals such as friends, colleagues, and family influence how we perceive certain technologies (Gu *et al*., 2021). Alabdullah *et al*. (2020) discovered that social influence was positively correlated to behavioral intention and was the second highest correlated construct with behavioral intention in fourth year dental students to adopt teledentistry. This finding relates to previous studies that established that social influence is positively correlated to behavioral intention in the adoption of e-health services (Ahmad & Khalid, 2017). Conversely, Shiferaw *et al*. (2021) studied healthcare workers' acceptance of telemedicine and established that the positive relationship between social influence and behavioral intention was not supported. Shiferaw *et al*. (2021) attributed this finding to healthcare workers having no choice but to adopt telehealth services to limit infection rates during the pandemic, regardless of the social influence significant others may have on telemedicine adoption.

Facilitating Conditions

Facilitating conditions refer to technical infrastructure and organizational support required when using systems (Venkatesh *et al*., 2003). Whether users have access to necessary hardware, software, technical support, and online training influences behavioural intention (Gu *et al*., 2021). The positive effect facilitating conditions have regarding e-health and health information systems is evident in studies (Boontarig *et al*., 2012). However, similar to social influence, it was established that the COVID-19 pandemic had placed urgency on the adoption of telehealth services, and healthcare professionals had to adopt some form of telehealth regardless of having

the necessary infrastructure or support. This may explain why there would be no positive correlation between facilitating conditions and behavioral intention, as mentioned in the study by Shiferaw *et al*. (2021). Ensuring that clinicians are exposed to familiar interfaces and workflows, as well as supplying adequate training and support, is vital to ensure sustained use of health information systems

Behavioural Intention

Behavioral intention is an individual's subjective probability to perform a certain behavior (Fishbein & Azjen, 1975). In the case of this study, behavioral intention to adopt Teledentistry amongst South African dental professionals was studied. It was not deemed necessary to include the Use Behavior construct as the model's final outcome since behavioral intention is said to be a sufficient predictor of actual behavior (Eccles *et al*., 2006; Asua, Orruño, Reviriego, & Gagnon, 2012). Furthermore, teledentistry has not yet been widely commercialized (Rho, Kim, Chung, & Choi, 2015).

2.8.3 Discussion of the UTAUT-based Conceptual Model

Technology in the healthcare sector has introduced various threats due to the recording and sharing of personal data. As a result, perceived risk and trust forming part of information security has become an essential aspect of modern HIS (Alaiad & Zhou, 2014; Cimperman, Brenčič, & Trkman, 2016). It was established that data disclosure has consequences for service risk and privacy concerns (Alaiad & Zhou, 2014). Consequently, it is deemed necessary to include perceived risk and trust in the already existing UTAUT model due to its relevance in predicting Behavioural Intention in a medical context.

Dental practices have to be compliant with the Protection of Personal Information Act (POPIA) and the Health Insurance Portability and Accountability Act (HIPAA) (Melon & Hernandez, 2020). POPIA governs the protection of personal information through how organizations need to use, process, and manage clients' personal information. All private information should be treated privately and confidentially (I. Singh & Y. Singh, 2022). HIPAA enforces two main rules, namely the security and privacy rule. The security rule emphasizes cybersecurity awareness and training for all employees, including management, and the need to guard electronic health information through physical, technical, and administrative means. The privacy rule indicates the required and allowed use of protected health information regardless of the means through which they are transmitted (Kim, 2017). Actions such as sending patient data to the wrong recipient, theft of assets such as computers and electronic devices holding

patient data, and disruption due to technical difficulties all compromise the above rules (van Deursen *et al*., 2013; NIST, n.d.).

The UTAUT model is justified for this study for four main reasons. The model comprehensively considers and includes all eight previous technology adoption models (Venkatesh *et al*., 2003). The model has also been adapted to investigate and measure technology use by clinicians (Bawack & Kamdjoug, 2018), and it's offered an explanation for 70% variance in behavioral intention and 50% in the actual use of the technology (Holden & Karsh, 2010; Cimperman *et al*., 2016; Duarte & Pinho, 2019).

The UTAUT model is not highly criticized and is the most reliable technology adoption model. Van Raaij and Schepers (2006) argue that high R^2, or the coefficient of determination, can only be achieved by using a minimum of four moderating variables (gender, age, voluntariness, and experience). Conversely, Abbad (2021) highlighted that most studies have dropped the moderating variables in studies utilizing the UTAUT framework. This assertion was based on research done by Dwivedi *et al*. (2019), who found that moderating variables may not impact adoption and usage context. Thus, it was deemed appropriate to focus the study on the five main variables from the UTAUT model (performance expectancy, effort expectancy, social influence, facilitating conditions, and behavioral intention) with the added variables of trust and perceived risk. As in a study conducted by Alabdullah *et al*. (2020) on the behavioral intention of dentistry students to utilize teledentistry, intention was used as the dependent variable instead of actual behavior, as teledentistry is not a commercialized concept. Furthermore, previous studies have indicated the sufficiency of behavioral intention as a marker for actual behavior (Eccles *et al*., 2006; Asua *et al*., 2012).

Considering the above discussion, the conceptual model adopted in this study is presented below. The model contains the five constructs (performance expectancy, effort expectancy, social influence, facilitating conditions, and behavioural intention) conceptualised with the constructs of perceived risk and trust.

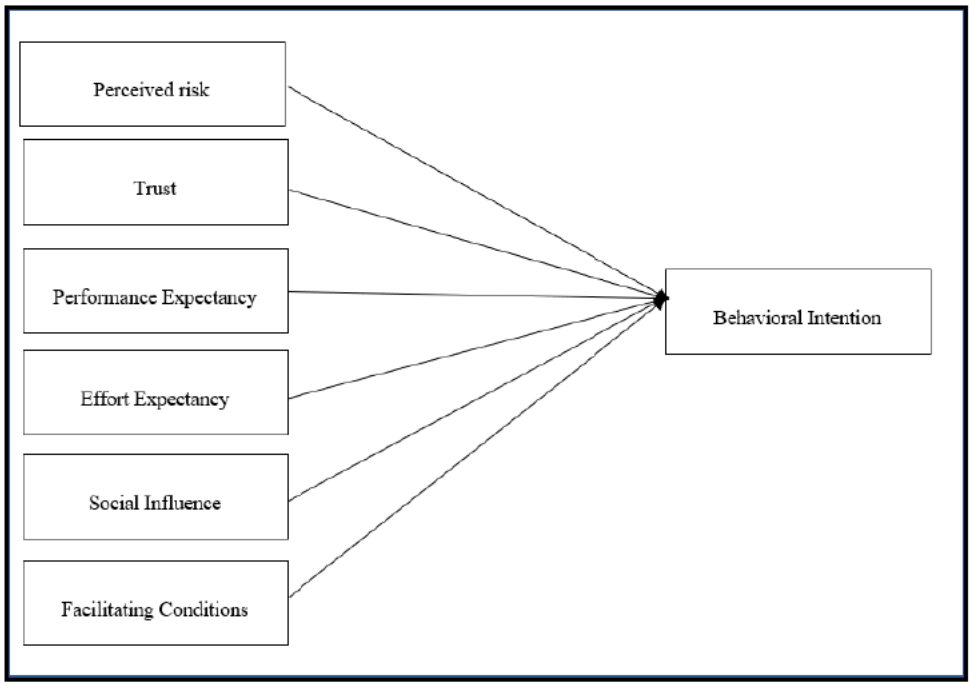

Figure 2-3 Conceptual model utilized in this study

2.9 Conclusion

This chapter intended to review the literature surrounding the topic of teledentistry and the factors influencing its adoption by dental professionals in South Africa. The chapter also highlighted perceived risk, trust, and its role in adopting e-health and telemedicine. Lastly, the study's conceptual framework, which used the UTAUT model developed by Venkatesh and conceptualized with the added variables of trust and perceived risk, was discussed. Substantial literature exists regarding telehealth and teledentistry adoption in numerous developing and developed countries, yet the topic is yet to be extensively investigated in a South African context. Given the dire need to address oral health disparities mentioned in this chapter, teledentistry is critical in tackling some of the country's challenges regarding oral health care. Furthermore, trust and perceived risk have only been explored in an e-health and telemedicine context.

Trust was discussed in the context of technology, healthcare, and patient-provider relationships. User-friendliness of applications, healthcare professional competence, and data were said to be related to trust in the literature. Furthermore, telehealth systems were said to decrease trust levels due to its lack of in-person interaction with patients. Likewise, perceived risk has been linked to the impersonal relationships built with the telehealth platform, lack of resources, and the digital divide that exists in developing countries. Both trust and perceived risk were

discovered to impact behavioral intention. However, this has not been investigated in the context of teledentistry adoption amongst dental professionals in South Africa. Lastly, this chapter looked at technology adoption models. The justification for the given conceptual model is that the model addresses all previous technology adoption models and accounts for the roles trust and perceived risk have played in the domain of e-health and telehealth adoption. The model's constructs were then discussed in the context of previous studies conducted using the UTAUT model.

CHAPTER THREE - RESEARCH METHODOLOGY

3.1 Introduction

The following section discusses the research methodology employed in the study. Section 3.2 will discuss the research design and approaches. Section 3.3 will discuss the study site and target population. Section 3.4 pertains to sampling strategies and sample size. Lastly, section 3.5 will cover data collection methods and quality control.

3.2 Research design

The following section discusses the research design, based on the research onion described by (Saunders, Lewis & Thornhill, 2019).

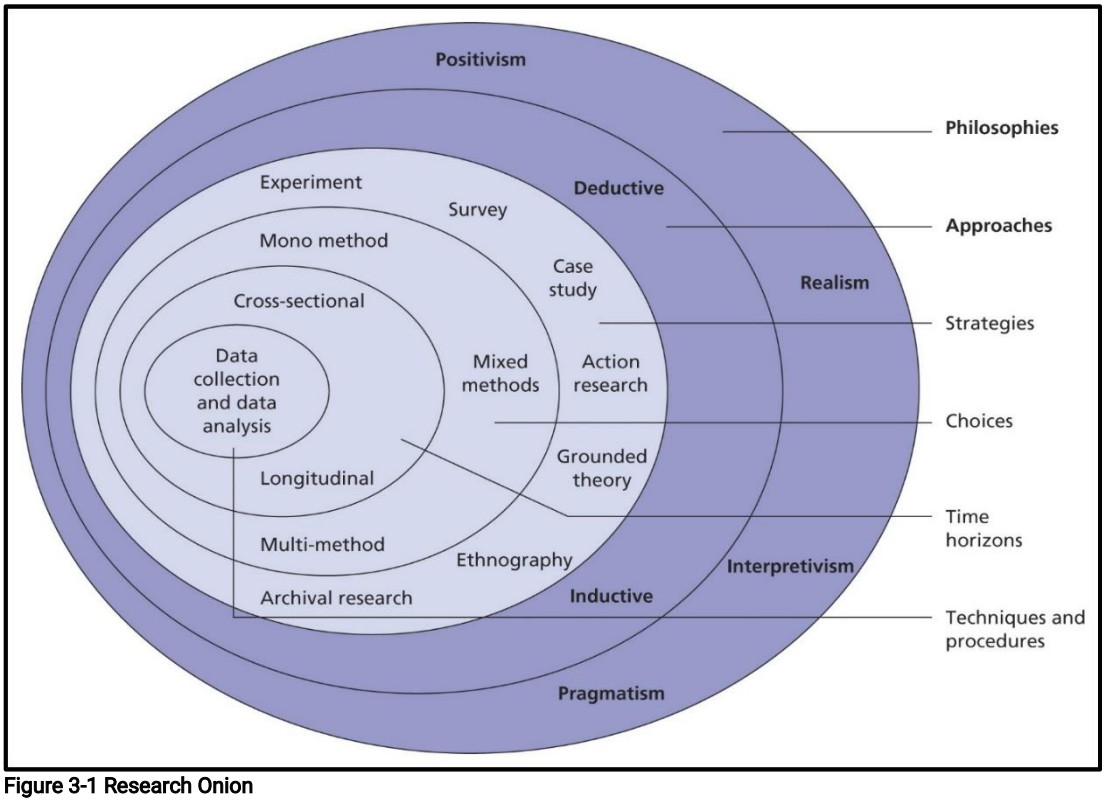

Figure 3-1 Research Onion

3.2.1 Research philosophy and approaches to theory development

Before choosing an appropriate research design, understanding the philosophy behind the research is vital. Research philosophy entails understanding the development of knowledge through one's own beliefs and assumptions (Saunders, Lewis, & Thornhill, 2019). Consistent beliefs and assumptions will help interpret research questions, choose a correct methodological approach, and collect and analyze data (Crotty, 2020). The choice of research philosophy that

underpins the current study is provided within the context of the discourse on research philosophy in general.

3.2.1.3 Research philosophies

Positivism relies on the hypothetico-deductive method to derive relationships between independent and dependent variables (Ponterotto, 2005). This philosophy has dominated the scientific and clinical research domains for many years in professional organizations and leading scientific journals (Hoyle, Harris, & Judd, 2009). Positivism relies on objective data from large sample sizes that provide better generalizations for the issue at hand. Ontologically realism and empiricism are emphasized, and reality is judged on recorded events (Mingers, 2006). Epistemologically, knowledge is obtained through one's experience of the world (Hjørland & Wikgren, 2005). Regarding Axiology, positivism relies heavily on objectivity and refutes participants' subjective experiences and values. Furthermore, the researcher cannot be part of the research in any way that may influence it (Park, Konge, & Artino, 2020).

Critical realism

The philosophy of critical realism was developed in the 1970s and 1980's by Bhaskar, providing an alternative to positivism and interpretivism (Archer *et al*., 2013; Bhaskar, 2013). Critical realism contains aspects of both positivism and interpretivism and emphasizes subjective information about social actors. These social actors are governed by independent structures influencing their activity (Sayer, 2010). In terms of ontology, Bhaskar (1998) refuted that knowledge is not only what is empirically known but also not entirely created through perceptions of social actors. Instead, the world is multidimensional, containing causal structures activated under certain situations (Mcevoy & Richards, 2003). Epistemologically, there is a focus on observing and interpreting meaning to explain what must exist before the event occurs (Wynn & Williams, 2012). Researchers must remain objective and avoid basing their values on their sociocultural background and experiences (Saunders *et al*., 2019).

Interpretivism

Interpretivism emphasizes meaning and how these meanings differ across people. Rather than studying subjects in the same way as physical entities, interpretivism values the different social realities people experience (Saunders *et al*., 2019). Interpretivism follows subjective qualitative research methods like unstructured interviews (Saunders *et al.*, 2019). Epistemologically, researchers are involved in the study, and the actions and perceptions of social actors are taken into account (Saunders *et al*., 2019).

Pragmatism

Pragmatism does not take a particular stance regarding what makes good and valid research. Research can be subjective through meanings or objective through observations, dependent on the study's research questions (Sekaran & Bougie, 2016). Through a collection of past actions, experiences, and interactions with the environment, pragmatists strongly favor eclecticism and pluralism and believe that the current truth changes over time. Everyone has unique opinions and differences that should be recognized (pluralism). Considering the previously mentioned information, the research project adopted a pragmatic approach. Primarily the study utilized the objective nature of numerical data from Likert-scale close-ended questions and a brief qualitative component at the end of the intended questionnaire where the participant offered further opinions regarding the topic. The pragmatic approach's risks were mitigated by mainly utilizing and emphasizing the quantitative data.

3.2.1.4 Approaches to theory development

Theory development is achieved through either deduction, induction, or abduction. A deduction is when one concludes by assessing whether all theory-derived premises are true (Saunders *et al*., 2019). The researcher develops a hypothesis or proposition and tests this rigorously through data collection. Deduction emphasizes adopting structured methodologies and reducing variables into their simplest forms. Furthermore, sample sizes need to be large enough to make reasonable generalizations. Induction conversely begins with data collection and, after that, developing a theory from this data. Research participants are valued for their personal experiences with the world rather than adopting a "one size fits all" approach. Priority is given to a smaller sample size than deduction and a qualitative approach (Saunders *et al*., 2019).

Abduction combines deduction and induction (Suddaby, 2006) and is used to explain a surprising finding through theories. Research studies are said to be abductive, when induction and deduction complement one another in the same study providing logics to test theories (Van Maanen *et al*., 2007). This research approach has flexibility in that it can apply to any research philosophy and is underpinned by pragmatism, or postmodernism.

3.2.1.5 Research approach and philosophy

Theory developed is based on one's research philosophy. Positivists lean towards deduction, and an objectivist stance. Interpretivism leans towards induction. Pragmatists are not inclined solely to deduction, induction, subjectiveness, or objectiveness but rather a collection of these through different methods ranging from qualitative or mixed methods approaches.

Table 3-1 Deduction vs Induction vs Abduction

Deduction	Induction	Abduction
Describes 'what' is happening	Describes 'why' something is happening	Both
Positivism	Interpretivism	Postmodernism, pragmatism, critical realism
Wealth of literature to build theoretical framework	Little to no literature available	Literature available only in one context
Quicker to complete as data collection only occurs once	Data collection is protracted, and takes longer than deduction	Data collection is protracted, and takes longer than deduction
Involves less risk	No useful data patterns or theory may emerge	No useful data patterns or theory may emerge

Note. Adapted from Research Methods for Business Students, by Saunders, Lewis and Thornhill (2019), p. 157

3.2.2 Research purpose

Exploratory research pertains to research undertaken when there is little to no knowledge of a topic, and the researcher needs to gather an initial understanding of the topic, research participants, and questions. This could be done by reviewing the literature, consulting subject experts, or doing group and in-depth interviews with participants (Saunders *et al*., 2019). Descriptive research explains what occurs in a general population rather than explaining why it occurs (QuestionPro, n.d.). Data collected is used to describe the topic (Sekaran & Bougie, 2016). Conversely, explanatory research seeks to explain why something happens through cause-and-effect relationships

This study was descriptive, and the researcher intended to investigate and describe what factors influence the adoption of Teledentistry in South Africa and the behavioral intention to adopt this technology. Often, research studies may include a combination of research purposes through research methods employed. As such, the conceptual model used in this study did build on relationships between variables, which was also established.

3.2.3 Methodological approaches

Methodological approaches pertain to quantitative, qualitative, and mixed methods approaches (Saunders *et al*., 2019). Quantitative research allows one to generalize findings to wider populations by collecting and analyzing numerical data (Bhandari, 2020). Furthermore, one can identify patterns and relationships and make predictions from this data. Conversely, qualitative data deals with non-numerical data such as text, video, and audio. The words and stories that people tell researchers form the basis of qualitative research. Qualitative research values the changing subjective experience of human beings in the social world rather than studying things,

objects, or the natural world (Hesse-Biber 2017). It is argued that qualitative research may be less credible than quantitative research as set rules do not govern it, and interpretive data may lack reliability and validity. However, qualitative methods are flexible, which is crucial if one needs to study meanings and interpretations (Padgett 2017; Rossman & Rallis 2017).

Lastly, mixed methods research is used in the social, behavioral, and health fields and involves gathering both quantitative and qualitative data in a single study. This data is then integrated, and the strengths of both methods are combined to answer the research question. Mixed methods research comes in six forms (convergent parallel, sequential exploratory, sequential explanatory, embedded, transformative, and multiphase), of which the first three are mainly used in research.

Convergent parallel, sometimes called a concurrent triangulation design, collects quantitative and qualitative data independently in a single phase and then compares the findings to find similarities or differences. When one method is embedded within the other, this is known as a concurrent embedded design (Saunders *et al*., 2019). Sequential exploratory design involves two phases, the first being qualitative data collection, which then aids with conducting quantitative research.

Telehealth research has seen an increase in the use of mixed methods design in recent literature and benefits from mixed methods research as it is a broad, complex, and multifaceted field (Caffery *et al*., 2017). This study used a predominantly quantitative approach and the majority of questions in the questionnaire were close-ended quantitative. However, aligned to the pragmatic research philosophy, an additional open-ended question was added to provide the study's respondents with an opportunity to respond in an unstructured manner where they leveraged their experience as dentists to add value to the study's data. This would provide the researcher with an opportunity to acquire access to information that was depth-driven and based on the respondents experience in the dental profession. This strategy is endorsed by Cresswell and Clark (2011) who formalise this approach by suggesting that the weightings of qualitative and quantitative data may be unequal or equal, so one method plays a dominating role and the other a supporting role.

3.3 Sample and Sampling techniques

3.3.1 Study site and target population

The study site of this study was South Africa, and the target population was HPCSA-registered dentists and dental specialists. Ozkan and Ata (2009) define dental professionals as a group of dentists, dental assistants, educators, students, and technicians. However, for this study, students, technicians, and assistants were excluded, as many of these professionals primarily work for qualified dentists and specialists, who are the primary adopters of teledentistry. Furthermore, Bhayat & Chikte (2019) point out that dentists and dental specialists have the capabilities of oral hygienists and therapists. Thus, it was deemed appropriate to focus the study on dentists and dental specialists. The study site, South Africa, was chosen due to lack of research regarding teledentistry adoption. Hence, the justification for choosing a broader population was chosen with the intention of introducing avenues for further research in specific areas of interest, such as teledentistry adoption in certain communities or provinces.

3.3.2 Sampling methods

3.3.2.1 Probability vs Non-Probability sampling

Subset selection through a sampling frame is termed sampling. Sampling involves two different sampling techniques: probability sampling and non-probability sampling. Probability sampling refers to each participant having an equal chance of being chosen by selecting a random participant from a sampling frame using a tool like a computer-generated random number (Saunders et al., 2019). With probability sampling, it is possible to specify the probability or chance of a unit being included in a sample. Although this technique has the least sample bias, it takes time and energy to carry out adequately (Brown, 1947). Non-probability sampling is mainly utilized when sampling frames cannot be obtained or the research question needs to be answered in a certain way (Saunders *et al*., 2019).

3.3.2.2 Sampling technique chosen for study

The study employed non-probability sampling, in particular convenience and snowball sampling. This sampling strategy was chosen with the view that the researcher had quick access to dental professionals in the country having an affiliation with the field of dentistry and could utilize social media platforms to reach a broader base of participants for the study.

LinkedIn is a social media platform where every user is connected to other users, and those users are connected, creating an extensive network. Choosing a sample from LinkedIn has various advantages, including eliminating geographic barriers and being able to reach a larger audience, personal communication between researcher and respondent, which increases the possibility of participation, cost efficiencies, and utilizing Linkedin's network structure (Kozlowski, Kaliszewski, Dabrowski, & Klimek, 2021). Sampling on the LinkedIn platform pertains to the virtual snowballing technique. This is also known as respondent-driven sampling (Heckathorn, 1997). Furthermore, virtual snowballing in Linkedin has reduced bias, as the respondents do not recommend participants; rather, the researcher selects them from that individual's network.

3.3.3 Sample size

Sample size selection under the non-probability sampling domain is ambiguous and is not governed by set rules such as the case of probability sampling, but rather the relationship between the study purpose and sampling technique (Saunders *et al*., 2019). The actual population size of dental professionals has not been established since 2021.The latest available figure stated that in 2021, 6586 dentists and 526 dental specialists were registered with the HPCSA. However, this study was based on the years 2022-2023, and no figures were readily available regarding the number of dentists and dental specialists, deeming it challenging to predict the exact sample size needed.

To address the above, the central limit theorem was utilized to explain why the sample mean obtained could accurately depict the general mean population of South African dental professionals. This was discussed further in the results section which follows the current chapter. Furthermore, to provide a discussion surrounding the response rate of the study (discussed in the results chapter), based on the study by Adenuga *et al*. (2017) where telemedicine adoption amongst clinicians in Nigeria was studied, the below formula was utilized to ascertain the sample size required when the population size or sampling frame is unknown:

$$(\text{Z score})^2 \times \text{StdDev}*(1-\text{StdDev}) / (\text{margin of error})^2$$

The above formula was used to calculate the required sample size of the study, discussed and calculated in section 3.3.4.

3.3.4 Response rate

The population in this study had been South African dentists and dental specialists. This study was carried out in 2022, and at this time, the exact figures regarding the population of dentists and dental specialists in South Africa were not available.

Smith and Albaum (2010) and Orji (2017) provide a means to calculate the required sample size when large population sizes are unknown.

$$(\text{Z score})^2 \times \text{StdDev}*(1-\text{StdDev}) / (\text{margin of error})^2$$

This equation has been utilized in various studies by Adenuga *et al*. (2017), Garvey and Ezimmuo (2019), and Widyatmoko and Yahya (2021).

The equation is based on the below values:

1. Population size – It needs to be assumed the population size is very large. In the case of this study, this had been all dentists and dental specialists in South Africa.
2. Standard deviation (StdDev) – The amount of expected variance within the dataset. A value of 0.5 is commonly used to ensure a sufficient sample size would be calculated.
3. Confidence level – The certainty that the actual mean falls within a certain confidence level. Three confidence levels are commonly used (90%, 95%, and 99%). The confidence level is utilized to obtain the z-score constant. A 95% confidence level was used in this study, which gives a z-score of 1.96 (Smith & Albaum, 2010)
4. Margin of error – Permissible error amount between sample and population mean (higher or lower than the population mean).

Substituting these values in the above equation, the required sample size was calculated as 385 respondents.

A total of 385 online questionnaires were distributed to particpants of which 158 completed responses were received, giving a response rate of 41%. Twelve of these responses had been utilized in the pilot study, and were excluded from the data analysis of the study.

3.4 Data Collection

3.4.1 The research instrument

Research strategies are broadly classified into experiments, surveys, archival and documentary research, case study, ethnography, action research, grounded research, and narrative enquiry. The survey strategy was adopted, regularly used with descriptive research, and holds authoritative value to be easy to explain and understand (Saunders *et al*., 2019). Surveys are a popular research strategy in the field of telehealth (Langbecker, Caffery. Gillespie, & Smith, 2017). Surveys have three main advantages over other research strategies (Langbecker *et al*., 2017). Results are easy to replicate and compare because of the ability to use common scales; generalizable results can be reproduced because large samples can be reached through low costs, and participants are more inclined to be open and honest as opinions are confidentially assessed.

3.4.2 Development of the research instrument

The research instrument of this project was a questionnaire distributed as a LimeSurvey and Google Forms online questionnaire. The questionnaire was approximately six physical pages long and consisted of three sections. Before capturing the participant's responses, participants were made aware of the project's details and ethical information on participation. To proceed with the questionnaire, participants had to select a checkbox and acknowledge they had read the above information. A brief definition of the term teledentistry was offered to participants, intended to properly inform the participants of what comprises the term 'teledentistry.'

Section A captured the demographic details of participants. Questions 1-3 comprised the participant's age, gender, and years of experience. Questions 4-6 comprised the dental professional's specialty, sector, and university. This was added to the questionnaire to add further insight into the topic and guide future research that may arise from the findings. Section B consisted of close-ended Likert scale questions in line with the conceptual model of this project. Section C consisted of an open-ended question to enhance understanding of the research questions in the project. This section was kept brief, as dental professionals often have busy schedules, and to increase completion rates of the survey. Section C was added to the questionnaire to supplement any findings that were not catered for in the close-ended questions that may be useful in answering the research questions.

3.4.3 Administration of the research instrument

The process that was followed in this research pertained to four steps:

1. An initial connections list was developed on LinkedIn for the studies population. In the initial step, users were searched for location and occupation. These were South Africa, and dental professional respectively.
2. The researcher sent the individual a connection request on LinkedIn. Once the individual accepted the connection request, they were offered further information regarding the research and asked if they would be willing to participate, given the ethical considerations mentioned in the survey.
3. The researcher further selected and added direct contacts in that participants' network to the initial list, building a more extensive network.
4. Lastly, the researcher further utilized Instagram and WhatsApp to reach a more significant number of South African dental professionals.

3.4.4 Pilot testing

Prior to administering questionnaires to participants, the questionnaire should be subjected to pilot testing with individuals similar to the actual particpants of the study (Saunders *et al*., 2019). The number of participants required for a pilot study is dependent on research objectives, time and size constraints of the study, and questionnaire design (Saunders *et al*., 2019). Sample sizes of pilot studies can either be 10, 12 or 30 individuals (Browne, 1995; Julious, 2005; Saunders *et al*., 2019). The questionnaire in the study was first piloted with nine participants from the LinkedIn platform and three from WhatsApp. The participants were randomly selected based on whether they were a dental professional residing in South Africa. The participants were asked if they faced any challenges or found any ambiguous aspects of the questionnaire that needed improvement. All twelve participants agreed they encountered no challenges while completing the survey. The twelve participants utilized in the pilot study were not used in the data analysis of this study. Before constructing the questionnaire, background knowledge was obtained from a Telehealth specialist in South Africa. They highlighted topics such as adequate infrastructure in South Africa regarding Teledentistry should be considered, training and knowledge in the field of teledentistry, and HPCSA compliance. These topics had already been addressed and considered, as the UTAUT framework addressed aspects such as facilitating conditions.

3.5 Data Analysis Methods

3.5.1 Reliability and Validity

3.5.1.1 Reliability

Reliability refers to measurement consistency of research instruments (Polit & Hungler, 1995). Reliability helps account for random errors that may be caused when using measurement scales. The ideal situation is to have as little variation as possible if data collection is repeated (McDowell & Newell, 1996). There are three ways of ensuring reliability of a research instrument: test-retest reliability (stability), inter-item reliability (internal consistency) and interrater reliability (equivalence) (Polit & Hungler, 1995).

Inter-item reliability was chosen to test internal consistency of the instrument due to its feasibility, being economically viable and an adequate way to detect errors (Polit & Hungler, 1995). Each of the constructs in the study contained a scale made up of individual items. Consistency measures how well these items fit together in a single group and was established through Cronbach's alpha. The internal consistency reliability is high when Cronbach's alpha value is close to 1.

3.5.1.2 Validity

Validity assesses how well research instruments measure intended outcomes. The study utilized a confirmatory factor analysis approach and covariance-based structural equation modeling (CB-SEM) using SmartPLS 4 to assess and address construct validity of the research instrument. Furthermore, during the construction of the research instrument, a discussion was held with a telehealth expert to ensure the questionnaire addressed the concept of content validity. The individual pointed out the importance of POPIA, infrastructural capacity, and the standing of the country as a whole regarding teledentistry. These topics were included in constructs such as “facilitating conditions” and “perceived risk” in the UTAUT conceptual model. The majority of items in the constructs were also adopted unchanged from the original UTAUT model proposed by Venkatesh, and some items had been extracted from previous research papers or journal articles on telehealth and teledentistry. The remainder of the items were developed based on the telehealth expert's discussion. A tabulated format of the measurement items and constructs with references can be found in the results chapter that follows.

3.5.2 Selection of Data Analysis Techniques

The study made use of both descriptive and inferential statistics. According to Mishra *et al*. (2019), descriptive statistics apply to frequency, central tendency, and dispersion or variation measurements. For this study, frequency, mean, and standard deviation were reported regarding descriptive statistics. These statistics were utilized when reporting on the demographic profile of the participants as well as to achieve an aggregated view of responses to the individual Likert scale items.

Inferential statistical analysis allows inferences on a sample taken from a population through parametric and non-parametric tests. Prior to conducting parametric and non-parametric tests, the normality of data was assessed through the Kolmogorov-Smirnov and Shapiro-Wilk tests. However, Ghasemi and Zahediasl (2012) point out that violations of normality are said to be negligible when sample sizes are > 30 or 40, and greater than 100 participants. Furthermore, the central limit theorem states that if the sample data is normally distributed, this would result in a normal sample distribution regardless of the shape of the data given the sample size is also large (>30 or 40). Taking this into account parametric tests were utilized for data analysis to offer a richer discussion regarding analysis. The one-sample t-test, bi-variate correlation analysis using Pearson correlation, and multiple regression were conducted regarding inferential statistics.

One sample t-test

The one sample t-test allows one to test whether the sample's mean is equal to a comparable standard (Sekaran & Bougie, 2016). This test will enable one to ascertain whether there is a general agreement or disagreement on each of the constructs in the conceptual framework. If $p<0.05$ (significance level), respondents generally agree with the item based on the five-point Likert scale mentioned earlier.

Pearson Correlation

Pearson correlation was utilized to determine if a linear correlation existed between that of the dependent and independent variables allowing for the answering of the research questions (Samuel & Okey, 2015). The p value indicates whether the relationship between an independent and dependent variable is statistically significant, and the r value indicates the strength of this relationship offering insight into which factors influence behavioral intention to adopt teledentistry amongst South African dental professionals (Samuel & Okey, 2015; Hazra & Gogtay, 2016).

Multiple Regression

Multiple regression analysis is used to establish the effect all independent variables (performance expectancy, effort expectancy, social influence, facilitating conditions, trust and perceived risk) have on the dependent variable (behavioral intention) in the study. This allowed one to view how multiple independent variables explain variance in a single dependent variable (Sekaran & Bougie, 2016). The square of the multiple correlation coefficient or multiple r (R^2) indicated the amount of variance in the dependent variable because of its predictors (independent variables).

3.5.3 Open-ended question Analysis

The open-ended component of the questionnaire was assessed through Giorgi's (2009) descriptive phenomenological approach. Phenomenology focuses on analyzing phenomena by highlighting and condensing themes within the data that offers explanation for their meaning units. According to Lee, Greenfield, and Pappas (2018) this process is guided by five main steps. The first step is to adopt a phenomenological attitude towards analysis. The second step is to familiarize oneself with the data by reading through it multiple times. The third step pertains to identifying general units of meaning within the participants account of their lived experiences. Lastly the fourth and fifth step involves transforming these general units of meaning (expressed in the individuals own words) into statements and a descriptive structure that explains the experience. NVivo 12 was utilized to carry out the above process, where general units of meaning were first derived from the data through keywords, and these were further synthesized into themes where the descriptive structure was expressed through statements and interpretation of these statements. This analysis can be found in the results chapter that follows.

3.6 Ethical Considerations

Before conducting this study, ethical clearance was requested from the University of KwaZulu-Natal. The data obtained from the Google Forms online questionnaire was safely stored and shall be discarded after five years. The respondents to the study were required to act in their personal capacity and were not expected to represent any specific group or organization.

The purpose of the research study was explained on the online questionnaire before participation, and all participants were reassured that their anonymity and confidentiality would be upheld and that participation in the study was voluntary, with them being allowed to withdraw at any time.

3.7 Summary

The methodology chapter provided the research design and methods selected, and the justification thereof which is explored further in chapter four. The study was established to be descriptive and followed a predominantly quantitative structure supplemented with a bried open-ended question at the end of the questionnaire The choice of research instrument was a survey disseminated as an online questionnaire created on the Lime Survey and Google Forms platforms. Non-probability convenience and snowball sampling were utilized with regards to sampling and the target population were South African dental professionals. The results chapter follows on from this chapter, where the questionnaire structure is revisited, as well as a discussion on the response rate and finally the descriptive and inferential statistical methods mentioned in this chapter are presented.

CHAPTER FOUR – RESULTS

4.1 Introduction

The following chapter presents the results obtained from participants through an online questionnaire. Dentists and dental specialists were sought after primarily on the LinkedIn platform by making use of LinkedIns connections feature. Further participants were sourced from social media platforms such as Instagram and WhatsApp. Thereafter the online questionnaire had been sent to the individuals to complete. The online questionnaire was first created on the LimeSurvey platform, where 36 questionnaires were completed. Initially, some participants had trouble accessing the LimeSurvey link, and it was decided to migrate the online questionnaire to the Google Forms platform to ensure participants were not having further accessibility issues. An additional 122 completed questionnaires were received from Google Forms, and of the 158 responses received in total, 12 responses were utilized for the pilot study. The 12 participants utilized in the pilot study were not used in the data analysis of this study.

The data received from the LimeSurvey and Google Forms platforms had been input into Microsoft Excel where answers to items were coded numerically. Duplicate and missing items were checked before being transferred to the SPSS v26 software. SPSS v26 software was utilized to analyze the quantitative data of study. Before analyzing the data, the questionnaire contained some negatively worded items that needed to be reverse-coded to ensure consistency within the constructs. These items were EE4, FC3, PR1.

4.2 Questionnaire structure and validity revisited

The online questionnaire distributed to participants contained three sections. Section A aimed to capture the demographic characteristics of the participants. Section B comprised close-ended Likert scale questions on the study's conceptual model, where a rating of 1 was equal to strongly disagree, and a rating of 5 was equivalent to strongly agree. This is further indicated in Table 4-1 below. The appropriate references of where some of the questionnaire items were extracted from are also provided in the table to show that content validity had been accounted for. Items had been extracted from these past questionnaires, with the only change being the addition of the word teledentistry to items. Items P3, P4, and P5 were created from journal articles by van Deursen, Buchanan, Duff (2013), and AAWD (2020). Lastly, section C included an open-ended question to allow for the addition of a written component that would further enhance the answers received from the close-ended questions.

Table 4-1 Questionnaire items

Constructs	No. of items	References
Performance Expectancy	5	Venkatesh *et al*. (2003); Khokhar *et al*. (2022)
Effort Expectancy	4	Venkatesh *et al*. (2003); Kamal, Shafiq & Kakria (2020)
Social Influence	4	Venkatesh *et al*. (2003); Arfi *et al*. (2021)
Facilitating Conditions	5	Venkatesh *et al*. (2003); Arfi *et al*. (2011)
Behavioral Intention	4	Venkatesh *et al*. (2003);
Trust	4	Arfi *et al*. (2021); Kamal, Shafiq & Kakria (2020)
Perceived Risk	7	Arfi *et al*. (2021); Kamal, Shafiq & Kakria (2020); van Deursen, Buchanan, & Duff (2013); AAWD (2020)

4.3 Results chapter outline

The results chapter is structured in the following manner:

1. An overview of the study's demographics is presented in a tabular and bar graph format.
2. Reliability and validity were analyzed through Cronbach's alpha values and confirmatory factor analysis with covariance-based structural equation modeling, respectively.
3. Normality testing was conducted to determine the distribution of the study's data.
4. An aggregated view of the responses to the individual items for each construct were presented with tables and stacked bar graphs to provide an overview of the construct's individual items.
5. The one-sample t-test was then presented to identify if the mean values obtained for the constructs were of significant value or had occurred by chance. The mean values obtained were compared to a neutral value of 3, forming the basis for the null hypothesis regarding the general agreement of the constructs.
6. Pearson correlation values were then presented to determine the type and strength of the relationship between the independent variables and behavioral intention.
7. Multiple regression was carried out to determine the independent variables' collective impact on the dependent variable.
8. Lastly, an analysis of the open-ended question was presented through themes that were identified during the descriptive phenomenological approach.

4.4 Study demographics

The data was categorized into various segments as shown in Table 4.2.

Table 4-2 Sociodemographic variables

		Frequency	%
Age	20-34	98	67.1%
	35-44	25	17.1%
	45-54	15	10.3%
	55-64	8	5.5%
Gender	Male	51	34.9%
	Female	95	65.1%
Work Experience (in years) ?	0-5	69	47.3%
	6-10	33	22.6%
	11-15	18	12.3%
	>16	26	17.8%
What is your speciality?	General Dentist	127	87.0%
	Orthodontics	3	2.1%
	Maxillofacial and Oral Surgery	3	2.1%
	Prosthodontics	6	4.1%
	Pedodontics	2	1.4%
	Periodontics	5	3.4%
Which sector(s) do you currently work in?	Private	88	60.3%
	Governmental	36	24.7%
	Both	22	15.1%
Which university did you attend?	Sefako Makgatho Health Sciences University	24	16.4%
	University of the Witwatersrand	36	24.7%
	University of Pretoria	27	18.5%
	University of the Western Cape	52	35.6%
	Other	7	4.8%

The age distribution of the participants revealed that the majority were between 20 and 34 years old, accounting for 67.1% of the sample (n = 98). This was followed by those aged 35-44 years (17.1%, n = 25), 45-54 years (10.3%, n = 15), and 55-64 years (5.5%, n = 8). Regarding gender, females comprised a larger portion of the sample at 65.1% (n = 95), compared to males at 34.9% (n = 51).

Work experience varied, with 47.3% (n = 69) having 0-5 years of experience, 22.6% (n = 33) with 6-10 years, 12.3% (n = 18) with 11-15 years, and 17.8% (n = 26) having more than 16 years of experience. In terms of specialization, the majority were General Dentists (87.0%, n = 127), followed by Prosthodontics (4.1%, n = 6), Periodontics (3.4%, n = 5), Orthodontics (2.1%, n = 3), Maxillofacial and Oral Surgery (2.1%, n = 3), and Pedodontics (1.4%, n = 2). As for the sector of employment, 60.3% (n = 88) worked in the private sector, 24.7% (n = 36) in the governmental sector, and 15.1% (n = 22) in both sectors.

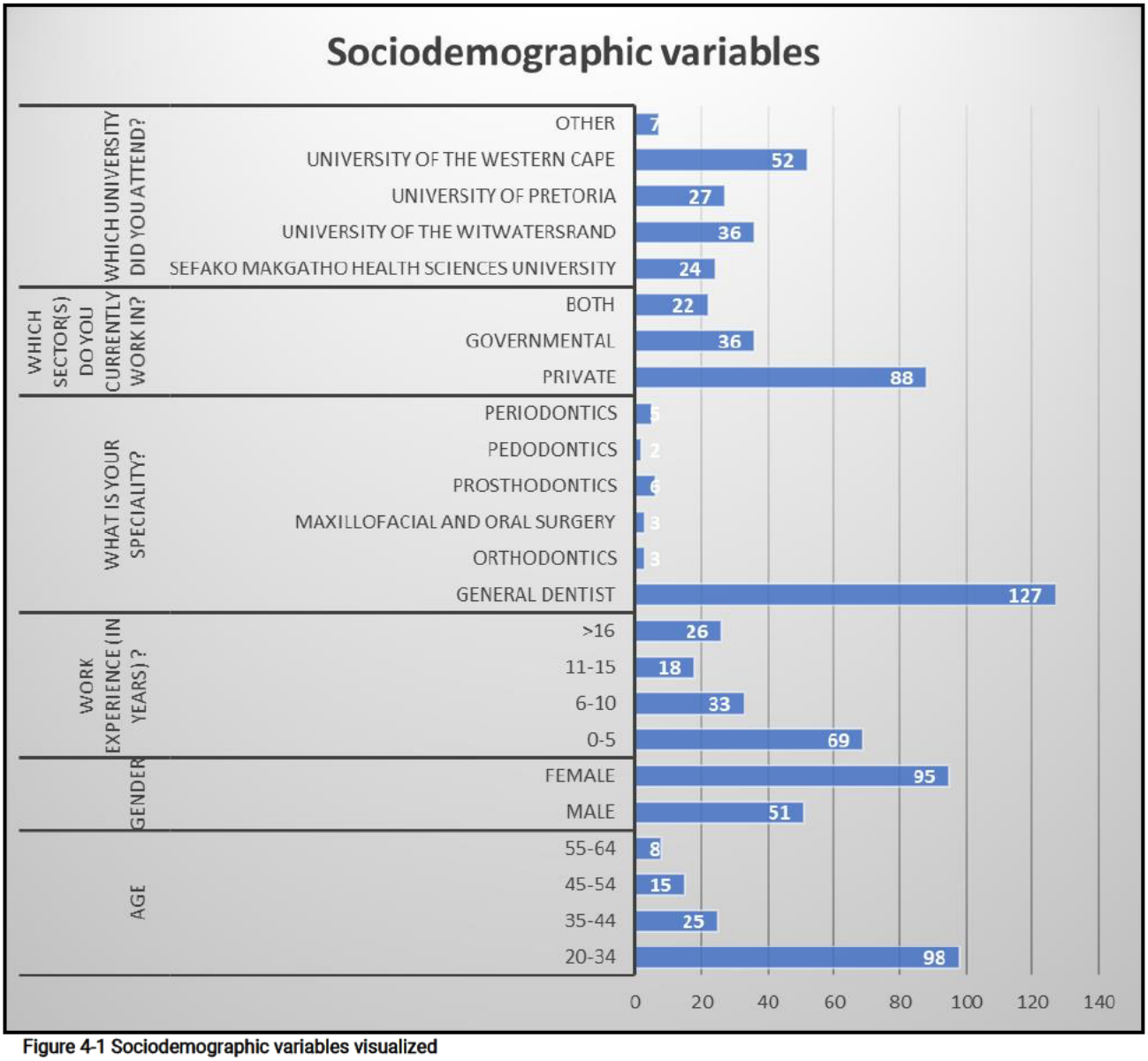

Figure 4-1 Sociodemographic variables visualized

From an educational background perspective, it can be established from Figure 4.1 that participants mostly graduated from the University of the Western Cape (35.6%, n = 52), followed by the University of the Witwatersrand (24.7%, n = 36), University of Pretoria (18.5%, n = 27), Sefako Makgatho Health Sciences University (16.4%, n = 24), and other universities (4.8%, n = 7).

4.5 Reliability and validity of research instrument

4.5.1 Validity

Confirmatory factor analysis (CFA) had first been utilized to ascertain the construct validity of the studies initial conceptual model. Stapleton (1997) highlights the viability of CFA to assess construct validity.

The model generated from the study's initial conceptual model can be found in Figure 4.2 .

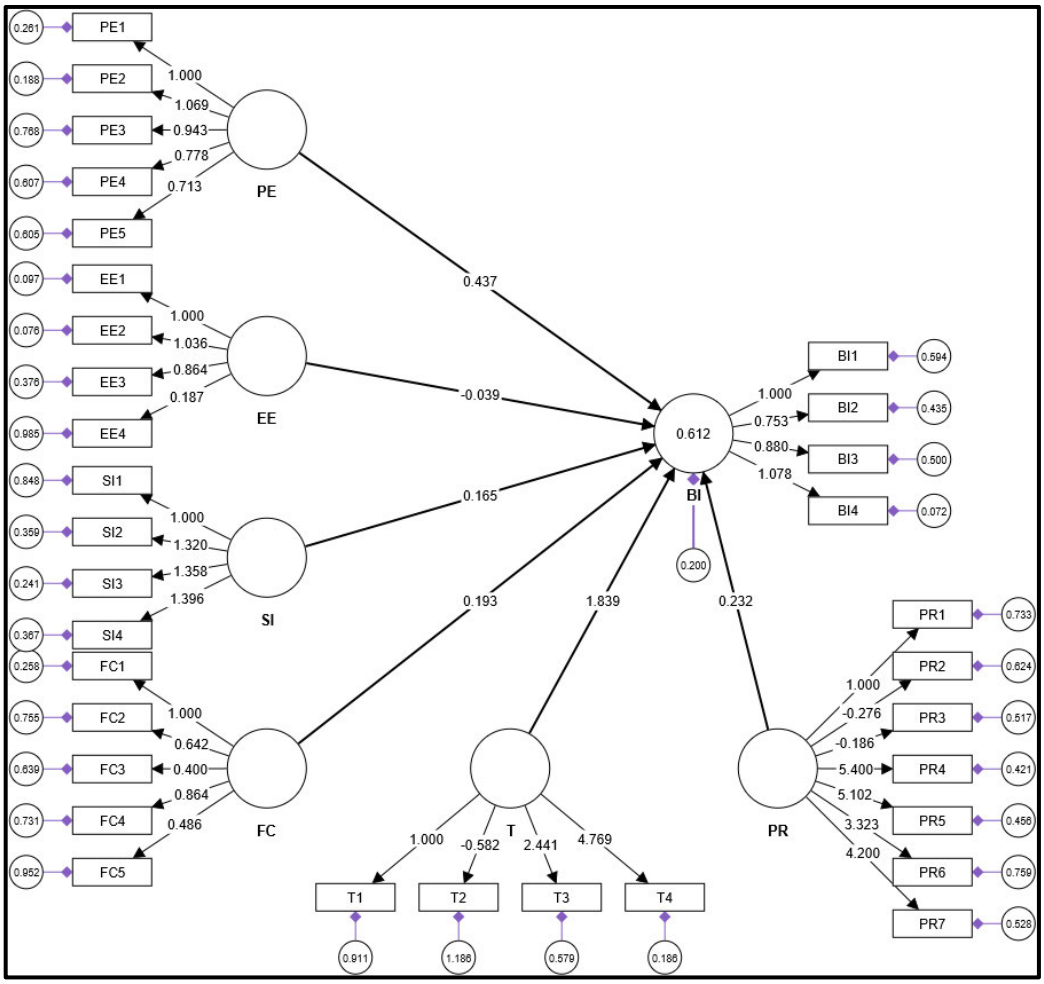

Figure 4-2 Initial CFA model

Each diagram shows multiple latent variables (factors), indicated by circles or ellipses, which are hypothesized to underlie the observed variables (indicated by squares or rectangles). Each observed variable is linked to one latent variable, suggesting that it is a measure of that construct. The numbers on the arrows between the observed variables and latent factors represent the standardized factor loadings, which are akin to regression coefficients in a regression analysis. They indicate the strength and direction of the relationship between an observed variable and its latent factor. In Figure 4.2 there are paths or correlations between

some of the latent factors, indicated by double-headed arrows. These suggest that the latent factors are hypothesized to be related to each other.

The initial model showed some improvements over the null model but did not fully meet established goodness-of-fit thresholds. The Chi-square value of the initial model was considerably lower (1398.947) compared to the null model's 3147.139, suggesting a better fit, yet this measure is sensitive to sample size (Schermelleh-Engel, Moosbrugger, & Müller, 2003). The ratio of Chi-square to degrees of freedom in the initial model was 2.861, which is marginally within the acceptable range of less than 3 (Kline, 2011), indicating a reasonable fit. However, the Root Mean Square Error of Approximation (RMSEA) for the initial model was 0.113, exceeding the preferred threshold of 0.06 (Hu & Bentler, 1999), denoting a less than ideal fit. The Goodness of Fit Index (GFI) was only 0.599, Adjusted Goodness of Fit Index (AGFI) was 0.540, Parsimonious Goodness of Fit Index (PGFI) was 0.522, Standardized Root Mean Square Residual (SRMR) was 0.227, Normed Fit Index (NFI) was 0.555, Tucker-Lewis Index (TLI) was 0.625, and Comparative Fit Index (CFI) was 0.653, all falling below the desirable threshold of 0.9 for GFI, AGFI, PGFI, NFI, TLI, CFI, and 0.08 for SRMR (Jöreskog & Sörbom, 1996; Hu & Bentler, 1999). Furthermore, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values for the initial model were 1542.947 and 1757.766, respectively, indicating potential for improvement as lower values denote a better fit (Burnham & Anderson, 2004).

This analysis highlights the need for model re-specification or enhancement to achieve a more satisfactory fit level in line with established statistical criteria. The two trust items that have been deleted are as follows: *Teledentistry systems will require me to be cautious with this technology. I fear to use Teledentistry due to loss of my patient's personal data and privacy*. The new model below was then re-assessed through co-variance based structural equation modelling (CB-SEM) and is illustrated in Figure 4.3.

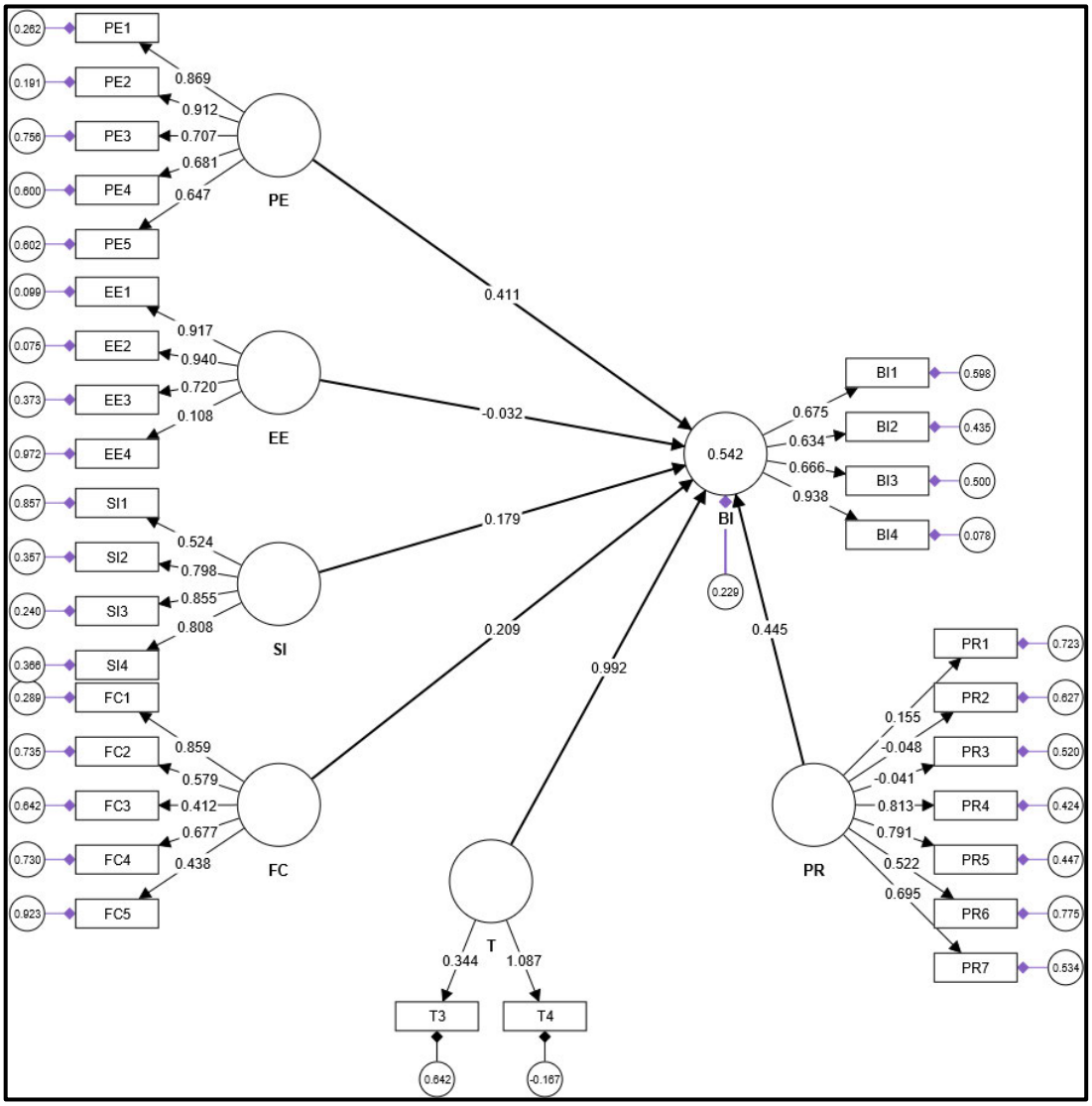

Figure 4-3 Adjusted CFA model

The validity of the covariance-based structural equation modeling (CB-SEM) is conducted using SmartPLS 4, particularly in validating data from a sample of 146 respondents after deleting two items from the trust variable in a study on teledentistry, several key aspects of the model's performance can be highlighted:

1. **Improvement in Model Fit After Item Deletion:** The removal of two trust items related to cautiousness and privacy concerns significantly improved the model fit. This is evident from the reduced Chi-square value in the estimated model (1172.518) compared to the null model (2916.871). The reduction in Chi-square value indicates that the modified model (with deleted items) aligns better with the observed data. The Chi-square/df ratio of 2.740

in the estimated model is a substantial improvement over the null model's 6.273. This ratio is well within the acceptable range of less than 3, suggesting a reasonable fit (Kline, 2011).

2. **Acceptable RMSEA Value:** The Root Mean Square Error of Approximation (RMSEA) for the estimated model is 0.109, which, while slightly above the preferred threshold of 0.06 (Hu & Bentler, 1999), is still within the acceptable limit of up to 0.08 for good model fit. This indicates that the model adequately approximates the population covariance matrix.
3. **Goodness of Fit Indices:** The Goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index (AGFI) values are 0.618 and 0.557, respectively. Although these values are below the ideal threshold of 0.9, they show an improvement from what would be expected in a model with poor fit, indicating that the model represents a fair proportion of the variance and covariance in the data. The Parsimonious Goodness of Fit Index (PGFI) value of 0.533 also supports the model's adequacy in terms of parsimony.
4. **Incremental Fit Indices:** Incremental fit indices like the Normed Fit Index (NFI), Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI) are 0.598, 0.670, and 0.696, respectively. These values, especially the CFI, are approaching the threshold of 0.9, indicating an acceptable fit of the model (Bentler, 1990).
5. **Model Complexity and Information Criteria:** The Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values (1308.518 and 1511.404, respectively) are reasonable, suggesting that the model is not overly complex given the data.

The use of CB-SEM in SmartPLS 4 for this study demonstrates a reasonable model fit, especially after the deletion of two problematic trust items. The improvements in chi-square, RMSEA, and other fit indices post-item deletion substantiate the validity of the model and indicate that the remaining trust items are more representative of the construct in the context of teledentistry. While there is room for further improvement, the current model provides a credible basis for analyzing relationships within the data.

4.5.2 Reliability

The reliability of the scales was assessed using Cronbach's alpha, which measures internal consistency, or how closely related a set of items are as a group. A Cronbach's alpha value of .70 or higher is considered acceptable, .80 or higher is good, and .90 or higher is excellent (George & Mallery, 2003). As presented in Table 4.3, the Performance Expectancy (PE) scale consisted of five items and demonstrated excellent reliability ($\alpha = .875$). The Effort Expectancy (EE) scale, comprising four items, showed acceptable reliability ($\alpha = .727$). Similarly, the Social Influence (SI) scale, with four items, indicated good reliability ($\alpha = .826$).

Table 4-3 Cronbachs alpha values

No	Scales	Items	Cronbach alpha
1	Performance expectancy (PE)	05	.875
2	Effort expectancy (EE)	04	.727
3	Social influence (SI)	04	.826
4	Facilitating Conditions (FC)	04	.734
5	Trust T (-2)	02	.610
6	Perceived risk (PR)	07	.612
7	Behavioral Intention (BI)	04	.874

Facilitating Conditions (FC) scale's four items also exhibited acceptable reliability (α = .734). Trust, although measured with only two items, had a Cronbach's alpha slightly below the acceptable threshold (α = .610), suggesting that the items may not be as closely related. The Perceived Risk (PR) scale included seven items and reported a Cronbach's alpha just above the lower limit of acceptability (α = .612), indicating marginal reliability. Lastly, the Behavioral Intention (BI) scale showed excellent reliability with a Cronbach's alpha of .874 for its four items.

These reliability coefficients suggest that most scales used in the study to measure constructs related to the adoption of teledentistry among dental professionals are reliable. However, the Trust and Perceived Risk scales may require further investigation or the addition of more items to improve their internal consistency (Tavakol & Dennick, 2011).

It is worth noting that reliability has been preserved at higher levels during the different deletions of some items. The Confirmatory Factor Analysis shows the items that have been removed, depending on their loadings. The two trust items that have been deleted are as follows: Teledentistry systems will require me to be cautious with this technology. I fear to use Teledentistry due to loss of my patient's personal data and privacy.

4.6 Normality

The assumption of normality is a key consideration when choosing between parametric and non-parametric tests. Parametric tests assume that the data samples are normally distributed. However, when this assumption is not met, as indicated by the results of the Kolmogorov-Smirnov and Shapiro-Wilk tests in Table 4.4, it is commonly argued that non-parametric tests should be used.

Table 4-4 Normality tests

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Performance expectancy (PE)	.094	146	.003	.968	146	.002
Effort Expectancy (EE)	.121	146	.000	.968	146	.002
Facilitating Conditions (FC)	.074	146	.052	.988	146	.267
Trust (T)	.138	146	.000	.955	146	.000
Perceived risk (PR)	.089	146	.006	.975	146	.008
Behavioral Intention (BI)	.130	146	.000	.946	146	.000
Social Influence (SI)	.103	146	.001	.973	146	.006
a. Lilliefors Significance Correction						

Despite this, there is a prevailing argument within statistical circles that parametric tests can still be robust and valid under conditions of non-normality, particularly when the sample size is large (Central Limit Theorem). According to the Central Limit Theorem, the sampling distribution of the mean will be normally distributed if the sample size is large enough (typically $n > 30$), regardless of the distribution of the population. With a sample size greater than 100 respondents, as in the current study, the Central Limit Theorem assures that the means of the samples are well-approximated by a normal distribution, making the use of parametric tests such as t-tests and ANOVAs statistically valid (Schmider *et al*., 2010).

Furthermore, empirical studies have found that parametric tests have more power than their non-parametric counterparts and are, therefore, more likely to detect true effects when they exist (Lumley *et al*., 2002). This is especially relevant in cases where the departure from normality is not extreme. Therefore, even though the normality tests have indicated significant deviations from normality for some variables, the robustness of parametric tests given the sample size of more than 100 respondents can be argued.

4.7 Aggregated view of the construct items

4.7.1 Performance expectancy

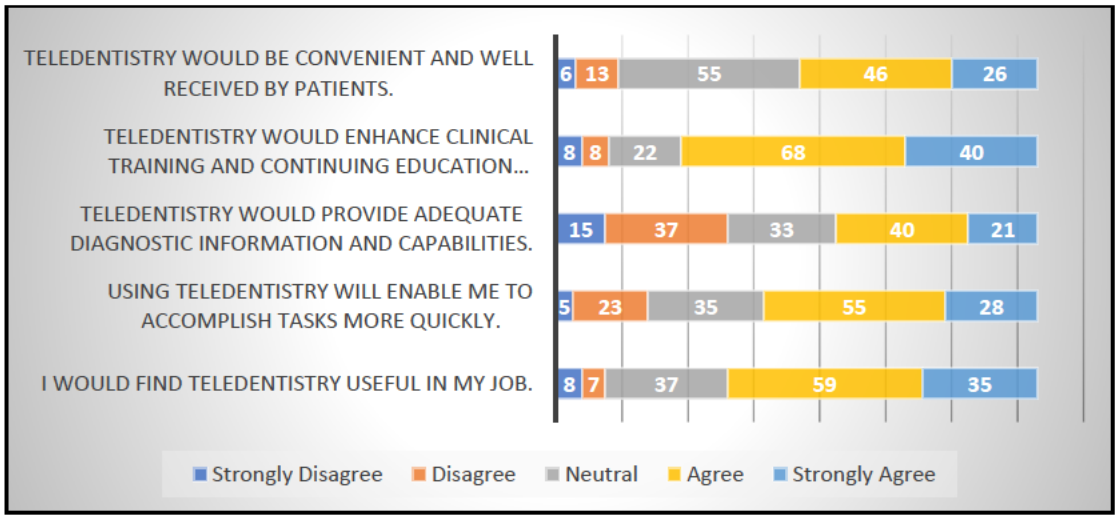

Figure 4-4 Aggregate view of PE

The aggregated count of responses to the questionnaire items pertaining to the construct of Performance Expectancy (PE) is illustrated in Figure 4.4. An analysis of the PE for teledentistry reveals several interesting patterns among the respondents. A significant majority of dental professionals agree or strongly agree that teledentistry would be useful in their job (64.4%), enable them to accomplish tasks more quickly (56.9%), and enhance clinical training and Continuing Education Programs (CEP) (73.9%). These figures suggest a strong acknowledgment of the potential benefits and efficiencies teledentistry could bring to their professional practice.

However, there is a relatively high percentage of neutrality on whether teledentistry would provide adequate diagnostic information and capabilities (22.6% neutral) and on its convenience and reception by patients (37.7% neutral). This neutrality could indicate a cautious optimism about teledentistry, with some professionals possibly requiring more evidence or personal experience with the technology before fully endorsing its capabilities.

The pattern of responses indicates a general positive expectation toward teledentistry, with the strongest consensus around its role in enhancing clinical training and education. The least certainty is about the adequacy of diagnostic information, which is crucial for clinical decision-making. Addressing these concerns could involve targeted demonstrations of teledentistry's effectiveness in providing diagnostic information and its convenience for patients to further encourage its adoption.

The data underscores the importance of teledentistry as a beneficial tool in dental practice, with potential implications for training, efficiency, and patient care, despite some areas where confidence in the technology could be improved.

4.7.2 Effort expectancy

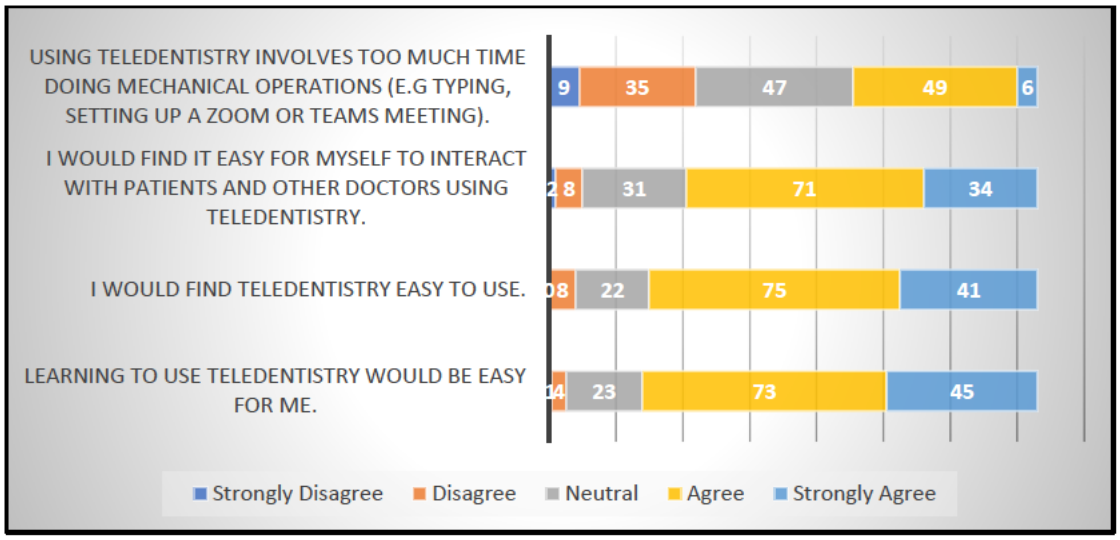

Figure 4-5 Aggregate view of EE

The aggregated count of responses to the questionnaire items pertaining to the construct of Effort Expectancy (EE) is illustrated in Figure 4.5. For EE related to Teledentistry, the data reveals a generally positive attitude among respondents towards adopting and using this technology. A significant majority (80.8% for learning to use, 79.5% for ease of use) expressed confidence, agreeing or strongly agreeing that learning and using Teledentistry would be easy. In terms of user interaction, 71.9% agreed or strongly agreed that it would be easy to interact with patients and other doctors, indicating optimism about the ease of interaction. However, opinions were more divided regarding the time spent on mechanical operations like typing and setting up meetings, with 37.7% disagreeing or strongly disagreeing about it being burdensome, 38.4% neutral, and 24.2% agreeing or strongly agreeing, suggesting some concerns about the time investment in these operations. This mixed response highlights a generally positive outlook towards Teledentistry, albeit with reservations about its mechanical aspects.

4.7.3 Social influence

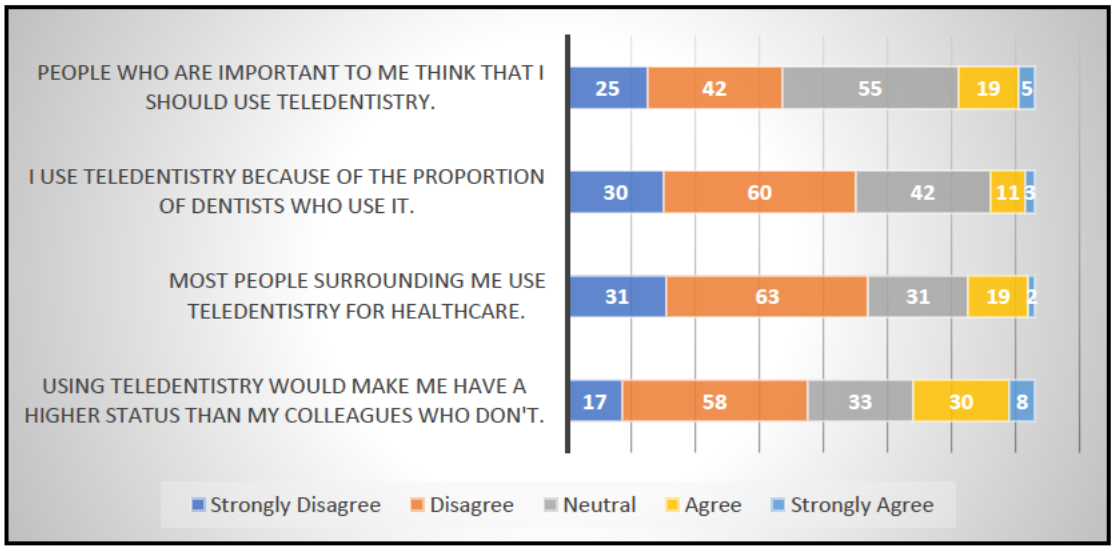

Figure 4-6 Aggregate view of SI

The aggregated count of responses to the questionnaire items pertaining to the construct of Social Influence (SI) is illustrated in Figure 4.6. The concept of SI on the adoption of teledentistry among dental professionals does not appear to be a strong motivator. A majority of respondents disagreed or strongly disagreed with the statement that using teledentistry would confer a higher status compared to colleagues who do not use it (51.3%). Similarly, a predominant number of participants disagreed or strongly disagreed with the notion that most people surrounding them use teledentistry for healthcare (64.4%), and a significant number also indicated that their use of teledentistry is not influenced by the proportion of other dentists who use it (61.6%).

However, when it comes to the perceptions of important people in their lives, the responses shift toward a more neutral stance, with 37.7% neither agreeing nor disagreeing that important others think they should use teledentistry. This suggests that while peer adoption and perceived status may not strongly influence the decision to use teledentistry, the opinions of valued individuals hold more weight in decision-making.

These patterns suggest that social factors related to status and peer behavior are less likely to influence the use of teledentistry, whereas the influence of significant others may be more pertinent, though still not decisively so. The relative neutrality on this latter point indicates a potential area where opinions of valued peers or mentors might be influential if they were to more strongly endorse teledentistry.

4.7.4 Facilitating conditions

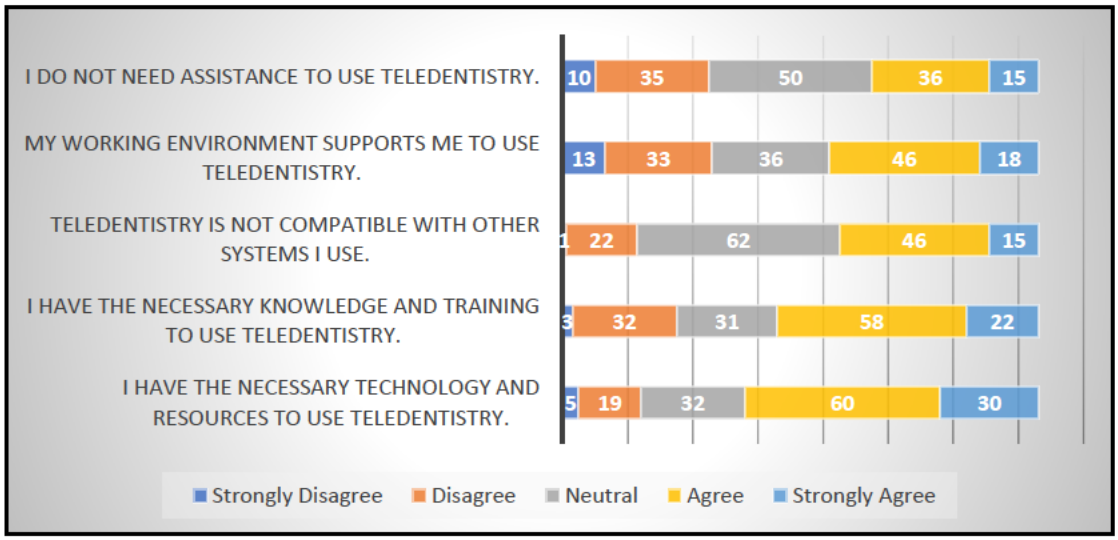

Figure 4-7 Aggregate view of FC

The aggregated count of responses to the questionnaire items pertaining to the construct of Facilitating Conditions (FC) is illustrated in Figure 4.7. The analysis regarding FC for the use of teledentistry among dental professionals reveals several noteworthy patterns. An interpretation in APA style would consider the spread of responses across various aspects that facilitate or impede the use of teledentistry:

The distribution of responses suggests a moderate level of agreement among participants regarding the presence of facilitating conditions for the adoption of teledentistry. A significant proportion of respondents agree or strongly agree that they have the necessary technology and resources (61.6%) and the necessary knowledge and training (54.8%) to use teledentistry. This indicates that, from a resource and knowledge standpoint, a majority of the respondents feel moderately equipped to adopt teledentistry in their practice.

However, perceptions about the compatibility of teledentistry with other systems and the supportiveness of the working environment present a more varied picture. While 41.8% agree or strongly agree that teledentistry is compatible with other systems, a notable 42.5% remain neutral on this aspect, indicating uncertainty or variability in experiences with system integration. Similarly, for the statement regarding the supportiveness of their working environment towards using teledentistry, 43.8% agree or strongly agree, but a substantial 24.7% are neutral.

The response to the need for assistance in using teledentistry further highlights this ambivalence. While a combined 35.0% agree or strongly agree that they do not need assistance,

a considerable 34.2% are neutral, and 30.8% disagree or strongly disagree, suggesting that there is a significant segment of the population that might require additional support.

These patterns suggest that while there are encouraging signs of readiness in terms of technology, knowledge, and resources, there is also a notable level of uncertainty or perceived lack of complete preparedness. The neutral responses and the perceived need for additional support highlight areas where targeted interventions, such as training programs or system integration support, could further facilitate the adoption of teledentistry.

4.7.5 Trust

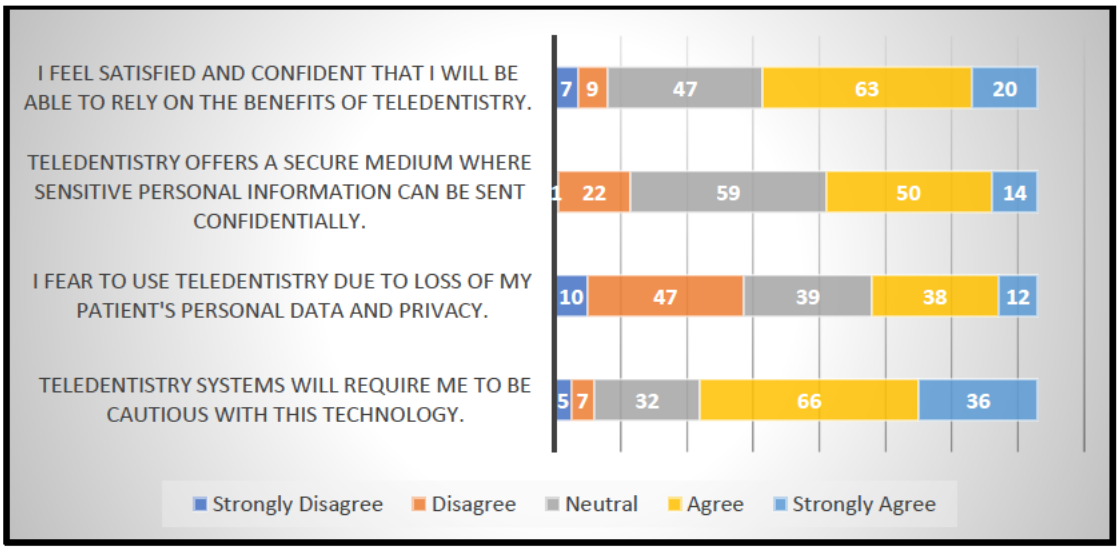

Figure 4-8 Aggregate view of Trust

The aggregated count of responses to the questionnaire items pertaining to the construct of Trust (T) is illustrated in Figure 4.8.

Cautious Approach to Teledentistry: A significant majority of respondents (70.9% combined Agree and Strongly Agree) acknowledge that teledentistry systems require them to be cautious. This high level of agreement indicates a prevalent perception that, while teledentistry is beneficial, it necessitates careful handling, likely due to concerns about data security, technology reliability, or patient privacy.

Concerns about Data Privacy and Security: The response to fears about the loss of patient data and privacy is quite varied. A total of 34.2% (combined Agree and Strongly Agree) express concern about this aspect of teledentistry, while 39.0% (combined Disagree and Strongly Disagree) are less concerned, and 26.7% remain neutral. This spread suggests a divided opinion among dental professionals, with a significant portion expressing apprehension about the security of patient data in teledentistry.

Confidence in Secure Data Transmission: Despite some concerns about data security, a majority (74.8% combined Agree and Strongly Agree) believe that teledentistry offers a secure medium for transmitting sensitive personal information. This indicates a general confidence in the security protocols of teledentistry platforms, which is crucial for the trust and acceptance of such technology in healthcare practices.

Satisfaction and Confidence in Teledentistry: Regarding the satisfaction and confidence in relying on the benefits of teledentistry, 56.9% (combined Agree and Strongly Agree) feel positive about it. However, a sizable proportion (32.2%) remains neutral, indicating that while there is a general sense of trust in the efficacy and advantages of teledentistry, some professionals might still be evaluating its benefits or waiting for more evidence of its effectiveness.

These patterns suggest that while there is a baseline of trust in teledentistry's capabilities and security, concerns about data privacy and the need for cautious usage are still prevalent. This highlights the importance of robust security measures, clear data protection protocols, and ongoing education about the safe and effective use of teledentistry to build higher levels of trust among dental professionals.

4.7.6 Perceived risk

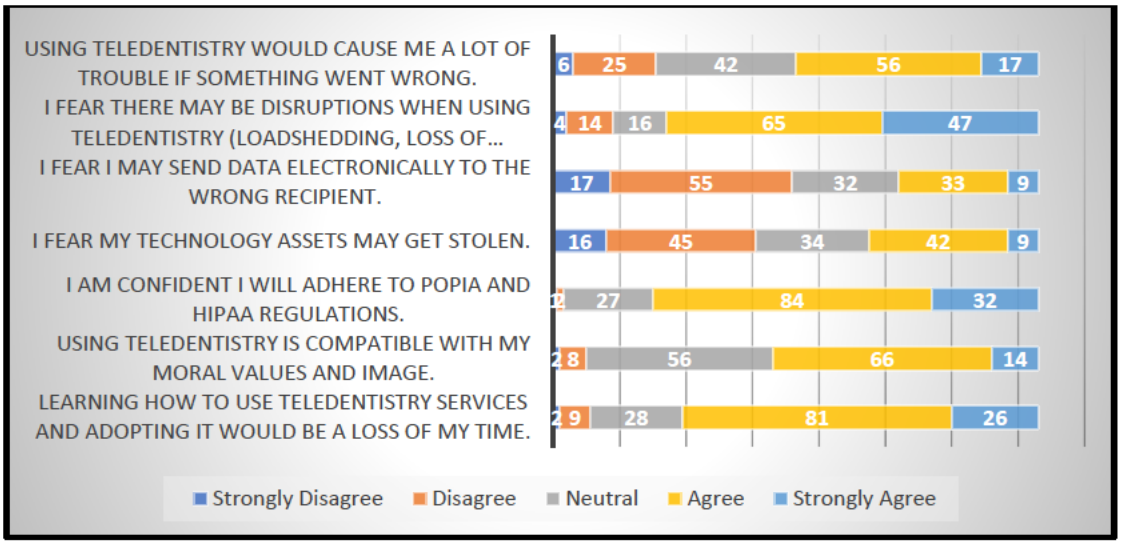

Figure 4-9 Aggregate view of PR

The aggregated count of responses to the questionnaire items pertaining to the construct of Perceived Risk (PR) is illustrated in Figure 4.9.

The participants expressed varying levels of agreement with statements concerning Teledentistry's impact on their time, moral values, adherence to regulations, fear of technology

theft, erroneous data transmission, potential disruptions, and trouble caused by malfunctions. A notable pattern emerged where a majority of respondents agreed (55.5%) or strongly agreed (17.8%) that learning to use and adopting Teledentistry services would not be a loss of time. Compatibility with moral values and image was also seen positively, with 45.2% agreeing and 9.6% strongly agreeing. Confidence in adhering to POPIA and HIPAA regulations was high, with 57.5% agreeing and 21.9% strongly agreeing.

Concerns over technology theft and sending data to the wrong recipient were significant, with 30.8% disagreeing and 11.0% strongly disagreeing with the former, and 37.7% disagreeing with the latter. Fear of disruptions due to load shedding or internet issues was a concern, with 44.5% agreeing and 32.2% strongly agreeing that this was a potential risk. Additionally, 38.4% agreed and 11.6% strongly agreed that using Teledentistry could cause a lot of trouble if something went wrong.

4.7.7 Behavioral intention

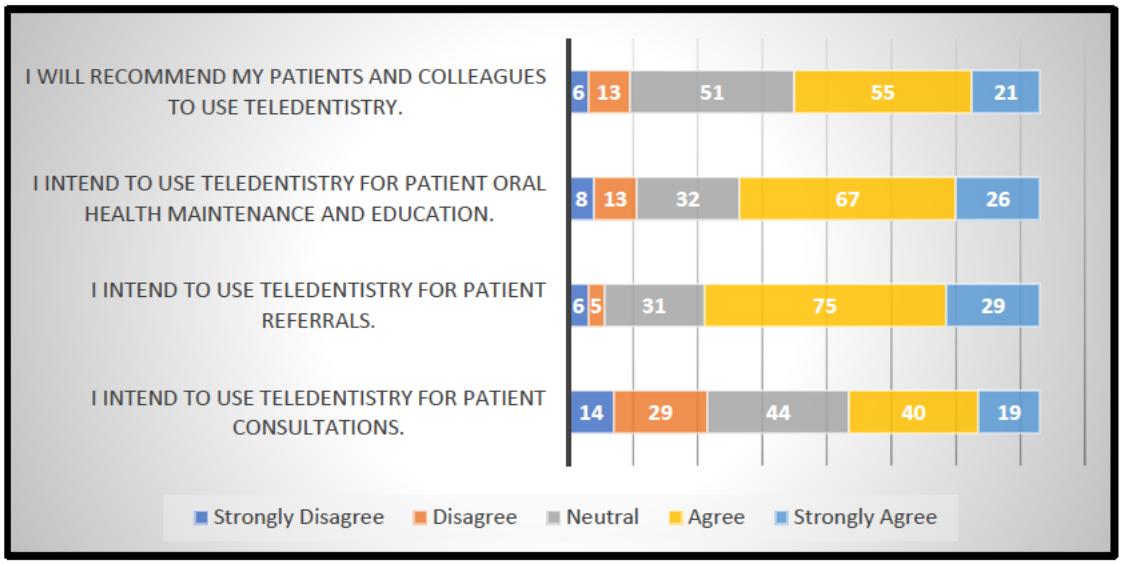

Figure 4-10 Aggregate view of BI

The aggregated count of responses to the questionnaire items pertaining to the construct of Behavioural Intention (BI) to use teledentistry is illustrated in Figure 4.10. Within the sample, the BI to use teledentistry for patient consultations, referrals, oral health maintenance, and education, as well as recommendations to patients and colleagues, was measured. The responses were distributed across five categories: Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree.

A considerable number of respondents indicated a positive intention to use teledentistry for patient referrals (71.3% combined Agree and Strongly Agree), and for patient oral health

maintenance and education (63.7% combined Agree and Strongly Agree). This suggests a high level of acceptance and a propensity to integrate teledentistry into these aspects of their professional practice. Moreover, recommendations to patients and colleagues to use teledentistry (52.1% combined Agree and Strongly Agree) further reflect a favorable attitude towards the adoption of teledentistry.

However, a notable proportion of respondents remained Neutral or undecided regarding these intentions (30.1% for patient consultations, 21.2% for referrals, and 21.9% for oral health maintenance and education). This neutrality could reflect uncertainties about the adoption of teledentistry or a lack of sufficient information to form a definitive opinion. The data indicates that while there is a significant inclination among dental professionals to adopt teledentistry for various aspects of their practice, there is also a degree of reservation. Efforts to address these reservations could involve providing additional information on the benefits and practicalities of teledentistry, thereby potentially increasing the positive response towards its adoption.

4.8 One sample t-test

A series of one-sample t-tests were conducted to determine if the mean scores of various constructs related to the adoption of teledentistry were significantly different from the neutral midpoint of 3.00 on a five-point Likert scale. The results indicated that all constructs, except for Social Influence (SI), were rated significantly higher than the midpoint, suggesting that respondents tended to agree with the items.

As casn be observed in Table 5.4, Performance Expectancy (PE) ($M = 3.5425$, $SD = .89040$) was significantly higher than the neutral point, $t(145) = 7.361$, $p < .001$, with a mean difference of .5425 and a large effect size (Cohen's $d = .89040$). Effort Expectancy (EE) had the highest mean score ($M = 3.7551$, $SD = .64492$), $t(145) = 14.148$, $p < .001$, with a mean difference of .7551, indicating a very large effect size (Cohen's $d = .64492$). Facilitating Conditions (FC), Trust (T), Perceived Risk (PR), and Behavioral Intention (BI) also showed significant differences from the midpoint with large effect sizes, suggesting these constructs are important in the context of teledentistry adoption.

Table 4-5 One sample Aggregate Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Performance expectancy (PE)	146	3.5425	.89040	.07369
Effort Expectancy (EE)	146	3.7551	.64492	.05337
Facilitating Conditions (FC)	146	3.3301	.73441	.06078
Trust (T)	146	3.4589	.78456	.06493

Perceived risk (PR)	146	3.4706	.52954	.04383
Behavioral Intention (BI)	146	3.5120	.88050	.07287
Social Influence (SI)	146	2.4623	.82490	.06827

Conversely, Social Influence (SI) (M = 2.4623, SD = .82490) was rated significantly lower than the midpoint, t(145) = -7.876, p < .001, with a mean difference of -.5377 and a large negative effect size (Cohen's d = -.82490). This indicates a disagreement with the SI items and suggests that social factors may not play a strong role in the intention to use teledentistry among the respondents.

The One sample t-tests were conducted on each of the constructs where a test value of 3 was as the comparison statistic (shown in Table 4.6)

Table 4-6 One sample tests

	Test Value = 3.00					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Performance expectancy (PE)	7.361	145	.000	.54247	.3968	.6881
Effort Expectancy (EE)	14.148	145	.000	.75514	.6496	.8606
Facilitating Conditions (FC)	5.432	145	.000	.33014	.2100	.4503
Trust (T)	7.068	145	.000	.45890	.3306	.5872
Perceived risk (PR)	10.739	145	.000	.47065	.3840	.5573
Behavioral Intention (BI)	7.026	145	.000	.51199	.3680	.6560
Social Influence (SI)	-7.876	145	.000	-.53767	-.6726	-.4027

As can be observed in Table 4.6, the mean values for each of the constructs where significant ($p<0.05$) thereby suggesting that the mean values were not obtained by chance and provided an accurate aggregation of the data obtained for these constructs.

The effect sizes (shown in Table 4.7), represented by Cohen's d and adjusted by Hedges' correction for small sample bias, were large for most constructs, indicating that the differences observed are not only statistically significant but also of practical significance (Cohen, 1988).

Table 4-7 One sample effect sizes

		Standardizer[a]	Point Estimate	95% Confidence Interval	
				Lower	Upper
Performance expectancy (PE)	Cohen's d	.89040	.609	.432	.785
	Hedges' correction	.89503	.606	.429	.781
Effort Expectancy (EE)	Cohen's d	.64492	1.171	.959	1.380

	Hedges' correction	.64828	1.165	.954	1.373
Facilitating Conditions (FC)	Cohen's d	.73441	.450	.279	.619
	Hedges' correction	.73824	.447	.277	.616
Trust (T)	Cohen's d	.78456	.585	.408	.760
	Hedges' correction	.78865	.582	.406	.756
Perceived risk (PR)	Cohen's d	.52954	.889	.696	1.079
	Hedges' correction	.53230	.884	.692	1.074
Behavioral Intention (BI)	Cohen's d	.88050	.581	.405	.756
	Hedges' correction	.88509	.578	.403	.752
Social Influence (SI)	Cohen's d	.82490	-.652	-.830	-.472
	Hedges' correction	.82920	-.648	-.825	-.470

a. The denominator used in estimating the effect sizes.

Cohen's d uses the sample standard deviation.

Hedges' correction uses the sample standard deviation, plus a correction factor.

4.9 Pearson correlation

The calculated Pearson correlation coefficient was used to explain relationships between Behavioral Intention (BI) to use teledentistry and various predictors within a sample of dental professionals (N = 146). The results, as shown in Table 4.8.

Table 4-8 Correlations

		Behavioral Intention (BI)	Performance expectancy (PE)	Effort Expectancy (EE)	Facilitating Conditions (FC)	Trust (T)	Perceived risk (PR)	Social Influence (SI)
Behavioral Intention (BI)	Pearson Correlation	--						
	N	146						
Performance expectancy (PE)	Pearson Correlation	.690**	--					
	Sig. (2-tailed)	.000						
	N	146	146					
Effort Expectancy (EE)	Pearson Correlation	.455**	.457**	--				
	Sig. (2-tailed)	.000	.000					
	N	146	146	146				
Facilitating Conditions (FC)	Pearson Correlation	.282**	.125	.513**	--			
	Sig. (2-tailed)	.001	.133	.000				
	N	146	146	146	146			
Trust (T)	Pearson Correlation	.572**	.637**	.523**	.207*	--		
	Sig. (2-tailed)	.000	.000	.000	.012			
	N	146	146	146	146	146		
Perceived risk (PR)	Pearson Correlation	.351**	.419**	.115	-.051	.100	--	
	Sig. (2-tailed)	.000	.000	.165	.544	.229		
	N	146	146	146	146	146	146	
Social Influence (SI)	Pearson Correlation	.461**	.520**	.217**	.177*	.359**	.160	--

	Sig. (2-tailed)	.000	.000	.009	.032	.000	.054	
	N	146	146	146	146	146	146	146

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

These results have been interpreted according to the 5-stage framework suggested in Agresti (2018, p. 140). The framework consists of *assumptions*, *hypotheses*, *test statistic*, *p-value* and *conclusions* about the data. A hypothesis testing approach is suggested where the null hypothesis (H_0) is a statement that the test parameter assumes a specific neutral value or a range of values and the alternate hypothesis (H_a) assumes an alternative range of values.

Performance Expectancy (PE)

PE was identified as an independent variable in the study and it was correlated with the study's dependent variable named Behavioural Intention (BI). In order to provide a concise empirical report of the outcome of this analysis, a hypothesis testing approach was used. The null ($H1_0$) and alternate hypotheses ($H1_a$) are stated as:

$H1_0$: *PE has no influence on the BI to adopt teledentistry in South Africa*

$H1_a$: *PE has a positive influence on the BI to adopt teledentistry in South Africa*

From Table 4.8 it can be observed that PE has a ***strong positive correlation*** with BI ($r = .690$, $p < .001$). This result suggests that the performance required to use teledentistry is a significant factor in determining whether dentists have a BI to use teledentistry.

Effort Expectancy (EE)

EE was identified as an independent variable in the study and it was correlated with the study's dependent variable named Behavioural Intention (BI). In order to provide a concise empirical report of the outcome of this analysis, a hypothesis testing approach was used. The null ($H1_0$) and alternate hypotheses ($H1_a$) are stated as:

$H2_0$: *EE has no influence on the BI to adopt teledentistry in South Africa*

$H2_a$: *EE has a positive influence on the BI to adopt teledentistry in South Africa*

From Table 4.8 it can be observed that EE has a ***moderate positive correlation*** with BI ($r = .455$, $p < .001$). This result suggests that the effort required to use teledentistry is a significant factor in determining whether dentists have a BI to use teledentistry.

Social Influence (SI)

SI was identified as an independent variable in the study and it was correlated with the study's dependent variable named Behavioural Intention (BI). In order to provide a concise empirical report of the outcome of this analysis, a hypothesis testing approach was used. The null ($H1_0$) and alternate hypotheses ($H1_a$) are stated as:

$H3_0$: *SI has no influence on the BI to adopt teledentistry in South Africa*

$H3_a$: *SI has a positive influence on the BI to adopt teledentistry in South Africa*

From Table 4.8 it can be observed Social Influence (SI) had a ***moderate positive correlation*** with BI ($r = .461$, $p < .001$), which supports the notion that social factors, such as the opinions of important others, can influence individuals' intentions to use new technologies (Venkatesh & Davis, 2000).

Facilitating conditions (FC)

FC was identified as an independent variable in the study and it was correlated with the study's dependent variable named Behavioural Intention (BI). In order to provide a concise empirical report of the outcome of this analysis, a hypothesis testing approach was used. The null ($H1_0$) and alternate hypotheses ($H1_a$) are stated as:

$H4_0$: *FC has no influence on the BI to adopt teledentistry in South Africa*

$H4_a$: *FC has a positive influence on the BI to adopt teledentistry in South Africa*

From Table 4.8 it can be observed Facilitating Conditions (FC) were found to have a weak but significant positive correlation with BI ($r = .282$, $p = .001$), indicating that having the necessary resources and support slightly influences the intention to use teledentistry.

Trust (T)

Trust was identified as an independent variable in the study and it was correlated with the study's dependent variable named Behavioural Intention (BI). In order to provide a concise

empirical report of the outcome of this analysis, a hypothesis testing approach was used. The null ($H1_0$) and alternate hypotheses ($H1_a$) are stated as:

$H5_0$: *Trust has no influence on the BI to adopt teledentistry in South Africa*

$H5_a$: *Trust has a positive influence on the BI to adopt teledentistry in South Africa*

From Table 4.8 it can be observed that Trust (T) in the technology showed a similarly ***moderate positive correlation*** with BI ($r = .572$, $p < .001$), aligning with literature that suggests trust as a critical factor in technology acceptance (Mayer *et al*., 1995).

Perceived Risk (PR)

PR was identified as an independent variable in the study and it was correlated with the study's dependent variable named Behavioural Intention (BI). In order to provide a concise empirical report of the outcome of this analysis, a hypothesis testing approach was used. The null ($H1_0$) and alternate hypotheses ($H1_a$) are stated as:

$H6_0$: *PR has no influence on the BI to adopt teledentistry in South Africa*

$H6_a$: *PR has a negative influence on the BI to adopt teledentistry in South Africa*

From Table 4.8 it can be observed that PR was ***positively correlated*** with BI ($r = .351$, $p < .001$), which is somewhat counterintuitive as risk is often expected to have a negative influence on technology adoption. This may warrant further investigation to understand the context in which perceived risk increases the likelihood of adopting teledentistry.

These correlations suggest that factors such as performance expectancy, effort expectancy, trust, and social influence are significantly associated with the behavioral intention to use teledentistry, which is in line with constructs from the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT).

4.10 Multiple Regression analysis

A multiple regression analysis was conducted to predict Behavioral Intention (BI) to use teledentistry among dental professionals, with Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Trust (T), and Perceived Risk (PR) as predictors. The model summary shown in Table 4.9 indicates that the set of predictors accounted for 56.1% of the variance ($R^2 = .561$) in Behavioral Intention, with an adjusted R^2 of .542, suggesting a good fit of the model with the data (Cohen, 1988). The change

in R^2 was significant ($F(6, 139) = 29.616$, $p < .001$), indicating that the predictors significantly explained the variability in the dependent variable, BI.

Table 4-9 Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.749[a]	.561	.542	.59579	.561	29.616	6	139	.000

a. Predictors: (Constant), Social Influence (SI), Perceived risk (PR), Facilitating Conditions (FC), Trust (T), Effort Expectancy (EE), Performance expectancy (PE)

b. Dependent Variable: Behavioral Intention (BI)

The analysis of variance (ANOVA) shown in Table 4.10 shows that the regression model significantly predicted Behavioral Intention ($F(6, 139) = 29.616$, $p < .001$), with the model explaining a significant portion of the variance in BI scores (63.076 out of 112.417 total variance).

Table 4-10 ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	63.076	6	10.513	29.616	.000[b]
	Residual	49.340	139	.355		
	Total	112.417	145			

a. Dependent Variable: Behavioral Intention (BI)

b. Predictors: (Constant), Social Influence (SI), Perceived risk (PR), Facilitating Conditions (FC), Trust (T), Effort Expectancy (EE), Performance expectancy (PE)

The lsiting of coefficients shown in Table 4.11 provides the unstandardized (B) and standardized (Beta) coefficients, which reveal the individual contribution of each predictor. Performance Expectancy was the strongest predictor ($B = .387$, $\beta = .391$, $p < .001$), followed by Trust ($B = .236$, $\beta = .210$, $p = .009$), Perceived Risk ($B = .248$, $\beta = .149$, $p = .021$), and Facilitating Conditions ($B = .183$, $\beta = .153$, $p = .025$). Effort Expectancy and Social Influence were not significant predictors in this model, with p-values of .574 and .073, respectively.

Table 4-11 Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.689	.454		-1.516	.132
	Performance expectancy (PE)	.387	.091	.391	4.268	.000
	Effort Expectancy (EE)	.060	.106	.044	.564	.574
	Facilitating Conditions (FC)	.183	.081	.153	2.272	.025
	Trust (T)	.236	.089	.210	2.639	.009

	Perceived risk (PR)	.248	.106	.149	2.329	.021
	Social Influence (SI)	.129	.072	.121	1.809	.073

a. Dependent Variable: Behavioral Intention (BI)

This analysis suggests that among the factors considered, Performance Expectancy, Trust, Perceived Risk, and Facilitating Conditions are significant predictors of Behavioral Intention to adopt teledentistry, which aligns with findings from prior research on technology acceptance models (Venkatesh & Davis, 2000).

4.11 Open-ended question analysis

Section C of the online questionnaire comprised of an open-ended question that aimed to capture additional/open ended comments based on dentist and dental specialists' perceptions/experiences of using teledentistry as a strategy to enhance/enable dental services offered in South Africa. The addition of an open-ended component allowed participants to further elaborate on their perceptions on the topic, offering further insight to their close-ended question responses. This also provided a basis for improved discussion regarding the research questions. Combining the "what" of quantitative research with the "why" of qualitative research increases the confidence in providing adequate findings (O'Cathain, Murphy, & Nicholl, 2007).

The descriptive phenomenological approach was adopted to report the findings obtained from the close-ended question. Phenomenology asserts that the world and human beings are inseparable entities that share an unquestioned relationship with each other. One exists because of the world they live in, and the world revolves around the existence of such individuals. This topic had been developed by Edmond Husserl who defined phenomenology according to two divisions: descriptive and interpretive phenomenology, of which descriptive phenomenology is most commonly used (Dodgson, 2023). As described in Chapter 3, descriptive phenomenology involved identifying units of meaning usually through words or sentences, and synthesizing or collating these units into structured statements, usually by identifying commonalities through themes.

There were a promising number of responses to the open-ended component, with minor omissions from some respondents stating N/B as a response, which may have been due to personal time constraints, or a lack of significant understanding on the topic. Data was imported into a Microsoft Excel spreadsheet, and thereafter imported into NVivo where the data was read, and then re-read to reinforce ones understanding of the data. Thereafter themes were broadly identified from measurement units, which were frequent keywords coded on the

qualitative software NVivo. The frequency of the meaning units and themes identified from these meaning units is illustrated in Figure 4.11.

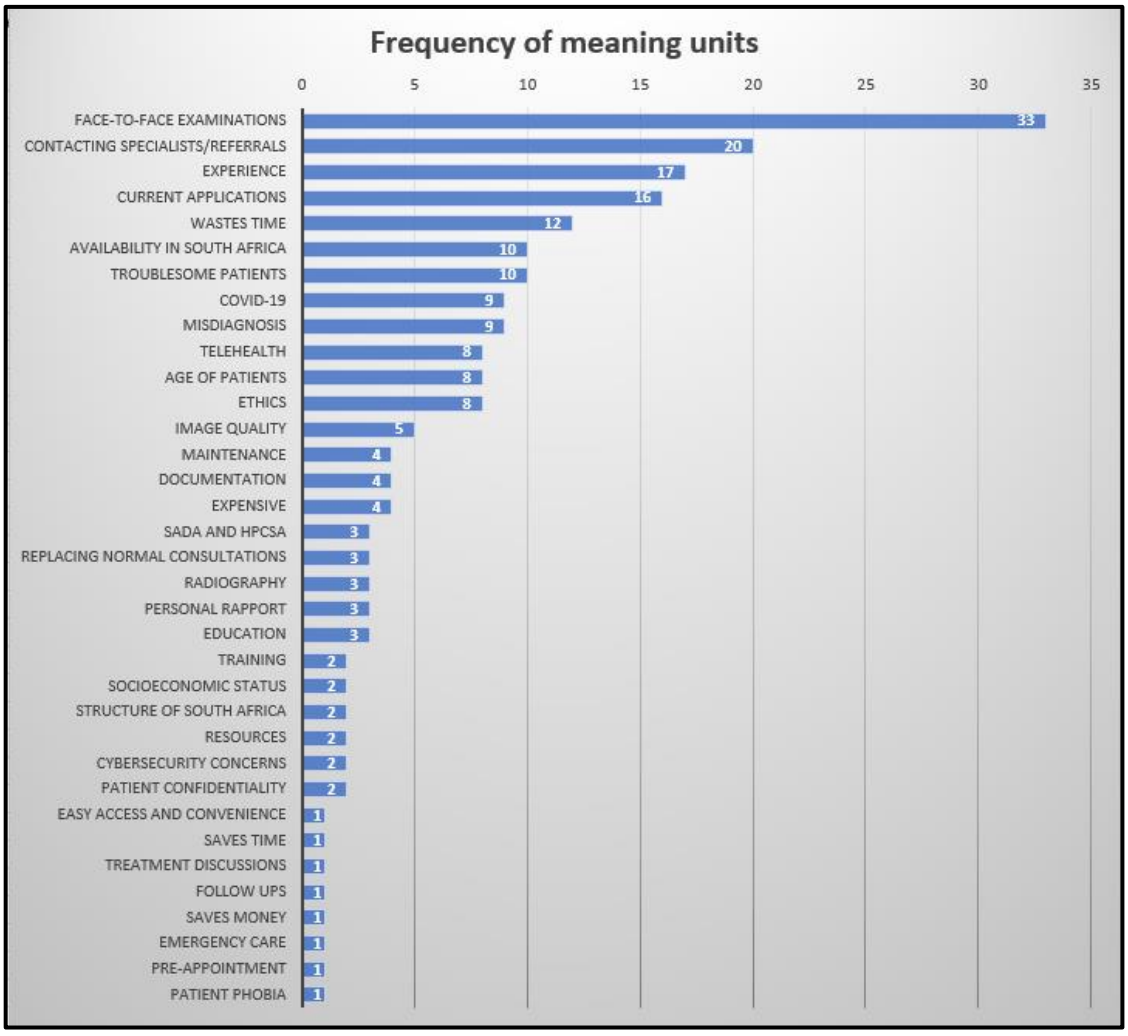

Figure 4-11 Frequency of meaning units

The three highest occurring meaning units were discussions around the importance of face-to-face examinations, making use of teledentistry for patient referrals, and the amount of experience dentists and dental specialists have with teledentistry. Furthermore, the six themes that were identified from the above and remaining meaning units are discussed below.

1. Inclinations towards in-person consultations

- **Face-to-face examinations**

  Participants passionately agreed that teledentistry should act as an enabler to dentistry, rather than a replacement. Clinicians fear that limiting dental treatment to digital means may be detrimental to diagnosis and treatment plans. A hybrid form of teledentistry could be achieved through the asynchronous form, where data such as patient information or

pictures are stored, and later shared with other dental professionals. This would promote a hybrid approach to teledentistry for dental professionals that are hesitant on fully adopting teledentistry in their practices.

Respondent 1: *"Teledentistry should not replace a face-to-face consultation as this would leave me open to missing information and having an incorrect diagnosis."*

Respondent 2: *"There is no definitive treatment that can be offered for any dental problem through teledentistry. Perhaps, teledentistry could have a place in guiding, educating and following up. But it can in now way replace a physical consult. Any treatment plan offered through teledentistry should not be considered as final."*

Participants pointed out that they utilize some forms of teledentistry, such as Vula software in government, and pictures, videos, and digital models are being sent by secure software links or emails. However, there was no mention of specialized software to promote online consultations as dental professionals emphasize that they prefer a hands-on approach to treat their patients since dentistry is a hands-on occupation.

Respondent 3: *"I would find it useful for diagnostic purposes only. Treatment is not possible with teledentistry. We already use Vula for referrals in government."*

Respondent 4: *"Most of dentistry requires requires physical examination and diagnosis in a chair. The only use I see for dentistry is education, marketing and promotions. Sending and receiving photos and videos, digital models to labs etc are already being done via secure software links or simply email. I feel "Tele" is more suitable for Medicine consultations than dentistry."*

- **Radiography**

  Adequate diagnosis of dental anomalies requires one to capture radiographs of the intra-oral cavity. Some participants expressed concerns of the capabilities of teledentistry to supply diagnostic capabilities that a radiograph would supply.

Respondent 5: *"From the little experience I had using it during the pandemic, it is quite difficult to get patients to explain their main complaint and send good quality pictures of exactly it is you want to see. Majority of dental patients also require x-rays, so not sure how that would work?"*

Respondent 6: *"Assessing a patient for an oral condition requires a thorough intra- and extra-oral examination, and in most cases requires taking radiographs."*

- **Personal rapport**

  The physical aspect of any medical profession creates a sense of rapport between the patient and clinician. Interestingly this was evident where a few participants had a passionate outlook on concerns that teledentistry may be detrimental to trust built during in-person consultations.

  Respondent 7: *"Dentistry consultations involve assessments that cannot be attended to over the phone.*

  As a result of these over the phone/video conferencing methods of communication one loses the personal aspect which is the basis of rapport in dentistry."

  Respondent 8: *"We need to meet our patients, physically assess them as gently as possible such that we build trust in them. Personally i would not like another person whom I don't trust assessing my patients.*

  One of the most important parts of the consultation is documentation. These video meetings do not allow me to photograph my patients oral cavities for documentation and continuous management.

  Personally, i believe the move into remote services will be detrimental to the dental care industry and would prefer that it is not a widely adopted approach.

  In the short life we have, the connections we make with our patient are some of the most beautiful parts of being a dentist."

  Therefore, dental professionals are not aware of ways to build trust over digital platforms which may be overcome by educating the dental professional population and patients on ways this can be achieved.

2. **Experience with teledentistry**

While there has been a promising number of clinicians that utilize, and highlight the advantages of teledentistry in their practice, some have reported not having used it in their practice before. However, it was mentioned that given the necessary time and resources, this would facilitate one to incorporate teledentistry into their practice indicating that individuals would not mind adopting it in their practice.

Respondent 9: *"I am yet to use Teledentistry but I believe that it has its benefits and downfalls. However, it is something I am willing to incorporate into my daily work tasks as it makes things easier for me and my patients."*

Some of the reasons why teledentistry have not been adopted yet in practices are concerns related to whether the rural communities have the resources as well to adopt teledentistry.

Respondent 10: *"I have not yet used teledentistry. However, the world the world is becoming more technologically advanced. Therefore I think I certainly look forward to using teledentistry in the future l.My concern though, is whether the rural communities will be sufficiently equipped to use teledentistry as a form of consultation."*

Furthermore, the accuracy of clinical diagnosis attained from in-person consultations is something that may be preventing clinicians to "step out of their comfort zones"

Respondent 11: *"Personally I have not used teledentistry so often, it is not bad at all. I just prefer a physical consultation for an accurate clinical examination and diagnosis thereof, it makes my life much easier but I would still recommend and of course use teledentistry at times for convenience sake"*

3. **Education and training**

- **Education**

The importance of utilizing teledentistry for both patient and clinician education was emphasized by numerous participants. From a clinician perspective, there has been a preference over using teledentistry to provide oral health education to patients rather than utilizing it for diagnosis and treatment plans.

Respondent 12: *"I think it has a place in clinical prevention and education, and for discussions amongst colleagues. It does not carry much weight in diagnosis and treatment"*

"It can enhance patient education regarding their oral health."

Another observation is that teledentistry is a concept that some clinicians are not educated about, mainly because of the lack of exposure they have had with this technology. It was mentioned that there has been more emphasis placed on telehealth initiatives rather than teledentistry, and it would be beneficial for clinicians to be educated about using this technology.

Respondent 13: *"I was involved in a telehealth pilot programme at Standerton Hospital in 2011. This was prior to the new telehealth guidelines by the HPCSA. We did not do any teledentistry then, and I don't think that teledentistry has kicked off yet, 12 years later. Hopefully there can be education and training about teledentistry so that we can feel more confident to start trying it, if it will help."*

This lack of awareness and knowledge was further emphasized by one participant who indicated that there only exist educational videos on social media platforms instead of facilitated and structured teledentistry programs that could be a driving force to promoting teledentistry in South Africa.

Respondent 14: *"I do not have any experience with teledentistry besides seeing educational videos on social media platforms for patient education."*

- **Training**

  Training is a vital component to any occupation, and this had been emphasized by participants that the successful adoption of teledentistry would require dental professionals to be trained adequately. This would make it easier for not just the primary dental practitioner, but also those working around them.

Respondent 15: *"It would require the entire dental team to be efficient in teledentistry to make it easier for the dr."*

Respondent 16: *"It requires some technological dexterity and training but once you know the system it simplifies dentistry."*

Respondent 17: *"We need training to be able to implement teledentistry"*

4. **Resource and infrastructure capabilities of South Africa to support teledentistry**

Participants expressed a general concern on which population would be able to benefit the most from teledentistry. Some dental professionals are of the opinion that teledentistry would benefit those in the private sector, who come from middle to high socioeconomic backgrounds. However there exists disparities in the public and rural sector where individuals are said to lack resources to fully adopt teledentistry. The public sector would need the necessary funding to support a teledentistry initiative as well. While the private sector are forecasted to benefit from teledentistry since it is convenient, and can provide avenues to promote oral health and education, there has not been a positive outlook amongst South African dental professionals for this technology to be utilized in the public sector.

Respondent 18: *"I think that there is place for teledentistry in South Africa in the private sector aimed at patient education. However, most people seek out dental treatment when they require physical hands on treatment. This is more so in the public sector. Therefore, the scope for teledentistry is very limited"*

Respondent 19: *"A lot of communities don't have access to technology, hence still making it difficult for them to benefit… they are the ones who need dental services, so we would still need to have other systems in place to give them basic services… once they have access to basic dental care- then perhaps using teledentistry might be a very good idea for referrals and second opinions with specialists"*

Furthermore, rural communities would require the knowledge, skills, access, and access to basic dental care services prior to introducing teledentistry

Respondent 20: *"A lot of communities don't have access to technology, hence still making it difficult for them to benefit… they are the ones who need dental services, so we would still need to have other systems in place to give them basic services… once they have access to basic dental care- then perhaps using teledentistry might be a very good idea for referrals and second opinions with specialists"*

5. **Confidentiality and cybersecurity risks**

There exists a general understanding that teledentistry may open avenues for individuals such as "hackers" where personal information may get compromised. Dental professionals

have highlighted that there needs to be secure mediums over which private information is shared

Respondent 21: *"I think its also NB to note that hackers are specifically trained in different delegations of the Internet. To hack into dental and medical patient records and the likes has become increasingly prevalent. If teledentistry were to work, the encryption and security behind such a movement would need to be bulletproof"*

Respondent 22: *"caution must be taken to being careful with sensitive patient information especially when having to send out information. In todays time, hacking is common in all departments and therefore extra caution should be taken as all other departments do when sending patient information."*

Furthermore, there have been concerns raised about teledentistry mediums that use a centralized database which may compromise patient confidentiality. While threats mainly come from external sources, manipulation of data can also be carried out by internal sources such as employees.

Respondent 23: *"Sincerely concerned about misuse of a centralised database by dental professionals- personal experiences have revealed massive disregard for patient confidentiality by colleagues. However, I believe it would be a effective tool if regulated appropriately."*

6. Favored applications of teledentistry by South African dental professionals

Teledentistry can be implemented in various ways, and the ways in which teledentistry can be utilized in South Africa were highlighted by dental professionals. The most favoured application of teledentistry was patient referrals and consulting specialists. Dental professionals believe that this would save time for both the clinician and patient as information can be readily available and passed onto other professionals should multiple opinions be needed.

Respondent 24: *"Teledentistry is something that enables clinicians to learn about different patient cases, it enables us to receive feedback from our fellow dentists and specialists that we do not have in our practice room / clinic. It is an excellent method that can be used to build bridges amongst health professionals and patients when done correctly."*

Respondent 25: *"I think it will definitely be of help as it will reduce patient waiting time when consulting with a different dentist since oral health care practitioner can easily assess their information. It will help dentists to easily ask for advice from their colleagues through teledentistry"*

Respondent 26: *"I believe it is a tool that is a huge benefit for inter-department referrals or communications between different practitioners as well as an efficient and time saving way to learn from each other"*

The capabilities teledentistry would have for patients based in rural areas were indicated as well, as it would save patients on transport costs and promote economic upliftment since employees will be taking less leave to see visit a dental professional.

Respondent 27: *"It would be beneficial especially to patients in rural areas as it will save them transport costs . Furthermore the economy will benefit as it will mean less leave / sick leave to access dental health care"*

Other notable favoured applications of teledentistry are being able to discuss treatment plans efficiently, following up with patients, attending to emergency cases and interestingly eliminating phobias associated with visting the dentist. This is critical element to teledentistry adoption, as dentistry is an occupation marked with fear and anxiety that may come from intolerance of pain.

Respondent 28: *"It can help with emergency care after consulting hours."*
Respondent 29: *"I think it's a great tool for treatment discussions, and to do follow ups."*
Respondent 30: *"it would also help get patients who have a dental phobia to try and get over their fear by knowing what to expect in their appointments and also assist in doing follow up appointments after procedures with patients not physically coming in to see the dentist"*

CHAPTER FIVE – DISCUSSION AND CONCLUSION

5.1 Introduction

South Africa is a country marked by significant levels of oral health disease, with an insufficient number of dental professionals to treat the large population size. Teledentistry is a tool that may resolve the disparities that currently exist with the unequal distribution of dental professionals in the public and rural sectors. The uptake and reception to telehealth and teledentistry has been investigated in numerous countries, however, teledentistry has not been extensively investigated in a South African dental professional context, and the factors influencing the adoption of this technology amongst South African dental professionals. Furthermore, the prevalence of cybersecurity and privacy risks in the healthcare sector cannot be ignored especially when adopting new technologies such as teledentistry. Given South Africa's vulnerability to cybersecurity attacks, perceived risk and trust need to be factored in as factors that may influence teledentistry initiatives.

This study aimed at determining the factors influencing the adoption of teledentistry in South Africa, the role trust and perceived risk have in adopting new technologies such as teledentistry amongst South African dental professionals, and the overall behavioural intention to adopt teledentistry. The discussion and conclusion chapter begins by addressing the above research questions based on the quantitative and qualitative data presented in chapter four (results) in light of previous research, and the implications thereof. The studies conclusion is then discussed, and lastly recommendations for future research and limitations of this study are provided.

5.2 Factors that influence the adoption of teledentistry in South Africa

5.2.1 Performance expectancy

Performance expectancy was determined to be a crucial component to teledentistry adoption indicated by a strong positive correlation with behavioral intention and being statistically significant ($r = .690$, $p < .001$). Furthermore, it explained the most variance in behavioral intention indicating the importance it has in teledentistry adoption amongst South African dental professionals ($B = .387$, $\beta = .391$, $p < .001$).

This finding of PE having the highest correlation with BI is in concordance with numerous studies. Alabdullah *et al*. (2020) found PE to be the highest correlated factor with behavioural intention when investigating factors influencing the adoption of teledentistry amongst final year dentistry students in the USA. Similarly, dental students in Saudi Arabia held performance

expectancy as the most important factor influencing the adoption of teledentistry (Sharka *et al*., 2023). The similarity of this study's findings to the above studies can be attributed to the sample in this study mainly comprising of a younger cohort, as in the case of dental students. This finding is of significance as it indicates that individuals that belong to younger age groups favour the performance gains they get out of using teledentistry the most compared to effort expectancy, social influence, and facilitating conditions.

Furthermore, dental professionals were strongly inclined to favor performance expectancy in terms of usefulness in their job, achieving tasks quickly, and enhancing training and education programs. However, there was marked skepticism regarding the performance expectancy of teledentistry to provide adequate diagnosis and whether patients would receive it appropriately. This finding can be attributed to confidence and competency. The role confidence and competency have in telehealth adoption was investigated with nine nurses in New Zealand during a qualitative study conducted by Honey and Wright (2018). It was highlighted that there are heightened levels of uncertainty and inadequacy when first adopting telehealth (Austen & McGrath, 2006); however, putting in place initiatives where the general population could be educated on proper use reduces the anxiety surrounding the incapabilities of telehealth to address uncertainty around ideals such as diagnostic capabilities and patient reception (Radhakrishnan, Jacelon, & Roche, 2012).

5.2.2 Effort expectancy

Effort Expectancy (EE) had a moderate positive correlation with BI ($r = .455$, $p < .001$), indicating that dental professionals are more likely to use teledentistry systems if they are simple to use.

This finding is similar to numerous other studies in the context of teledentistry and telehealth. Adenuga *et al*. (2017) investigated the factors influencing telemedicine adoption amongst Nigerian clinicians and established that effort expectancy has a significant positive effect on behavioral intention. Similarly, Connoly, Miller, Lindsay, & Bauer (2020) stressed that effort expectancy had the highest impact on behavioural intention in adopting telemental health initiatives. Connoly *et al*. (2020) highlighted that as providers explored telemental health technologies and gained more experience with it their opinions on the amount of effort required to use it decreased. These findings imply that effort expectancy would gradually improve the more dental professionals use teledentistry in their practice.

Most notably this study indicated that there were mixed responses regarding whether teledentistry involved too much time on mechnical processes. Dental professionals were not

certain if setting up teledentistry in their practice would be a time wasting and tedious process. Cobelli, Cassia, and Donvito (2023) investigated the relationship of the market orientation paradigm with UTAUT in investigating pharmacists' attitudes to adopting telemedicine. They established a strong link between the factors of UTAUT and market orientation. This has implications for the above-contended item, as marketers can craft teledentistry initiatives to indicate to dental professionals that their technologies are quick and efficient and don't take much time to set up. This will increase the uptake of teledentistry in dental practices if dental professionals are reassured of the effortless capabilities of teledentistry.

Contrastingly, Woo and Dowding (2020) found effort expectancy is not linked to behavioural intention in patients with health failure. Woo and Dowding (2020) attributed this finding to the types of devices used to initiate telehealth initiatives. Heart failure treatment only requires using a blood pressure cuff, oximeter, and weight scale, which are easy to use. In comparison, teledentistry can involve complex technologies where behavioural intention could be altered if substantial effort is required.

5.2.3 Social influence

Social Influence (SI) had a moderate positive correlation with BI ($r = .461$, $p < .001$), which supports the notion that social factors, such as the opinions of important others, can influence individuals' intentions to use new technologies (Venkatesh & Davis, 2000). However, many respondents believed teledentistry wouldn't give them a higher status than their colleagues who don't, and they don't utilize teledentistry because of the proportion of dentists who use it. Instead, they feel that individuals outside their dental colleague circle who are important to them should use teledentistry. This was highlighted by the fact that social influence was not a direct predictor of behavioral intention ($B = .129$, $\beta = .121$, $p = .073$).

This finding was also established in a study that assessed mental healthcare professionals' opinions on online therapy (Sander *et al*., 2022), where it was suggested that only mental healthcare professionals' friends, family, and acquittances have an impact on their behavioral intention to adopt online therapy, but not of their co-workers or colleagues. Furthermore, Shiferaw *et al*. (2021) ascertained that social influence did not significantly predict behavioral intention. This indicates that there was a paradigm shift to adopt telehealth initiatives regardless of social influences due to the COVID-19 pandemic. Although this highlights that individuals working with dental professionals don't sway their opinions or thoughts on its use, Connoly *et al*. (2020) highlight the importance of organizational-level involvement to improve telehealth

providers' attitudes towards its adoption through developing policies, sharing information with providers, and training.

Conversely to the findings above, Bawack and Kamdjoug (2018) established that clinicians do believe utilizing health information systems would give them a higher status than their colleagues who don't. Bawack and Kamdjoug (2018) offer an explanation that older health professionals value the knowledge and empowerment they get from learning computer skills, as this would result in a promotion. This research study contained a younger cohort of dental professionals which also offers an explanation to the contrast in findings. Teledentistry initiatives could be targeted with the viewpoint that their adoption would result in a competitive advantage, resulting in ideals such as promotions. This would lead to more individuals adopting in their practices.

5.2.4 Facilitating conditions

Facilitating Conditions (FC) were found to have a weak but significant positive correlation with BI ($r = .282$, $p = .001$), indicating that having the necessary resources and support slightly influences the intention to use teledentistry.

This finding was also present when investigating the factors influencing teledentistry adoption amongst dentistry students (Alabdullah *et al*., 2020). Even though the relationship between facilitating and behavioral conditions is notably weak, Alabdullah *et al*. (2020) highlight that it's still significant. Another critical factor to consider is the role of support needed to support teledentistry adoption amongst dental professionals in South Africa. The responses regarding the need for assistance were notably uncertain; many respondents were unsure if they needed assistance using teledentistry. This aligns with a systematic literature review on the adoption of telemental health services where several articles mentioned the importance of strong technical support to accompany telehealth (Connoly *et al*., 2022).

Numerous responses were given to the open-ended question regarding facilitating conditions, mainly on public and rural sector concerns. While South African dental professionals had exhibited a fairly positive outlook on facilitating conditions, they had pointed out that the rural and public communities need technological resources and knowledge on teledentistry to ensure its success in South Africa. This could be an avenue for further research, where the study focuses on the public sector and rural patients instead of dental professionals.

Lastly, there was an indication in the open-ended responses of the questionnaire that some dental professionals lack awareness and training of teledentistry. Even though this was a few responses, it indicates the need for dedicated teledentistry awareness programs in South Africa. These could be carried out at a tertiary level, or initiated by the South African Dental Association annually.

5.3 The roles played by trust and perceived risk in the adoption of teledentistry

Trust (T) in teledentistry adoption showed a similarly moderate positive correlation with BI ($r = .572$, $p < .001$), aligning with literature that suggests trust as a critical factor in technology acceptance (Mayer *et al*., 1995). Similar findings have been established in studies by Cao, Kurata, Lim, Sengoku, and Kodama (2022), and Zhu *et al*. (2022). Zhu *et al*. (2022) determined the importance of brand image of mHealth initiatives and the professionalism of the healthcare provider in trust. Cao *et al*. (2022) highlighted the importance of design, government intervention, and research, which all led to positive correlations between trust and behavioral intention. The above findings have implications for this study in that the more trust one has in teledentistry, the more likely South African dental professionals are to adopt it. Furthermore, while South African dental professionals acknowledge that they need to be cautious when utilizing teledentistry, and teledentistry offers secure mediums where data can be transferred, there is uncertainty surrounding reliance on benefits attained from it. This indicates the need for initiatives to highlight the benefits one acquires from teledentistry and whether it would result in long-term gains for dental professionals. Apart from financial gains, if patients can provide positive feedback on teledentistry treatment and can be retained through teledentistry treatment, this would highlight the benefits of adopting teledentistry.

Perceived Risk (PR) was positively correlated with BI ($r = .351$, $p < .001$), which was a surprising finding as perceived risk usually has a negative impact on behavioral intention. While most studies on telehealth initiatives indicate negative effects of perceived risk on behavioral intention, there are studies indicating a non-significant relationship with behavioral intention.

The acceptance of mobile health was assessed amongst young Japanese adults, and no significant relationship had been found with behavioral intention. This is also in line with other studies conducted by Pan and Gao (2021), where legal risks were deemed not to influence behavioral intention negatively, but negative influences came from performance and privacy risks. Similarly, in a study by Bakshi and Tandon (2021), financial risk was not seen as a negative influence on behavioral intention. The above findings have implications in that,

perceived risk is a complex construct made up of different domains that don't all negatively impact behavioral intention, corroborated by Cao *et al*. (2022). Results revealed, the perceived risk construct investigated various domains of perceived risk which may have offered an explanation as to why there was not the expected negative influence with behavioral intention. This would necessitate the need to investigate perceived risk in its own right, and the adoption it has on teledentistry adoption amongst South African dental professionals.

The open-ended component of the questionnaire indicated that not many South African dental professionals had further opinions on perceived risk, security, and trust. Those who offered additional views on this construct expressed awareness that teledentistry may be open to bad actors such as hackers and also indicated that threats may come from internal sources such as fellow employees. This was a promising finding, as the general population would otherwise only be aware of external threats.

5.4 How the adoption of teledentistry can be enhanced in South Africa

The open-ended component of the questionnaire in this study provided a basis for discussion for this research question. It was established that South African dental professionals still favour an asynchronous modality of teledentistry in their practices, with an emphasis on diagnostic capabilities and rapport building. Keeping this in mind, initial consultations could be carried out in-person with subsequent appointments being held virtually to gauge maintenance practices being carried out by the patient. Perhaps the development of a dedicated teledentistry mobile application that tracks patient treatment both in-person and at home could be beneficial. The mobile application could include all discussions held in the initial in-person consultation, and steps needed to be taken by the patient at home to ensure treatment is fully effective. In the case of dental hygiene and periodontitis as an example, the user can take weekly pictures of their oral cavity and upload it to the app to assess periodontal treatment.

At a tertiary education level, teledentistry should be offered as its own extensive module at both a beginner undergraduate level, and a more advanced postgraduate course offered to further enhance training and education in this field. These modules should be offered by the public health departments of tertiary institutions to promote the use of teledentistry in rural and public communities. Furthermore, organizational or state-funded centres for the rural and public population in each province could provide an avenue for patients who don't have the technological means or know how to utilize teledentistry. Since it was established that there needs to be a hands-on approach to dentistry coupled with teledentistry, there could be a dentist located in each of these centers, where patients initially get screened virtually for minor dental

anomalies, and get directed to the dentist physically present in these centers for further treatment.

Another concern is the misuse of centralized databases by dental professionals. Appointment of a HIPAA and POPIA officer to oversee teledentistry initiatives would ensure all protocols are being adhered to regarding data safety and integrity. The implementation of two-factor authentication is crucial to ensure there are multiple protection mechanisms in place during transmission of data. The introduction of temporary codes or tokens for virtual consultations only given to the patient who is undergoing the virtual consultation will also ensure that external threats are mitigated. Lastly the platforms that are being used for teledentistry should have dedicated security mechanisms built in that ensure data integrity and security. It would be irresponsibile for dental professionals to utilize mainstream technologies available to the general public for teledentistry. There needs to be specialized software developed to undertake teledentistry practices. It was identified from the open-ended component of the questionnaire that South African dental professionals aren't aware of specialized teledentistry software. The only software that was mentioned was Vula. This is surprising given the plethora of teledentistry tools that are being used globally such as Toothpic, Dentulu, and Denteractive. This finding aligns to the awareness South African dental professionals have of teledentistry. It is a field that should be getting explored more through innovative technologies.

5.5 The behavioural intention to adopt teledentistry

The behavioral intention to adopt teledentistry services amongst South African dental professionals were investigated over four categories or items. Whether dental professionals will recommend patients and colleagues to use teledentistry or intend to use teledentistry for patient oral health maintenance and education, referrals, and patient consultations. The most favourable teledentistry behavioral intention was the intention to utilize teledentistry for patient referrals, indicating the value and adequacy of addressing referral systems within their practices. This was followed by the intention to use teledentistry for patient oral health maintenance and education and the intention to recommend teledentistry to patients and colleagues. This aligned with responses given in the open-ended component of the questionnaire, where South African dental professionals had notable opinions on the capabilities of teledentistry to act as standalone treatment plan for their patients. They feel that teledentistry will never be able to replace the physical and tactile dependence of dental treatment and that teledentsitry should be an adjunct to dentistry rather than a replacement. This was further emphasized by the low numbers of individuals who agreed or strongly agreed to use teledentistry for patient consultations. However, the quantitative and qualitative data both indicated the value in utilizing teledentistry

for patient referrals, and education. The hesitant feelings towards adopting teledentistry for consultations could be explained through inadequate awareness or knowledge of teledentistry. Very few case studies have compared traditional dentistry and teledentistry in South Africa. While exploring the literature, the last and only case study comparing teledentistry to traditional dentistry in South Africa was conducted by Bissessur and Naidoo (2019).

5.6 Conclusion

This study began by reviewing literature regarding the study's research topic and aims (Chapter 2). A discussion was first provided on the landscape of oral health in South Africa, and the concepts of telehealth, which are the building blocks of understanding teledentistry adoption in the context of South Africa. The perceived risk and trust variables were then discussed to address the cybersecurity concerns when adopting technologies such as teledentistry. Lastly, these factors were discussed in terms of a conceptual framework that addressed the gap in the literature.

The selected research methods, with justification, were then discussed (Chapter 3), leading to the presentation of the results (Chapter 4). Summarizing the results, performance expectancy, effort expectancy, social influence, facilitating conditions, trust, and perceived risk were all found to be significantly positively correlated to behavioral intention, with performance expectancy being the strongest correlation and facilitating conditions being the weakest. The phenomenological approach was used to analyze the qualitative component of the questionnaire, with the three most common meaning units being face-to-face examinations, using teledentistry for patient referrals, and the amount of experience dentists and dental specialists have with teledentistry. Furthermore, six themes were identified through the phenomenological approach: experience with teledentistry, education and training, resource and infrastructure capabilities of South Africa to support teledentistry, confidentiality and cybersecurity risks, and favored applications of teledentistry by South African dental professionals. Lastly, the final chapter (Chapter 5) provided an analysis of the results obtained in Chapter 4 considering previous research and the implications thereof.

The studies main contributions are discussed below:

Theoretical contributions: This is the first time the concept of teledentistry has been studied in the context of South African dental professionals and the factors influencing their adoption of teledentistry. Furthermore, the wholistic concept of telehealth acceptance, y*et al*one

teledentistry has not been investigated with the constructs of perceived risk and trust integrated into a comprehensive technology model such as UTAUT highlighting another valuable contribution

Practical contributions: Considering the positive correlations of the study variables with behavioral intention mentioned in paragraph two, various practical contributions were established to drive forward the successful adoption of teledentistry in South Africa.

It was established that there are heightened levels of uncertainty and inadequacy when first adopting teledentistry services. This necessitates the need to develop structured educational and awareness programs regarding teledentistry use that would improve the above disparities. This can be achieved at a tertiary education level where fourth and final-year students receive extensive training regarding teledentistry and have to utilize teledentistry for a certain amount of time to graduate. The more experience dental professionals get in the learning phase, the more comfortable they will be with it after leaving university.

Secondly, since effort expectancy is a significant contributor to behavioral intention, teledentistry providers need to ensure the technologies they promote or create are simple and easy to use. South African dental professionals were uncertain whether teledentistry takes too much time to set up. Teledentistry providers can possibly provide demonstrations of utilizing these technologies before they are fully adopted in practices.

Organizational level involvement is crucial to establishing new teledentistry policies, providing high-level training programs, and teledentistry educational initiatives. The South African Dental Association may be able to play an active role in this through annual workshops and honoring those who pioneered a shift towards technological advancements in the field of teledentistry. Incentives notably influence the adoption of technologies, and if dental professionals feel they are appreciated for their efforts in adopting new methods of dentistry, this may act as a driving force for innovation.

5.6 Limitations and potential future research

The exact population size of dental professionals during 2022 was unknown which influenced the capabilities to calculate the exact sample size needed. However, future studies can focus on limiting the sample size to a few participants with the view of taking on a qualitative-dominated study, or more participants could be sought after in a quantitative study, perhaps focusing on teledentistry patients instead of dental professionals.

The perceived risk and trust constructs provided interesting findings, where it was established that perceived risk is positively correlated with behavioral intention. This relationship could be studied in future studies. Furthermore, the trust and perceived risk constructs could be revisited in future studies, to investigate additional items improving reliability of the measurement items. As discussed in this study, these constructs are complex and are not limited to certain items.

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APPENDIX 1 – Ethical Clearance Letter

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

07 October 2022

Ismaeel Mahomed (218013453)
School Of Man Info Tech & Gov
Pietermaritzburg Campus

Dear I Mahomed,

Protocol reference number: HSSREC/00004815/2022
Project title: Factors that influence the adoption of teledentistry by dental professionals in South Africa
Degree: Masters

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 27 September 2022 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 07 October 2023.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

Humanities and Social Sciences Research Ethics Committee
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 8350/4557/3587 **Email:** hssrec@ukzn.ac.za **Website:** http://research.ukzn.ac.za/Research-Ethics
Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

APPENDIX 2 – Questionnaire

Definition of teledentistry: *Teledentistry is the use of Information Communication Technologies (videoconferencing technologies such as Zoom or Microsoft Teams, SMS, MMS, phone calls, social media, or email) over distances to provide diagnoses, treatment plans, oral health education, referrals, and patient maintenance. This technology is used for patients located in rural areas or areas with no nearby dentist, who have limited time, movement, or resources and/or need care while away from home.*

SECTION A – DEMOGRAPHICS

Please read and complete the following section of the questionnaire. Your answer can be selected by clicking on the relevant box/circle

Demographic Data				
1. Which age group do you belong to?	20-34	35-44	45-54	55-64
2. What is your gender?	Male	Female	Neutral	
3. Work Experience (in years)?	0-5	6-10	11-15	>16
4. What is your speciality?	General Dentist	Orthodontics	Maxillofacial and Oral Surgery	Prosthodontics
	Pedodontics	Periodontics		
5. Which sector(s) do you currently work in?	Private	Governmental	Both	
6. Which university did you attend?	SMU	WITZ	UP	UWC

SECTION B – CLOSE-ENDED QUESTIONS

Please indicate the extent to which you agree or disagree with the following statements:

7. Performance Expectancy

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I would find teledentistry useful in my job					
Using teledentistry will enable me to accomplish tasks more quickly					
Teledentistry would provide adequate diagnostic information and capabilities					
Teledentistry would enhance clinical training and continuing education.					
Teledentistry would be convenient and well received by patients					

8. Effort Expectancy

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Learning to use teledentistry would be easy for me					
I would find teledentistry easy to use					
I would find it easy for myself to interact with patients and other doctors using teledentistry					
Using teledentistry involves too much time doing mechanical operations (e.g. typing, setting up a Zoom or Teams meeting)					

9. Social Influence

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Using teledentistry would make me have a higher status than my colleagues who don't					
Most people surrounding me use teledentistry for oral healthcare.					
I use teledentistry because of the proportion of dentists who use it.					
People who are important to me think that I should use teledentistry.					

10. Facilitating Conditions

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I have the necessary technology and resources to use teledentistry.					
I have the necessary knowledge and training to use teledentistry					
Teledentistry is not compatible with other systems I use					
My working environment supports me to use teledentistry.					
I do not need assistance to use teledentistry.					

11. Trust

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Teledentistry systems will require me to be cautious with this technology.					
I fear to use teledentistry due to loss of my patient's personal data and privacy					
Teledentistry offers a secure medium where sensitive personal information can be sent confidentially					
I feel satisfied and confident that I will be able to rely on the benefits of teledentistry.					

12. Perceived Risk

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Learning how to use teledentistry services and adopting it would be a loss of my time.					
Using teledentistry wouldn't be compatible with my moral values and image.					
I am confident I will adhere to POPIA and HIPAA regulations.					
I fear my technology assets may get stolen.					
I fear I may send data electronically to the wrong recipient.					
I fear there may be disruptions when using teledentistry (loadshedding, loss of internet connection, slow internet connection)					
Using teledentistry would cause me a lot of trouble if something went wrong.					

13. Behavioural Intention

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I intend to use teledentistry for patient consultations.					
I intend to use teledentistry for patient referrals.					
I intend to use teledentistry for patient oral health maintenance and education.					
I will recommend my patients and colleagues to use teledentistry.					

SECTION C – OPEN-ENDED QUESTION

Please ***leverage your experience as a dentist*** to provide ***additional/open ended comments*** and suggestions of how the teledentistry could be used to enhance/enable dental services offered in South Africa?