Intent to use a Healthcare Related Internet of Things service (IoTs) in South Africa

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DECLARATION

I, __Naseelah Kaleemah Hassim___, declare that this research article is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the Graduate School of Business Administration, University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Naseelah Kaleemah Hassim

Signed at …………………………………………………………

On the ……………26……….. day of ……………AUGUST………… 20…18..

DEDICATION

Muhammed Vally –

Without you, none of this would have been possible. Your continuous kindness and willingness to help me whenever I needed it inspire me to be just like you and humbly follow in your footsteps in completing this Masters. Your dedication to what you do, the way you strive for your students to learn evidence based medicine, and the hard work that you put into being the best clinician you can be by enrolling in a Postgraduate Diploma in Diabetes Management, make me so proud of you. You have helped me in so many ways through my journey in my professional development and my personal development.

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3. Reliability: Alpha Table
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5. Key for Structural Equation Model for Healthcare Practitioners
6. E-survey

ABSTRACT

Purpose – The purpose of this study is to identify individual's (both healthcare practitioner and public) intention to adopt healthcare related IoT services (HR-IoTS).

Materials and methodology – The technology acceptance model (TAM) was used to assist in predicting intention to use. An e-survey was distributed via email to all participants living the Gauteng area. Four constructs (perceived ease of use, perceived usefulness, attributes and user satisfaction) formed part of the e-survey. Chi squared testing was used to descriptive data for both groups (i.e. healthcare practitioners and general public). Thereafter, a structural equation model (SEM) was used to predict intention to use. Two structural equations were built for each group.

Results – A total of (N = 208) respondents were gained and separated into a group of general public (N = 140) and healthcare practitioners (N = 64). The SEM for the general public was tested and it was found to have convergent validity, discriminant validity and reliability. The results within the general public and healthcare practitioners indicate no statistically significant difference between gender and intention to use HR-IoTS. In the general public, there was a statistically significant difference between various age groups; however, the older age groups were not well represented. In the healthcare group, no statistically significant difference was identified in the various age groups compared to their intention to use and confidence in recommending HR-IoTS. The structural equation developed for the general public indicated that the there was a significant positive association between the intention to use HR-IoTS and perceived ease of use and perceived usefulness. There was significant negative association between intention to use a HR-IoTS and the attributes of an IoT device and this result was also statistically significant. Within the healthcare group, it was found that there was a statistically significant difference between prior knowledge of IoT services and confidence in recommending HR-IoTS. There was a statistically significant difference in perceived ease of use in the healthcare practitioners group, however, the model developed was not robust.

Conclusion – Among members of the general public it was clear that there was a positive association between perceived ease of use and perceived usefulness of a HR-IoTS and the intention to use such a service but this was not the case for attributes of usability. It can thus be concluded that the attributes of a HR-IoTS may preclude members of the public from using it. Whilst there was a significant positive association between perceived ease of use and HR-IOTs among healthcare practitioners, the structural equation did not pass the goodness of fit test.

Keywords: Heatlhcare related IoT Services, IoT, Technology Adoption Model, TAM, Intention to use

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CHAPTER 1: Introduction and Literature Review

The world has been described as a dynamic environment (Nsingo and Steyn, 2007). With the advent of technology, and the increased rate with its life cycle, there are bound to be ways to improve efficiency using technological advances (Sundmaeker et al, 2010). Increasingly, objects are being interconnected using computing devices that are internet enabled with objects being given the ability to transmit and receive information across networks (Sundmaeker et al, 2010). This advance can be referred to as the Internet of Things (IoT) which can be defined as “things” being connected to the information networks which allows for data to be collected from items (Vatsa and Singh, 2015) such as sensors, monitors, mobile devices, and wearables to be processed, analysed, cleaned and mined and provide useful information to assist in providing better services (Yan et al, 2014). This is done through the insertion of a microchip and communications antenna to an object (Gao and Bai, 2014). The object thus carries its own version of an IP which is called a Radio Frequency Identification (RFID) chip; which enables the device with an internet connection and a unique identifier that enables it to collect and transmit information. (Sundmaeker et al, 2010; Achituv and Haiman; Miorandi et al, 2012; Hsu and Lin, 2016; Gao and Bai, 2014; Roberti, 2017).

The IoT comprises of anything that allows for the object to be communicated with from a distant or remote location with intermittent or continuous internet connection to allow for data to be collected from it (Sundmaeker et al, 2010; Gao and Bai, 2014; Yan et al, 2014). This is through an ecosystem which allows for autonomous communication between objects through a wireless type of network solution (Mącik, 2017). The IoT has gained traction in healthcare due to its promise for cost reduction, efficiency in the future; increased patient monitoring (RFIDWORLD, 2017), given its ability to track and collect information on everything (Sundmaeker et al, 2010; Gao and Bai, 2014; Hsu and Lin, 2016). An example of this consists of a warehouse which houses pharmaceutical products and for these products to be easily located by an individual with a virtual reality headset communicating directions as well as amounts of items required. This data that is generated would be stored using the internet to the cloud and allow for the data to be used remotely to locate the necessary items (Vatsa and Singh, 2015). The IoT can be explained as being an aggregate of technologies that capture meaningful data (through the use of a sensor) which monitors objects, measures data and communicates the information using IP networks using the RFID chip (Sundmaeker et al, 2010).

1.1. Potential benefits of IoT

One area where the IoT may have significant impact is the healthcare industry by redefining how apps, devices and people interact and connect with each other in delivering healthcare solutions. The implementation of IoT may reduce costs (Brewka and Capelle, 2017), because patient monitoring can be done in real time and enables point of care testing that reduces visits to doctors (Achituv and Haiman, 2016). Other benefits included providing real time information access that enables doctors to make informed decisions as well as offer treatment that is evidence based (Watson Health, 2017).

1.2. IoT and Healthcare

This research was performed through the use of the technology acceptance model (TAM) through a quantitative based approach to determine whether individuals, both healthcare professionals and their patients intend on intend on using Healthcare Related IoT Services (HR-IoTS) in a South African setting (Abu-Dalbouh, 2013).

According to Gubbi et al, (2013), the term IoT was coined by Kevin Ashton in 1999 (Gao and Bai, 2014; Ashton, 2009). The IoT explains the significant advancement of technology which has affected all aspects of living (Brewka and Capelle, 2017). A compounded annual growth rate of 22.8% is expected in the RFID blood monitoring systems market from 2012 – 2019 (RFIDWORLD, 2016). Blood monitoring systems help to reduce errors in blood transfusion and handling (RFIDWORLD, 2016).

There is an expected growth in the healthcare industry in the next seven years to $3.89 billion (RFIDWORLD, 2016a) with an expected increase to $4.866 billion by 2022 (RFIDWORLD, 2015). This growth has been attributed to the motivation to reduce medical errors and deaths in a hospitals as well as to research expenditure (RFIDWORLD, 2016a; RFIDWORLD, 2015).

Individuals interact with IoT on a daily basis such as medical aid organisations wherein a person’s data is being used to determine their ability to redeem rewards by living a healthy life which is based on how frequently they access gym services, exercise and buy vegetables at a supermarket (Brewka and Capelle, 2017). This aids in direct influence of that individuals’ ability to make better health-related decisions in the future and for medical aid organisations to determine how to optimally reduce claims (Davenport, 2014; Brewka and Capelle, 2017). Thus, a client choosing healthier purchase options as well as engaging in healthier lifestyle choices could look forward to added benefits with the opposite being true for a client making unhealthy lifestyle choices.

1.2.1. Potential of IoT in Healthcare

The digital age has brought about greater efficiency with the starting point being computers, with progression to connecting people via the internet and finally to things being connected to the internet (Yan et al, 2014; Brewka and Capelle, 2017). The IoT enhances the speed at which information is obtained and becomes useable (Coetzee & Eksteen, 2011; Gomes, 2016) thereby enhancing efficiency. There has specifically been phenomenal excitement over the possibilities that this brings within the healthcare setting and aids problem solving (Atzori et al., 2010; Xu, He & Li, 2014; Djikman, 2015).

Enabling data collection from these tangible items and gaining valuable real-time information can then be used to act on this information (Yan et al, 2014). Examples include IoT connected lighting, IoT connected home security devices, IoT connected traffic lights that switch on only when a car approaches it (Panday et al., 2017) as well as smart farming, smart cities, smart energy, smart buildings, smart manufacturing, smart transport, and smart health (Mącik, 2017).

From a health perspective, a Doctor or Clinical Pharmacist can utilise data obtained using an IoT enabled blood pressure monitor to adjust a patient's medication doses and also monitor efficacy of therapy in reducing the client's blood pressure from a remote location. This enables the Doctor or Clinical Pharmacist in calling the patient back to adjust the prescription which reduces the requirement to monitor an individual's response to the hypertensive medication in a hospital/out-patient setting which is quite expensive. Equally so, a patient with diabetes mellitus can test their blood glucose level at home with this information being delivered to their Doctor or Clinical Pharmacist who can make a determination on the drug's efficacy which can subsequently reduce costs and enable better conservation of scarce resources. The IoT has the ability to revolutionise many industries including those that contribute to economic development such as manufacturing and healthcare (Djikman, 2015). There are many devices which have been enabled with sensors to be able to communicate to relevant healthcare practitioners (Achituv and Haiman, 2016). The blood glucose monitor is called a "gluco phone" (Sankar Bhunia, 2015), while many other types exist such as a device that measures physiological data such as epileptic seizure activity called "Embrace" among others (Bidwell et al, 2015; Achituv and Haiman, 2016).

Healthcare practitioners do not make use of supportive technology (Abu-Dalbouh, 2013) which could aid them in providing higher quality, cost effective care for their patients. Despite the increasing advancement of the healthcare industry, there remains a need to determine whether healthcare practitioners and their patients are ready to accept the IoT in their daily lives. Motivation has been made for investment into technology to enable services provided by healthcare practitioners (Abu-Dalbouh, 2013; Grimshaw et al, 2004; Meijden et al, 2003). Evidence has been provided that quality of healthcare, based on particular guidelines, can improve in the healthcare sector (Wollersheim et al, 2005; Abu-Dalbouh, 2013).

This motivates for advances to take place in the healthcare sector where the implementation and advances in healthcare can allow for greater scale and improved healthcare to take place in South Africa. Although studies have mentioned security and privacy being the main challenges facing IoT applications (e.g. Zhao and Ge, 2013 and Yan et al., 2014).

A study was conducted by Abu-Dalbouh, (2013) evaluating whether mobile tracking on patient progress applications will be accepted using a questionnaire approach in the healthcare industry. The TAM was adapted to incorporate perceived usefulness, perceived ease of use, user satisfaction, and attribute of usability and used to make a determination on this (Abu-Dalbouh, 2013). Other studies conducted by Lyles et al., (2011), and Duncan et al., (2011), showed the successful use of mobile based interventions in chronic disease management. In a study conducted by Steele et al. (2009) it was found that at-risk groups accepted the use of sensors. Social media has been used as an influencer whereby physical activity is posted onto a social media platform (Steele and Lo, 2013; Clarke and Steele, 2011).

In the US, chronic disease is the cause of 80% of deaths and contributes to 70% of health costs which affect their ability to perform certain activities of daily living (Steele and Lo, 2013). There has been application development which assists in patients managing their own condition while being monitored by a health professional with the added advantage of not having to visit the health professional on a daily basis (Marshall et al., 2008; Steele and Lo, 2013). There has additionally been an increase in applications that assist patients in preventing their chances of illness (Steele and Lo, 2013). Therefore IoT can assist in community-based and home-based care especially given the large geographical dispersion of people in rural areas thus reducing the travel burden (Steele and Lo, 2013). Furthermore, this has the potential to identify chronic illness in individuals immediately as opposed to when check-ups take place (Steele and Lo, 2013). Individuals who are at risk for chronic illness can utilise sensors and be monitored along with individuals who already have chronic illness.

IoT has also been attributed to improving emergency detection. In a study by Petersen et al., (2004) it has been reported that individuals who suffer an acute myocardial infarction, 30% of these individuals die post their myocardial infarction while in hospital (Steele and Lo, 2013). Thus, remote monitoring of physiological data can assist in such an event and assist in saving lives (Steele and Lo, 2013). Steele and Lo, (2013) provide examples of the use of the IoT in healthcare through constant monitoring via a blood glucose sensor-based monitor or an ECG sensor for individuals at risk for diabetes or a heart attack respectively.

1.3. Various Constituents of the IoT

The four main constituents will be discussed further below. IBM has Watson Health which is an artificial intelligence IT-driven system that allows for most recent treatment methods to be programmed into it which has the ability to move to many different countries and grant that country the ability to employ these treatment methods in real-time as opposed to when the health professional decides to update their knowledge on a topic (Watson Health, 2017). An actuator can perform a surgery as soon as the new technique becomes viable as opposed to when the Surgeon attends a course to learn the new technique or watches a video to learn about the technique. This allows a connection which takes place across geographical boundaries purely through an internet connection (Ehret and Wirtz, 2017).

There are four constituents of the IoT which include actuators, sensors, information technology (IT) - driven services and information protocols combined with middleware (Ehret and Wirtz, 2017).

Actuators can be identified as a system which enables signals to be sent from a different location while a tangible object such as a robot carries through the command from the signal received (Ehret and Wirtz, 2017). A simple example of this would be closing curtains at home through a signal sent from home. An example consists of an insulin pen's dosage can be automatically increased from a different location by a Doctor based on data gained by the individual's glucose reading.

An IT – driven service collects data and from all available sources, collates this, transforms it into readable information and gives access to this to individuals despite geographical boundaries (Ehret and Wirtz, 2017). IBM's Watson is an example of this whereby, it collects information from all possible resources available on the internet to supply a response to a health – related query (Watson Health, 2017).

A sensor connects a physical tangible object with an internet connection to gain real-time information (Ehret and Wirtz, 2017). An individual's pacemaker can send information to a Doctor on an individual's health and risk for a heart attack. Furthermore, a signal can be sent to request an ambulance by the pacemaker should a heart attack occur.

There has thus far been a great number of how medical applications are assisting businesses in coming into more frequent and successful contact with their target groups and create a better platform for access (Balandin, et al., 2013; Gomes, 2016).

Wearable technology and various innovative technologically-driven solutions, are gaining traction in the market warranting a greater need for sustainability according to Amendola et al., (2014) and Gomes, (2016).

Other examples of IoT consist of an individual who is unable to request an ambulance or emergency services due to being unconscious following a stroke, heart attack, or seizure whereby a sensor picks up on this and signals emergency services (Steele and Lo, 2013). False alarms are avoided through the prompt on a smart phone requesting confirmation if it is a false alarm while no response indicates an emergency situation (Steele and Lo, 2013). Other examples include a reminder is sent to an individual to refill a prescription enabling better adherence. Or, Discovery Limited's 'impact alert' during an accident which allows for signalling immediate assistance in an accident (Discovery, 2018).

1.4. Technology Acceptance Model (TAM)

A determinant of actual usage behaviour is the acceptance by a user toward the technology (Yi et al, 2006; Gao and Bai, 2014). A model that has been used previously to investigate consumer usage, intention and actual usage have been performed, is the TAM which is illustrated in *figure 1* (Davis, 1989; Gao and Bai, 2014). This model looks to gain more frequent IoT engagement by consumers (Gao and Bhai, 2014). According to Abu-Dalbouh, (2013) health professionals continue to use conventional methods to provide care for patients; despite advances in healthcare that have been created to complement this service. Thus, there is a requirement for the need amongst healthcare professionals to determine the view of health professionals on their acceptance of technology in the healthcare industry (Abu-Dalbouh, 2013). Whether healthcare-related information systems adequately meet the needs of its users and healthcare organisations was investigated using the modified TAM by Abu-Dalbouh, (2013) and can be found in *figure 2*. The TAM was found to adequately detect whether using mobile technology in the healthcare industry was effective (Abu-Dalbouh, 2013). The motivation for this study was seen to provide the much needed investigation as to the investment of supportive technology applications by healthcare practitioners (Abu-Dalbouh, 2013).

Figure 1 Final Version of TAM (Venkatesh and Davis, 1996, p. 453; Chuttur, 2009, p. 10; Mącik, 2017, p. 396)

The TAM has been chosen due to its popularity gained in the information systems community (Abu-Dalbouh, 2013). The model was founded by Davis, (1989) and was based on the theory of reasoned action which was developed by Fishbein and Ajzen, (1975). TRA has determined a means of measuring behaviours such as attitude, differentiates between attitudes and beliefs, and mentions the causal link of external stimuli on behaviour, attitude and beliefs (Fishbein and Ajzen, 1975; Abu-Dalbouh, 2013). The measures of acceptance of technology include the ease of use and usefulness which contribute to the behavioural aspect which consists of usage behaviour (Venkatesh and Davis,1996) and TAM 2 was developed based on TAM. Research based studies (e.g. Yousafzai et al, 2007) found behavioural intention being influenced by perceived usefulness when determining when to use a certain item. Studies have additionally found that TAM can predict system usage behaviour (Yousafzai et al, 2007; Venkatesh and Davis, 1996). However, the behavioural element in understanding the reasons for usage were lacking thus motivating for an extension of TAM to TAM 2 (Venkatesh and Davis, 1996; Chuttur, 2009). One of the criticisms of TAM is its subjectivity with data collection (Venkatesh and Davis, 1996; Chuttur, 2009).

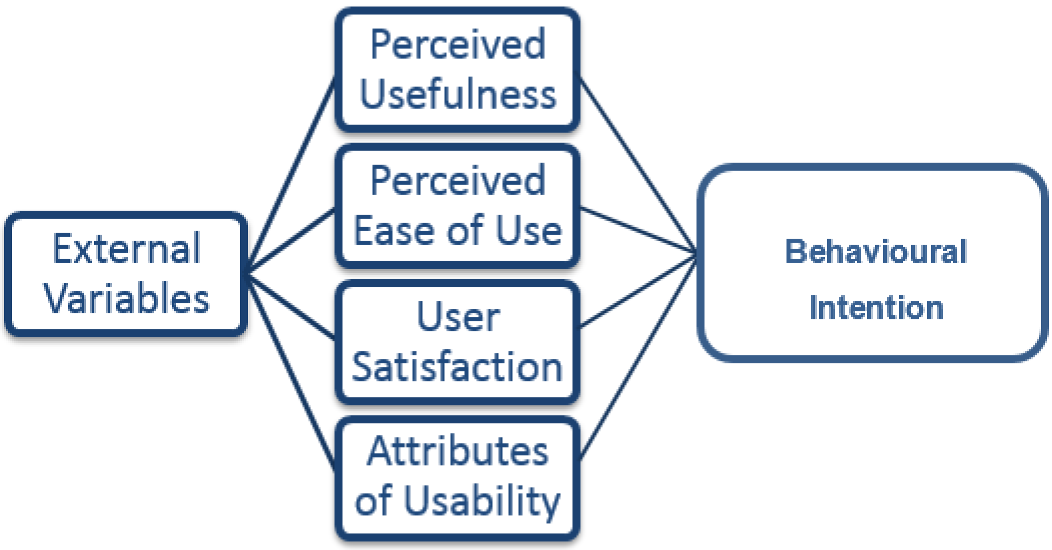

Figure 2 Modified TAM (Abu-Dalbouh, 2013)

The original TAM which was initially suggested by Davis, (1989) and has become the most popular (Svendsen et al, 2013; Saarelainen, 2017; Abu-Dalbouh, 2013; Ma and Liu, 2004; Kim and Chang, 2007; Yarbrough and Smith, 2007). The reason that this model was developed was to determine the understanding behind how decisions to use technology applications is made (Abu-Dalbouh, 2013). This assists in gaining an understanding of what leads to success and failure in organisations attempting to implement modern IT applications (Abu-Dalbouh, 2013). In essence, TAM assists in gauging the acceptance of technology by its intended user (Abu-Dalbouh, 2013).

TAM aids in external factor responses which lead to gaining responses regarding perceived usefulness and perceived ease of use which influence attitude toward use and therefore translated into behavioural intention and actual usage (Mącik, 2017; Davis, 1989; Porter and Donthu, 2006). Variables consisting of perceived ease of use and perceived usefulness were put forth in the TAM as a cause of behavioural intent to use a technology which can explain consumer acceptance (Gao and Bai, 2014; Abu-Dalbouh, 2013; Saarelainen, 2017). According to Davis et al, (1989), the perceived usefulness can be thought of as whether the use of technology will augment or enhance their performance (Gao and Bai, 2014; Abu-Dalbouh, 2013; Saarelainen, 2017). Whether using the technology will be effort free or relatively free from physical and mental effort determines its perceived ease of use (Gao and Bai, 2014). User satisfaction is the evaluation of the technology in its ability to meet the expectations formulated by the user in various situations (Abu-Dalbouh, 2013). Attribute of usability speaks to the ease with which IoT can be used and what can be changed that consumers find not working (Abu-Dalbouh, 2013). TAM has previously been applied to a variety of technological services including, inter alia, the adoption of e-health (Dünnebeil et al, 2012; Fox, (2007); Gao and Bai, 2014).

Initially, TAM was used in a workplace to predict IT system use, it can be extended to predict consumer acceptance in a variety of settings because IoT can be considered a new IT type (Gao and Bai, 2014). In addition to this, Ajzen, (2011) reports that resources and skills are necessary in order for consumers to have an intent to perform a behaviour (Gao and Bai, 2014). The variables that TAM indicates determines a user’s willingness to accept the technology is based on their attitude, perceived usefulness and perceived ease of use (Abu-Dalbouh, 2013; Saarelainen, 2017). The use of the application is determined by a user’s intention to use the technology while their intention is affected by their attitude (Davis et al., 1989; Abu-Dalbouh, 2013; Venkatesh et al., 2012).

The motivation behind choosing the TAM to conduct the research is its ability to explain the acceptance of technology among different populations and different kinds of technologies (Abu-Dalbouh, 2013). Also, it has been proven to be valid by King and He, (2006) (Ma and Liu, 2004) as well as valid in a healthcare setting by Chau and Hu, (2002a), (2002b) and Chismar and Wiley-Patton, (2003) (Abu-Dalbouh, 2013). Perceived ease of use, perceived usefulness, user satisfaction, and attribute of usability for the TAM and will aid in understanding the acceptance of IoT, through the use of an e-survey, (Abu-Dalbouh, 2013) by its consumers, both health practitioners and patients.

It has been suggested by Brewka and Capelle, (2017), that there has been neglect of the human element related to the implementation of the IoT; and the disregard of the consumer that the service will be offered to; which results in lack of usage of IoT services despite consumers being aware of it. It is imperative to recall that individuals are responsible for the implementation of the IoT in an organisation and as such are crucial to the success of this implementation which motivates for the human element to be understood (Brewka and Capelle, 2017; Motiwalla and Thompson, 2009). Attributes of usability includes the human element according to Abu-Dalbouh, (2013) and will thus be used in this study.

There are concerns regarding privacy of those who access such services, an absence of human intervention in autonomous devices as well as collection of sensitive data (Mącik, 2017). Handling of the data needs to additionally comply with legislature; as data contains sensitive information and therefore security is required to mitigate threats (Sicari et al, 2015; Babar, 2011). Although IoT has great future potential, there is the additional concern about real-time person location that comes into play (Udo, 2001). Financial information, identifiable information, geolocation and health information all pose a risk when implementing the IoT (Federal Trade Commission, 2015).

The perspective of the consumer is an often neglected opinion in the success and start-up of a new business (Glazer, 2017). A crucial element to success for a business is to identify what it is the consumer needs and whether the consumer is interested in what a business is offering (Yan et al, 2014; Køien, 2011). Without the consumer, there is no business. It is ultimately about getting the service to the customer. It has been mentioned above about the potential and opportunity that IoT brings the world of business and people; however, it has not taken into consideration whether this has the ability to create value for individuals as well as the readiness of individuals to adopt the service (Federal Trade Commission, 2015). A good example is where Google's attempts to make an individual's travel easier by sending traffic notifications in their most accessed areas. However, do consumers truly value this information and service? The IoT and the services and opportunities that it affords needs to provide value (McKendrick, 2015).

1.5. Conclusion

The IoT is clearly a revolutionary system that can bring about changes to the healthcare sector. It is clear from the literature reviewed above that the IoT has a place in the healthcare sector and its place could benefit both practitioners and patients alike. The use of the Big Data that could be obtained from such services may also be useful to design interventions for specific patients. Technology which improves communication in healthcare can assist in physicians obtaining advice, education, and opinions from their peers which can aid in providing healthcare to individuals (Steele and Lo, 2013; Gagnon et al., 2006). This can further aid in practice for novice health practitioners who require assistance when treating patients. IoT has the potential to aid in cost reductions, increased patient monitoring and better quality of healthcare (Achituv and Haiman, 2016; Abu-Dalbouh, 2013). In order to best understand intention to use a HR-IoTS one could use questions constructed around the TAM model. It has been suggested by Mącik, (2017) that acceptance of this technology has been poorly explored. It is with this in mind that this research is commissioned.

In concluding, to the best of our knowledge, there has been no data applying the TAM model to investigate intention to use a HR-IoTS in South Africa. After multiple searches of various databases, we developed aims and objectives and the rationale for building the structural equation from the TAM which will be detailed further in materials and methods.

CHAPTER 2: Materials and Methods

2.1. Aims and Objectives

2.1.1. Aims

The aim of this study was to determine the intent to use HR-IoTS by both healthcare professionals and the general public in the Gauteng Area.

2.1.1.1. Objectives

The above was achieved using the following objectives:

1. To determine the perceived ease of use of HR-IoTS for both healthcare professionals and the general public.

2. To determine the perceived usefulness of HR-IoTS for both healthcare professionals and the general public.

3. To determine the effect attributes of an IoT service would have on intent to use HR-IoTS for both healthcare professionals and the general public.

4. To determine the effect that user satisfaction would have on the intent to use HR-IoTS for both healthcare professionals and the general public.

5. To develop a structural equation for both healthcare professionals and the general public which would determine their intent to use a HR-IoTS for both healthcare professionals and the general public.

2.2. Research Methodology

This research study utilised a quantitative research methodology in order to meet its objectives. The e-survey was chosen because it was less expensive to conduct and less time consuming (Abu-Dalbouh, 2013). This research study aids in clarifying the amount of individuals who intend on using a HR-IoTS in

South Africa and whether is a viable investment option. The Likert scale assisted in gaining an idea of the degree of agreeance with statements made on a seven point scale (Abu-Dalbouh, 2013; Wegner, 2014). Questions were based on the modified TAM, which are based around the perceived usefulness, perceived ease of use, user satisfaction, and attributes of usability (Abu-Dalbouh, 2013).

2.3. Population and Sample

2.3.1. Population

The intended sample population consisted of individuals who reside and make use of health services in Gauteng Province. Participants consisted of individuals aged from 20 – 69-year-olds and were either healthcare practitioners or patients who reside in South Africa.

2.3.2. Sample and sampling method

The sample was a convenient sample. E-survey respondents consisted of a target amount of 196 individuals. The sample size was calculated at a 95% confidence level and a 7% confidence interval with a population size of 28.9 million people i.e. the approximated population of the residents of Gauteng in the Republic of South Africa. Respondents were invited to participate through their email addresses, the University of the Witwatersrand Database and professional networks; and to invite other individuals who would be interested in participating. The survey comprised of two sections, namely demographic data and a set of Likert Scale questions designed to determine the intent to use HR-IoTS. All information from the participants was kept strictly confidential (with Qualtrics providing no identifiable data) and the data was stored on password protected excel spreadsheets with access restricted to the researcher. The aim was to formulate conclusions that are based on the population being studied (Abu-Dalbouh, 2013).

2.4. Procedure for data collection

Data from the E-surveys was collated within Qualtrics and exported to an excel spreadsheet. The data was transformed so that it could be exported to Stata for statistical analysis purposes. Graphs and tables were designed using Microsoft Excel as opposed to Stata for ease of use.

2.5. Data analysis and interpretation

The primary aim of this study was to quantify and determine the intent to use HR-IoTS. The excel spreadsheet data was first cleaned and respondents who were either outside the area of Gauteng or did not complete the entire survey were exclude from the dataset. Thereafter the data was exported into Stata version 14.2 for statistical analysis. For both the descriptive and inferential statistics the data was analysed to determine p-values and in some cases 95% confidence intervals. Statistical significance was set at $p<0.05$.

Chi-squared testing was utilised to identify the differences (Wegner, 2014) between the age and intention to use HR-IoTS, gender and intention to use HR-IoTS for both the general public and healthcare practitioners as well as age and previous exposure to IoT with confidence in healthcare practitioners recommending HR-IoTS to their patients.

SEM was used to analyse the data and come to a determination regarding the intention of various respondents' use of HR-IoTS. In order for this to be done, the chosen model i.e. the modified TAM needed to be measured for validity, reliability and internal consistency. This was to determine how well the TAM is at measuring HR-IoTS (Lee, 2015). This allowed for a true score to be obtained from the data collected (Lee, 2015).

2.5.1. Building a Structural Equation Model and testing the TAM

SEM was used to analyse the data and come to a determination regarding respondents' intent to use HR-IoTS.

The first action performed consisted of testing the measurement model i.e. The TAM. The reason that the measurement model needs to be tested is to ensure that the model is valid and reliable. There were 140 observations in the General Public group and 64 observations in the Healthcare Practitioners group. Due to responses being collected from two separate groups which consist of the general public and healthcare practitioners, two structural equations were built. Structural models tell us how one variable relates to, is predictive of, or causes another variable.

A measurement model that is adequate to make use of should fit well, have convergent validity i.e. high factor loadings and good discriminant validity i.e. low-moderate factor correlations. Reliability on the other hand, is determined through gaining internal consistency or repeatability.

A low covariance was sought between the various constructs to motivate for their being different constructs. The model was tested via goodness of fit to determine if it fits the data. Lastly, correlation between indicators within a factor were sought. These are representative of convergent validity, discriminant validity and reliability.

CHAPTER 3: Results

3.1. Introduction

234 respondents were gained via the e-survey. Of the 234 respondents, 9 were excluded because they fell out of the inclusion criteria in that they were not residents within Gauteng Province. 13 respondents were also excluded because they did not have complete responses to all the questions on the e-survey. Therefore, the usable data consisted of (n = 208) respondents. This was larger than the prior calculated minimum of (n = 196). However, of these, 32.7% (n= 64) respondents were gained from healthcare practitioners while 67.3% (n = 140) of the respondents were from the general public as demonstrated in *figure 3*.

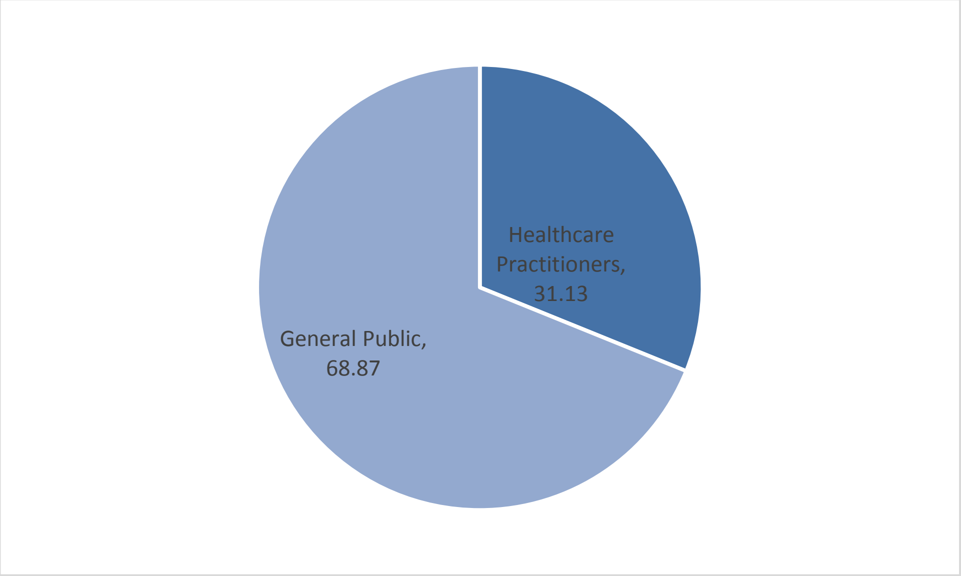

Figure 3 Responses from Healthcare Practitioners vs General Public

3.2. General Public

3.2.1. Building and testing the model

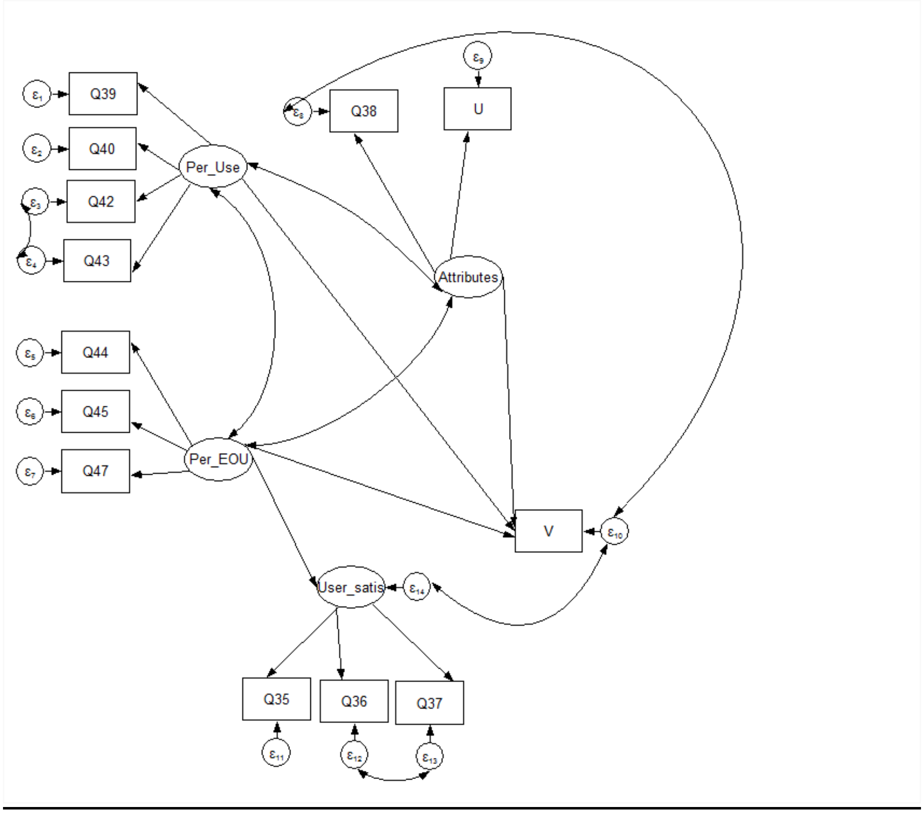

Figure 4 TAM and its Constructs (Exogenous and Endogenous Variables)

Figure 4 illustrated the SEM built to test the TAM for the general public. For further information on how the structural equation is built, please see supplementary file 1. Table 1 demonstrated the covariance between various exogenous variables.

3.2.2. Covariance between exogenous variables

Table 1 Covariance between exogenous variables (General Public)

Latent/Exogenous Variables (Constructs)	Covariance
Perceived Usefulness and Perceived Ease of Use	0.50
Perceived Ease of Use and User Satisfaction	0.35
User Satisfaction and Attributes of Usability	0.60

Perceived Ease of Use <u>and</u> Attributes of Usability	0.74
Perceived Usefulness <u>and</u> Attributes of Usability	0.62

A covariance of less than 0.90 was taken to represent a low covariance. The covariance between perceived usefulness and perceived ease of use was 0.50; the covariance between perceived ease of use and user satisfaction was 0.35; the covariance between user satisfaction and attributes of usability was 0.60; the covariance between perceived usefulness and attributes of usability was 0.62; and lastly, the covariance between perceived ease of use and attributes of usability was 0.74. Therefore, it can be concluded that the exogenous variables can be in different constructs i.e. there was discriminant validity between factors in that they aren't the same. This was determined by squared standardised loading (R^2) with a value of greater than 0.70 indicating good evidence for convergent validity.

3.2.3. Goodness of Fit

The goodness of fit test will assist in determining whether the data fits the chosen model. The Root Mean Squared Error of Approximation (RMSEA) was 0.025 (which was less than 0.05). The Comparative Fit Index (CFI) was 0.994 (which is greater than 0.95). The Tucker-Lewis Index (TLI) was 0.992 (which was greater than 0.95). The Chi Square Model vs Saturated (chi_ms) was 0.297 (which was greater than 0.05). Due to missing values in our data set, we were unable to obtain the Standardised Root Mean Squared Residual (SRMR). Table 2 indicates goodness of fit between the data and the model.

Table 2 Goodness of Fit Test on General Public

Goodness of Fit Test	Expectation	Result
1. Root Mean Squared Error of Approximation (RMSEA)	<0.05	0.025

2. Comparative Fit Index (CFI)	>0.95	0.994
3. Tucker-Lewis Index (TLI)	>0.95	0.992
4. Chi Square Model vs Saturated (chi_ms)	>0.05	0.297

The above table clearly illustrated that there was goodness of fit between the data and the chosen model which meant that it could be used to determine whether the intention to use a HR-IoTS with our dataset from the general public.

3.2.4. Correlation

There should be correlation between indicators within a factor. These correlations should be higher than correlations with indicators in other factors. The objective is for each row to be lower than the preceding rows. When looking at the row 1 and column 1 the value reads as 0.77. When compared to row 2 and column 2, it reads as 0.60 which was lower in value. Furthermore, both of these are less than R^2 = 0.9; thereby indicating that there was discriminant validity. The first value in each column is 1.00 indicating a perfect correlation. This was due to the correlation being gained between the same endogenous variable. Table 3 indicates the correlation to determine discriminant validity.

Table 3 Correlation indicating discriminant validity (General Public)

R^2	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	0.77	1.00										

3	0.60	0.64	1.00									
4	0.48	0.39	0.52	1.00								
5	0.37	0.37	0.33	0.22	1.00							
6	0.21	0.17	0.14	0.23	0.72	1.00						
7	0.36	0.27	0.22	0.24	0.67	0.67	1.00					
9	0.17	0.13	0.24	0.53	0.11	0.27	0.16	1.00				
10	0.26	0.30	0.32	0.61	0.31	0.24	0.27	0.86	1.00			
11	0.39	0.43	0.38	0.41	0.39	0.38	0.34	0.56	0.67	1.00		
12	0.22	0.25	0.18	0.14	0.13	0.11	0.13	0.24	0.36	0.53	1.00	
13	0.23	0.11	0.14	0.17	0.22	0.17	0.30	0.13	0.13	0.09	0.12	1.00

When looking at 3 x 1 and 3 x 2 (i.e. 0.60 and 0.64), these value are higher than those in row 4.

3.2.5. Reliability

The overall alpha value of 0.884 is greater than the 0.70 standard for the general public. This indicates that the TAM used in the e-survey is reliable and internally consistent. The table with the alpha value can be found in the supplementary files.

3.2.6. Descriptive Statistics

The demographic data collected consists of gender and age of the respondents. The age range consisted of categorical data which was collected from 20 – 69. The age ranges of 50 – 59 and 60 – 69 were excluded from the dataset because they consisted of outliers in the dataset. The gender consisted of male and female.

3.2.6.1 Age vs whether the general public would like to use HR-IoTS:

Descriptive statistics were run to compare the respondents' ages and whether they would like to use HR-IoTS. Thereafter, Chi Square testing was used to determine whether the younger (i.e. 20 – 29) age range would be more likely to enjoy using HR-IoTS. Table 4 indicates the differences in the age of the general public and their willingness to use a HR-IoTS.

Table 4 Age vs percentage of members of the general public who would like to use HR-IoTS

Age (%)	Strongly Agree	Somewhat Agree	Agree	Neither Agree nor Disagree	Disagree	Somewhat Disagree	Strongly Disagree	Total
20 – 29 (number)	40	39	11	2	0	2	1	95
20 – 29 (%)	42.11	41.05	11.58	2.11	0.00	2.11	1.05	100.00
30 – 39 (number)	15	10	4	3	1	2	1	36
30 – 39 (%)	41.67	27.78	11.11	8.33	2.78	5.56	2.78	100.00
40 – 49 (number)	2	3	1	2	0	0	1	9
40 – 49 (%)	22.22	33.33	11.11	22.22	0.00	0.00	11.11	100.00
50 – 59 (number)	0	1	0	1	0	0	0	2
50 – 59 (%)	0.00	50.00	0.00	50.00	0.00	0.00	0.00	100.00
60 – 69 (number)	1	0	0	0	0	0	1	2
60 – 69 (%)	50.00	0.00	0.00	0.00	0.00	0.00	50.00	100.00

Total (number)	58	53	16	8	1	4	4	140
Total (%)	40.28	36.81	11.11	5.56	0.69	2.78	2.78	100.00

This was compared to the seven indicators on the Likert scale. The largest number of participants was in the age range of 20–29 (40.71%).

Strongly Agree vs Strongly Disagree

42.11% of the respondents between the ages of 20–29 responded strongly agree while 1.05% responded strongly disagree that they would like to use HR-IoTS. 41.67% of the respondents between the ages of 30–39 strongly agreed while 2.78% strongly disagreed that they would like to use HR-IoTS. 22.22% of respondents between the age ranges of 40–49 strongly agreed while 11.11% strongly disagreed that they would like to use HR-IoTS.

Somewhat Agree vs Somewhat Disagree

41.05% of respondents between the ages of 20-29 somewhat agreed while 2.11% somewhat disagreed that they would like to use HR-IoTS. 33.33% of respondents between the ages of 40–49 somewhat agree while none somewhat disagree that they would like to use HR-IoTS. 27.78% within the age range of 30-39 somewhat agree while 5.56% somewhat disagree that they would like to use HR-IoTS.

Agree vs Disagree

11.58% of respondents between the ages of 20–29 agreed while none disagree that they would like to use HR-IoTS. 11.11% of respondents between the ages of 30–39 and 40 – 49 agreed that they would like to use HR-IoTS. 2.78% of respondents between the age ranges of 30–39 disagreed that they would like to use HR-IoTS, while none disagreed in the age range 40–49.

The highest percentages were gained in the 20–29 age range with 42.11% who strongly agree, 41.05% who somewhat agree, and 11.58% who agree that they would like to use HR-IoTS. This demonstrates that this is the age range that mostly would like to use HR-IoTS, are in the age range of 20–29. However, when looking across all groups, the majority of respondents indicated their willingness to use HR-IoTS. The respondents in the age range 40–49 had the lowest percentage i.e. respondents that would like to use HR-IoTS.

The p-value is 0.012 and thus suggest a statistically significant difference between the various age groups and whether they would like to use HR-IoTS.

3.2.6.2 Gender

There was a marginal difference between male and female on whether they would like to use HR-IoTS. *Figure 5* illustrated the total responses from female and male respectively while *Figure 6* compares the percentage of each gender and whether they would like to use HR-IoTS. Table 5 indicate the differences in the gender of the general public and their willingness to use HR-IoTS.

45.61% (n=26) male participants and 36.78% (n=32) female participants strongly agreed that they would like to use HR-IoTS. 44.83% (n=14) females somewhat agreed that they would like to use HR-IoTS. This was the highest answer in terms of percentage among female participants indicating that most female participants only somewhat agreed. The p-value was 0.053 which was greater than 0.05 suggesting that there was no statistically significant difference in gender when it pertained to willingness to use HR-IoTS.

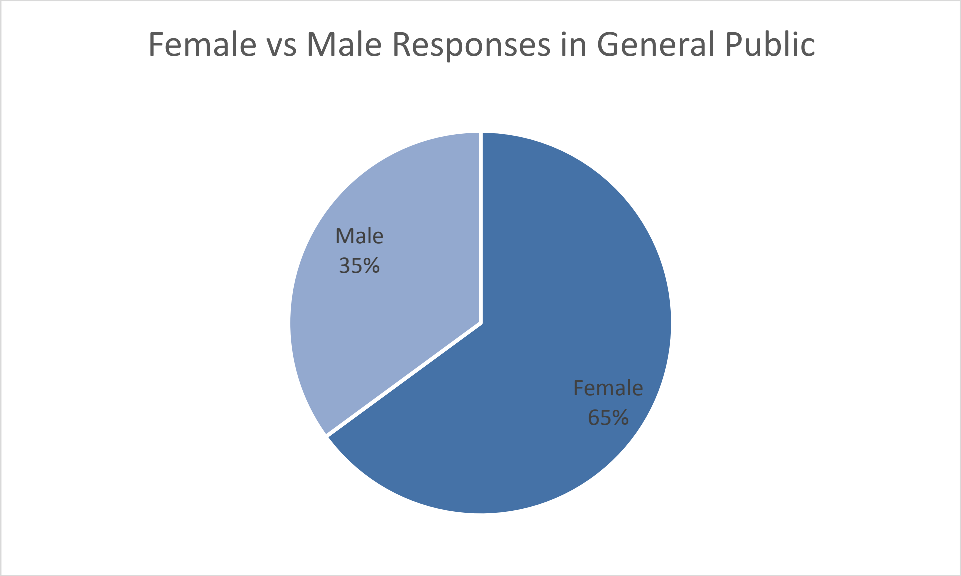

Figure 5 Total of Male vs Female Responses in the General Public

Table 5 Gender vs percentage of the general public who would like to use HR-IoTS

Gender	Strongly Agree	Somewhat Agree	Agree	Neither Agree nor Disagree	Disagree	Somewhat Disagree	Strongly Disagree	Total
Male (number)	26	14	9	5	1	0	2	57
Male (%)	45.61	24.56	15.79	8.77	1.75	0.00	3.51	100.00
Female (number)	32	39	7	3	0	4	2	87
Female (%)	36.78	44.83	8.05	3.45	0.00	4.60	2.30	100.00
Total (number)	58	53	16	8	1	4	4	144
Total (%)	40.28	36.81	11.11	5.56	0.69	2.78	2.78	100.00

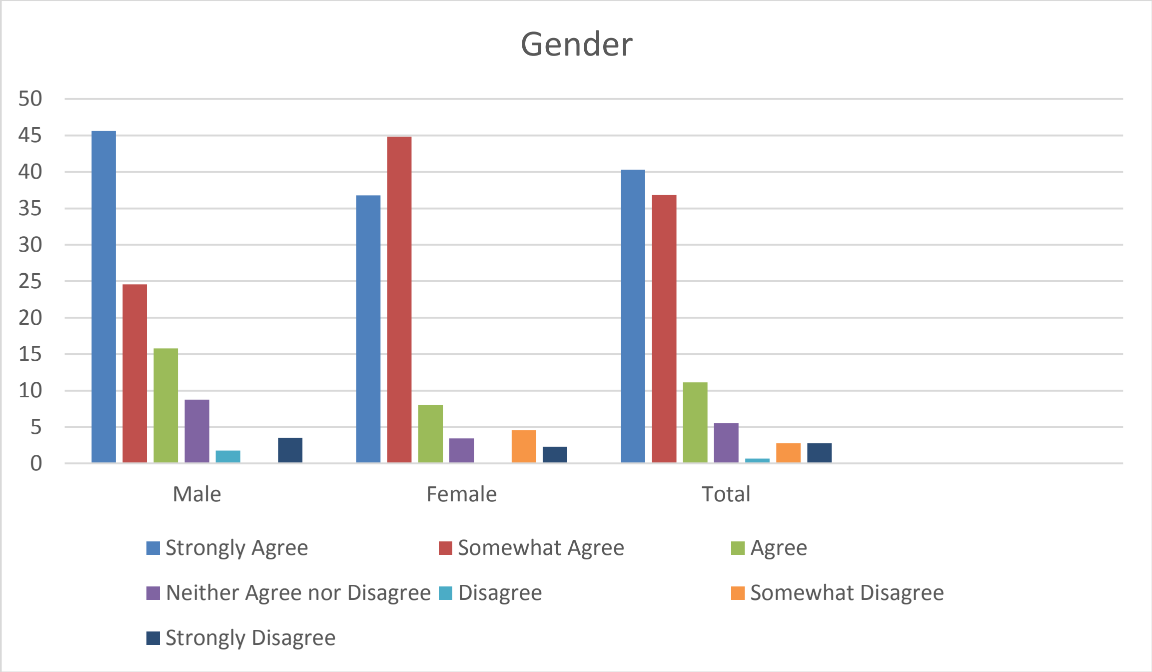

Figure 6 Gender vs percentage of the general public who would like to use HR-IoTS

3.3. Healthcare:

3.3.1. Healthcare Practitioners:

Healthcare practitioners included in this study were doctors, nurses, pharmacists, occupational therapists (OTs), physiotherapists, clinical associates, biokineticists, and other healthcare practitioners. Most of the participants who replied to the survey were either pharmacists or occupational therapists. As such all other healthcare practitioners were combined in a third group called other for data analysis purposes. Table 6 demonstrates the type of healthcare professionals as well as the number and percentage that were willing to use a HR-IoTS.

3.3.2. Type of Healthcare practitioner

Table 6 The type of healthcare practitioner vs the percentage that would like to use HR-IoTS

Healthcare Practitioners (%)	Strongly Agree	Somewhat Agree	Agree	Neither Agree nor Disagree	Disagree	Somewhat Disagree	Strongly Disagree	Total
Pharmacists (number)	19	8	3	0	1	0	0	31
Pharmacists (%)	61.29	25.81	9.68	0.00	3.23	0.00	0.00	100.00
OTs (number)	8	4	5	1	0	0	0	18
OTs (%)	44.44	22.22	27.78	5.56	0.00	0.00	0.00	100.00
Others (number)	6	7	1	0	0	1	0	15
Others (%)	40.00	46.67	6.67	0.00	0.00	6.67	0.00	100.00
Total (number)	33	19	9	1	1	1	0	64
Total (%)	51.56	29.69	14.06	1.56	1.56	1.56	0.00	100.00

61.29% (n=19) of the pharmacists 44.44% (n=8) of OTs, and 40.00% (n=6) of other healthcare practitioners strongly agreed that they would like to use HR-IoTS. 25.81% (n=8) of pharmacists, 22.22% (n=4) of OTs, and 46.67% (n=7) of other healthcare practitioners somewhat agreed that they would like to use HR-

IoTS. 9.68% (n=3) of pharmacists; 27.78% (n=5) of OTs; and 6.67% (n=1) of other healthcare practitioners agreed that they would like to use HR-IoTS.

None of the healthcare practitioners (i.e. pharmacists, OTs and other healthcare practitioners) strongly disagreed that they would like to use HR-IoTS. None of the pharmacists or OTs somewhat disagreed, while 6.67% (n=1) of other healthcare practitioners somewhat disagreed that they would like to use a HR-IoTS. 3.23% (n=1) of pharmacists disagreed while none of the OTs or other healthcare practitioners disagreed that they would like to use HR-IoTS.

From the results obtained from all healthcare practitioners, it can be concluded that the majority of pharmacists (96.77%) would like to use HR-IoTS. This is followed by occupational therapists (OTs) (94.44%) and other healthcare practitioners (93.33%) whose responses indicated that they would in some way like to use HR-IoTS. Thus, it can be concluded that a majority of healthcare practitioners would like to use HR-IoTS.

The p-value of 0.686 obtained from a Chi squared test suggested that there was no statistically significant difference between the various professional groups and whether they would like to use a HR-IoTS.

3.3.3. Gender:

Tables 7 examine the number and the percentage of healthcare practitioners who would like to use a HR-IoTS in terms of their gender.

73.91% (n=17) males and 39.02% (n=16) females strongly agreed that they would like to use HR-IoTS. 36.59% (n=15) females and 17.39% (n=4) males somewhat agreed that they would like to use HR-IoTS. 8.70% (n=2) males and 17.07% (n=7) females agreed that they would like to use HR-IoTS. 2.44% (n=1) females and no males disagreed that they would like to use HR-IoTS. However, one male (2.44%) and no females somewhat disagreed that they would like to use HR-IoTS. The p-value was 0.172 which was greater than 0.05 suggesting no statistically significant difference in gender when it pertains to using IoT healthcare services amongst healthcare practitioners.

Table 7 Gender vs the percentage of healthcare practitioners who would like to use HR-IoTS

Gender	Strongly Agree	Somewhat Agree	Agree	Neither Agree nor Disagree	Disagree	Somewhat Disagree	Strongly Disagree	Total
Male (number)	17	4	2	0	0	1	0	24
Male (%)	73.91	17.39	8.70	0.00	0.00	0.00	0.00	100.00
Female (number)	16	15	7	1	1	0	0	40
Female (%)	39.02	36.59	17.07	2.44	2.44	2.44	0.00	100.00
Total (number)	33	19	9	1	1	1	0	64
Total (%)	51.56	29.69	14.06	2.44	2.44	2.44	0.00	100.00

3.3.4. Age

Table 8 indicate the differences in the age of healthcare practitioners and their willingness to use HR-IoTS. Age ranges between 40 – 49, 50 – 59, and 60 – 69 were excluded because they were considered as outliers.

Table 8 Age vs the percentage of healthcare practitioners would like to use HR-IoTS

Age	Strongly Agree	Somewhat Agree	Agree	Neither Agree nor Disagree	Disagree	Somewhat Disagree	Strongly Disagree	Total
20 – 29 (number)	20	13	8	0	1	0	0	42
20 – 29 (%)	47.62	30.95	19.05	0.00	2.38	0.00	0.00	100.00
30 – 39 (number)	10	6	0	1	0	1	0	18
30 – 39 (%)	55.56	33.33	0.00	5.56	0.00	5.56	0.00	100.00
40 – 49 (number)	2	0	1	0	0	0	0	3
40 – 49 (%)	66.67	0.00	33.33	0.00	0.00	0.00	0.00	100.00
50 – 59 (number)	1	0	0	0	0	0	0	1
50 – 59 (%)	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
60 – 69 (number)	0	0	0	0	0	0	0	0
60 – 69 (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Total (number)	33	19	9	1	1	1	1	64
Total (%)	51.56	29.69	14.06	1.56	1.56	1.56	0.00	100.00

47.62% (n=20) of the respondents between the ages of 20 - 29 strongly agreed while none strongly disagreed that they would like to use HR-IoTS. 55.56% (n=10) of the respondents between the ages of 30–39 strongly agreed while none strongly disagreed that they would like to use HR-IoTS. 30.95% (n=13) of respondents between the ages of 20-29 somewhat agreed while none somewhat disagreed that they would like to use HR-IoTS. 33.33% (n=6) within the age range of 30–39 somewhat agreed while none somewhat disagree that they would like to use HR-IoTS. 19.05% (n=8) of respondents aged 20–29 agreed while 2.38% (n=1) disagreed that they would like to use HR-IoTS. None of the respondents between the ages of 30–39 agreed nor disagreed that they would like to use HR-IoTS.

This demonstrates that this is the age range that mostly would like to use HR-IoTS, are in the age range of 20–29 and 30–39. However, when looking across all groups, the majority of healthcare practitioners would like to use HR-IoTS

A chi-squared test was to determine whether there was statistical significance between the different agent groups of healthcare professional and their intent to use HR-IoTS. The p- value obtained was 0.686 and this suggests that there was no statistically significant difference between any of the age groups despite the apparent ages of the participants in the survey.

3.3.5. Confidence in IoT Healthcare Related Services of Healthcare Practitioners:

Table 9 indicates the age of healthcare practitioners in relation to their confidence in recommending a HR-IoTS to their patients.

The respondents in the age ranges of 40 – 49, 50 – 59, and 60 – 69 were excluded to prevent outliers from the sample.

Ages 20-29

28.57% (n=12) of respondents strongly agreed; 16.67% (n=7) of respondents somewhat agreed; and 40.48% (n=17) of respondents agreed to feeling confident in recommending the HR-IoTS as a method of tracking their patients' health progress in the age range of 20–29.

None of the respondents in this strongly disagreed; 4.76% (n=2) of respondents somewhat disagreed; and 2.38% (n=1) of respondents disagreed to feeling confident in recommending the HR-IoTS as a method of tracking their patients' health progress in the age range of 20 – 29.

Ages 30-39

38.89% (n=7) of respondents strongly agreed; 16.67% (n=3) of respondents somewhat agreed; and 27.78% (n=5) of respondents agreed to feeling confident in recommending the HR-IoTS as a method of tracking their patients' health progress in the age range of 30 – 39.

None of the respondents across any age group strongly disagreed or disagreed while 5.56% (n=1) of respondents somewhat disagreed to feeling confident in recommending the HR-IoTS as a method of tracking their patients' health progress in the age range of 30 – 39.

Table 9 Age vs confidence of healthcare practitioners in recommending HR-IoTS to their patients

Age	Strongly Agree	Somewhat Agree	Agree	Neither Agree nor Disagree	Disagree	Somewhat Disagree	Strongly Disagree	Total
20 – 29 (number)	12	7	17	3	1	2	0	42
20 – 29 (%)	28.57	16.67	40.48	7.14	2.38	4.76	0.00	100.00
30 – 39 (number)	7	3	5	2	0	1	0	18
30 – 39 (%)	38.89	16.67	27.78	11.11	0.00	5.56	0.00	100.00
50 – 59 (number)	2	0	0	0	1	0	0	3
50 – 59 (%)	66.67	0.00	0.00	0.00	33.33	0.00	0.00	100.00
60 – 69 (number)	1	0	0	0	0	0	0	1
60 – 69 (%)	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Total (number)	22	10	22	5	2	3	0	63
Total (%)	34.38	15.63	34.38	7.81	3.13	4.69	0.00	100.00

A Chi-squared was used to test for statistical significance of the data. There was no statistically significant difference ($p = 0.406$) between respondents' age's and their confidence in recommending HR-IoTS.

3.3.6. Prior knowledge vs confidence by healthcare practitioners in recommending HR-IoTS.

Table 10 illustrates the results of the comparison between prior knowledge of IoT and the percentage of healthcare practitioners' confidence at recommending a HR-IoTS to their patients.

Table 10 prior knowledge of IoT and confidence by healthcare practitioners in recommending HR-IoTS.

Prior Knowledge of IoT	Confidence in Recommending HR-IoTS							
	Exposure	**Strongly Agree**	**Somewhat Agree**	**Agree**	**Neither agree nor disagree**	**disagree**	**Somewhat disagree**	**Strongly disagree**
	Strongly Agree (number)	9	0	1	0	0	0	0
	Strongly Agree (%)	90.00	0.00	10.00	0.00	0.00	0.00	0.00
	Somewhat agree (number)	3	3	4	0	0	0	0
	Somewhat agree	30.00	30.00	40.00	0.00	0.00	0.00	0.00

	(%)							
	Agree (number)	1	4	2	0	1	0	0
	Agree (%)	12.50	50.00	25.00	0.00	12.50	0.00	0.00
	Neither Agree nor Disagree (number)	2	0	2	2	0	0	0
	Neither Agree nor Disagree (%)	33.33	0.00	33.33	33.33	0.00	0.00	0.00
	Disagree (number)	0	0	1	1	0	1	0
	Disagree (%)	0.00	0.00	33.33	33.33	0.00	10.00	0.00
	Somewhat Disagree (number)	0	1	9	0	1	1	0
	Somewhat Disagree (%)	0.00	8.33	75.00	0.00	8.33	8.33	0.00
	Strongly Disagree (number)	7	2	3	2	0	1	0
	Strongly Disagree (%)	46.67	13.33	20.00	13.33	0.00	6.67	0.00

	Total (number)	22	10	22	5	2	3	0
	Total (%)	34.38	15.63	34.38	7.81	3.13	4.69	0.00

90% (n=9) of healthcare practitioners who had prior knowledge of the IoT were also more willing (strongly agree) to recommend a HR-IoTS to their patient. Also 75% (n=9) of participants who somewhat disagreed with having prior knowledge of the IoT agreed that they would recommend the use of a HR-IoTS to their patient. The above results indicate that healthcare practitioners who had prior knowledge about the IoT were more confident in recommending HR-IoTS to their patients.

To determine whether or not these results were statistically significant, a Chi-squared test was used. The p-value obtained from the Chi squared test was 0.001 which suggested that there was a statistically significant difference between the healthcare practitioners' prior knowledge of IoT and their confidence in recommending HR-IoTS.

3.4. Inferential Statistics General Public:

The inferential statistics obtained for the general public were obtained by running the structural equation which was able to predict the intention to use a HR-IoTS. The constructs included in this equation were perceived ease of use, perceived usefulness, user satisfaction and attributes of usability. Table 11 illustrates the results of the exogenous variable with regards to intention to use a HR-IoTS.

Table 11 Outcome of exogenous variables

Outcome: I Would Like to Use a HR-IoTS						
Constructs	OIM Coefficient	Standard of Error	z	P-value	95% CI	
Perceived Usefulness	0.56	0.15	3.69	<0.0001	0.26	0.85
Perceived Ease of Use	0.69	0.13	5.33	<0.0001	0.43	0.94
Attributes of Usability	-0.78	0.18	-4.15	<0.0001	-1.15	-0.41
Constant	1.51	0.12	12.55	<0.0001	1.28	1.76

For every one point increase in the *outcome* (i.e. I would like to use a HR-IoTS), there is a 56.10% increase in the *perceived usefulness*. With a p-value of <0.0001 and a 95% CI (0.26 to 0.85) that did not pass 1 indicating that healthcare practitioners perceive HR-IoTS to be useful. This result indicates there was a significant positive association between perceived usefulness and the intention to use HR-IoTS.

For every one point increase in the outcome, there is a 69.41% increase in *perceived ease of use.* With a p-value of <0.0001 and a 95% CI (0.43 to 0.94) that did not pass 1 indicating that HR-IoTS to be easy to use. This result indicates there was a significant positive association between perceived ease of use and the intention to use HR-IoTS.

For every one point increase in the outcome, there is a 78.37% decrease in attributes of usability. With a p-value of <0.0001 and 95% CI (-1.15 to -0.41) that passed 1 indicating that HR-IoTS attributes are not usable. The 95%

confidence interval in perceived usefulness does not pass through one and thus is statistically significant. This result indicates there was a significant negative association between the attributes of usability and the intention to use HR-IoTS.

3.5. Inferential Statistics Healthcare Practitioners

A different structural equation was built for healthcare professionals. Due to there being more complete data available, the outcome for intention to use a HR-IoTS by a healthcare professional could be predicted using the constuct of percieved each of use, percieved usefulness, attributes of usability and user satisfaction. *Figure 10* illustrates the structural equation that was developed after 15000+ iterations were used on Stata.

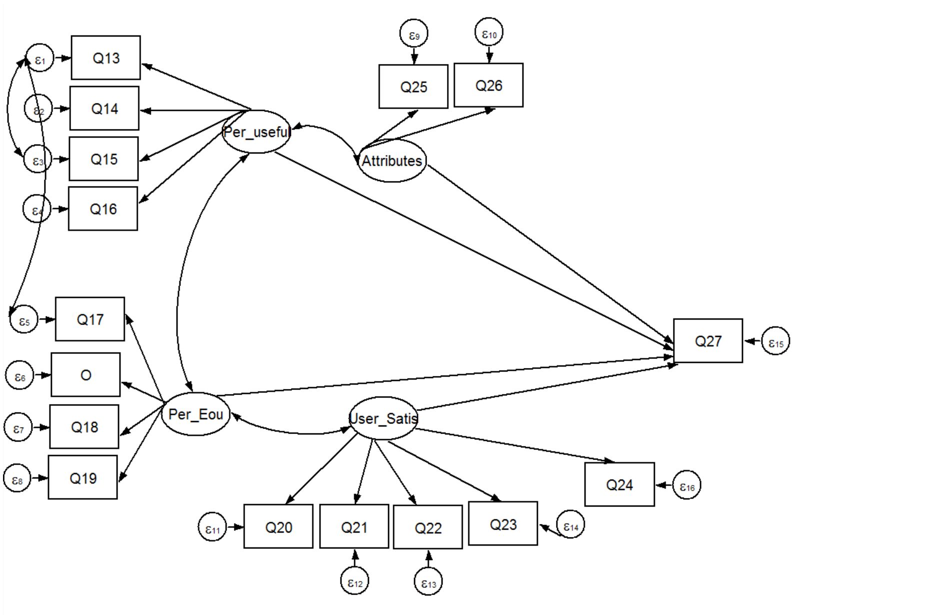

Figure 7 Structural Equation Model for Healthcare Practitioner

The inferential statistics obtained for healthcare professionals were obtained by running the structural equation (illustrated above) which was able to predict the intention to use HR-IoTS. The constructs included in this equation was perceived ease of use, perceived usefulness and attributes of usability and user statist. Table 12 illustrates the results of the exogenous variable with regards to intention to use HR-IoTS.

Table 12 Outcome of exogenous variables

Outcome: I Would Like to Use HR-IoTS						
Constructs	OIM Coefficient	Standard of Error	z	P-value	95% CI	
Perceived Usefulness	0.85	0.14	0.62	0.54	-0.18	0.36
Perceived Ease of Use	0.58	0.08	7.58	<0.0001	0.43	0.73
User Satisfaction	-0.19	0.21	-0.09	-0.93	-0.43	0.39
Attributes of Usability	0.31	0.26	1.20	0.23	-0.20	0.83
Constant	1.80	0.18	9.74	<0.0001	1.44	2.16

For every one point increase in the *outcome* (i.e. I would like to use a HR-IoTS), there is an 85.47% increase in the *perceived usefulness*. With a p-value of 0.54 this result was not statistically significant.

For every one point increase in the outcome, there is a 57.87% increase in *perceived ease of use.* With a p-value of <0.0001 and a 95% CI (0.43 – 0.73) that did not pass 1 indicating that HR-IoTS to be easy to use.

For every one point increase in the outcome, there is a 31.40% increase in *attributes of usability.* With a p-value of 0.93 and 95% CI (-0.43 - 0.39) that passed 1 indicating that healthcare practitioners do not perceive HR-IoTS to provide satisfaction.

For every one point increase in the outcome, there is a 1.95% decrease in *user satisfaction*. With a p-value of 0.23 and 95% CI (-0.20 - 0.83) that passed 1 indicating that healthcare practitioners do not perceive HR-IoTS attributes to be usable. Despite the fact that the 95% CI did not pass through one this result was still not statistically significant since the p value was >0.05. Table 13 illustrates the results of the goodness of fit test for healthcare practitioners.

3.5.1. Goodness of fit:

Table 13 Goodness of fit test for healthcare practitioners

Goodness of Fit Test	Expectation	Result
1. Root Mean Squared Error of Approximation (RMSEA)	<0.05	0.222
2. Comparative Fit Index (CFI)	>0.95	0.663
3. Tucker-Lewis Index (TLI)	>0.95	0.588
4. Chi Square Model vs Saturated (chi_ms)	>0.05	407.86

There was no goodness of fit between the model and the data. Thereafter, covariances were added to attempt to improve the goodness of fit, however, the fit could not be improved upon. Thus, we were unable to determine convergent validity, discriminant validity, and reliability.

CHAPTER 4: Discussion of results

4.1. TAM:

The TAM was tested to determine if this was adequate to use in order to collect the data. In order to utilise this model, it needed to be determine that this model had validity as well as reliability and internal consistency. This was established through testing the model. Validity was obtained through analysis of the covariance between the various constructs. It was found that all of these were below 0.90 suggestive of a low covariance. Goodness of fit was found between the data and the chosen model (i.e. the modified TAM). Thereafter discriminant validity was determined as R^2 was found to be less than 0.90. Reliability and internal consistency was determined through finding an alpha that was greater than 0.70. Therefore, the TAM was found to be usable in various populations and is not subject to information or response bias. These all demonstrate that the model is valid and reliable. However, the constructs used in my study were not the same as the constructs used in Tavares and Oliveira, (2016) therefore my validity and reliability cannot be compared.

4.1.1. Validity and Reliability:

The model was built using SEM. The covariance was found to be below 0.90 indicating that the questions in their respective constructs were different enough to warrant their being in different constructs.

With regard to testing the model, it was determined that the model fits well and has good convergent validity (i.e. high factor loading) and good discriminant validity (i.e. low moderate factor correlations). Discriminant Validity was determined through finding that R^2 was less than 0.9 through the use of correlation. The goodness of fit test was conducted by finding the RMSEA, CFI, TLI, and chi_ms were within their relevant ranges.

4.2. General Public

4.2.1. Gender

There was no statistical difference between various genders (i.e. male and female) and whether they would like to use HR-IoTS. This demonstrates to us the robustness of our data collection and tells us there was no gender differences between willingness to use an IoT service. The findings of our study were similar to that Leitner et al, (2010) who also noted a lack of gender differences in terms of willingness to use an IoT service. We expected this result, and thus it was unsurprising. Given that this result was only taken from a sample population who lived in Gauteng, we cannot generalize the data to the entire country, but we theorize that this is unlikely to change even if we had respondents from the entire country.

4.2.2. Age

In the general population sample there was a statistically significant difference (p = 0.012) between the age groups and whether they would like to use a HR-IoTS. However, when comparing this study to the study by Porter and Donthu, (2006), found that the demographic data was not statistically significant. The reason for the difference could be that there were small amounts of respondents in the two older age groups (i.e. 50 – 59 and 60 – 69). As such, they could be considered outliers in the dataset. As such this result should be interpreted with caution. Although no statistically significant difference was found between the younger and older age group in the study by Porter and Donthu, (2006), it was found that there were lower usage rates amongst the older age group (>50-years-old) and higher usage rates amongst the younger age group (<35-years-old). In the future, more respondents within the age ranges of 50–59 and 60–69 should attempt to be obtained, in order to gain an understanding of whether they would like to use HR-IoTS. This is especially relevant given the potential use of HR-IoTS in chronic disease management (Karahoca et al., 2018).

4.3. Healthcare Professionals

4.3.1. Gender

In the healthcare practitioner sample, there was no statistically significant difference between various genders (i.e. male and female) and whether they would like to use HR-IoTS. The findings of our study support the assertion that there is no statistically significant difference between males and females intent to use an IoT service which is similar to the findings of Leitner et al, (2010). The sample used in our study cannot be generalised to the greater population of South Africa, in the same way as the findings of the study by Achituv and Haiman, (2016) was generalised to the greater population of Israel. There is a possibility, that had the entire population of South Africa been used, instead of the population of one province (despite it being the most densely populated province in the country), I may have found a similar result to their study and this could explain the differences between my results and the results found by Achituv and Haiman, (2016). Furthermore, there were differences in the methodology and therefore direct comparison becomes more of a challenge.

4.3.2. Age

In the healthcare practitioner population sample, there was a no statistically significant difference between the various age groups and whether they would like to use a HR-IoTS. When comparing this result to the study by (Porter and Donthu, 2006), it was found that the demographic data was not statistically significant. However, it was furthermore found that although no statistically significant difference found, it was found that usage rates were lower amongst the older group (>50-years-old) and higher amongst the younger group (<35-years-old) (Porter and Donthu, 2006). In another study by Lu et al, (2006), it was found that in the Chinese population, older people do not adopt new technology as fast as younger people do. Furthermore, a study by Achituv and Haiman, (2016) found that older healthcare practitioners had lower willingness to use HR-IoTS than younger healthcare practitioners and this finding was statistically significant. Alternatively, in a study by Tavares and Oliveira, (2016), it was found that older individuals more so than younger individuals make use of IoT type electronic health record technologies. Comparatively, the dataset in our study suggests that there is no statistically significant difference between younger healthcare practitioners and older healthcare practitioners. However, it should be noted that in the dataset used in our study, there were very few respondents in the older age groups which could be the reason as to the contradiction in the results between our study and the above-mentioned studies. In the future, more respondents within the age ranges of 40–49, 50–59 and 60–69 should attempt to be obtained, in order to gain an understanding of whether they would like to use HR-IoTS in their practices.

4.3.3. Age and confidence

Among healthcare practitioners, there was no statistically significant difference between various age groups and their confidence in recommending HR-IoTS. This is expected.

4.3.4. Exposure and Confidence in recommending:

Among healthcare practitioners, it was found that those who had prior knowledge of IoT were more likely to recommend HR-IoTS to their patient and this result was statistically significant ($p = 0.001$). A similar finding was observed by Achituv and Haiman, (2016) who also noted amongst healthcare practitioners, those more willing to adopt HR-IoTS as well as recommend these to their patients had prior exposure to IoT. Thus our findings support the findings of Achituv and Haiman, (2016), despite methodological differences.

4.4. Healthcare Design of SEM

Despite numerous attempts to introduce covariance into the model for healthcare practitioners, there was poor goodness of fit between the model and the data. Our findings with regards to the model and goodness of fit are in contrast to those of Porter and Donthu, (2006). Porter and Donthu, (2006) were able to introduce links between their variables and in so doing, established a better fit of their model to their data. The most plausible explanation for why the model did not fit our dataset was due to the fact that we did not have a sufficient number of healthcare practitioners who answered the e-survey. There was insufficient power in terms of respondents who were healthcare practitioners to build a model which demonstrated goodness of fit for the dataset. As such, we are unable to make firm conclusions with regards to the intent to use HR-IoTS within the healthcare practitioners' context. A recommendation that can be made is to either consider producing one survey which targets both healthcare practitioners and patient simultaneously or alternatively, to produce a survey that solely targets healthcare practitioners. A possible reason for the poor response to our e-surveys from healthcare practitioners could be their limited available free time to answer our survey. Despite the fact that our survey was designed to be completed within 5 minutes, this still did not ameliorate the lack of time that healthcare practitioners have.

4.5. General Public and the Structural Equation Results

The findings of our study illustrate that perceived ease of use ($p<0.0001$) has a positive effect on the behavioural intention to use HR-IoTS. Furthermore, our study findings illustrates that there is a positive relationship between perceived usefulness ($p<0.0001$) and the behavioural intent to use HR-IoTS. However, negative attributes of HR-IoTS, were negatively associated with the behavioural intention to use HR-IoTS.

When comparing our results to that of Gao and Bai, (2014), we find a similar result to ours. Gao and Bai, (2014) also reported a positive relationship between perceived ease of use and perceived usefulness on behavioural intention to use an IoT service. However, their findings do not support our findings with regards to the relationship between a behavioural intention to use HR-IoTS and attributes of that service. This can be accounted for by the fact that Gao and Bai, (2014), did not include attributes of the IoT service as one of the constructs in their SEM. Gao and Bai, (2014) also found that there was a positive relationship between perceived usefulness ($p<0.001$) and perceived ease of use ($p<0.001$) with behavioural intention. Similar results were found in our study.

The positive association between perceived ease of use as well as perceived usefulness with regards to intent to use HR-IoTS, is a finding that is consistent with that of Karahoca et al., (2018). Karahoca et al., (2018) also noted that there is a relationship between perceived ease of use and perceived usefulness in that if something is perceived to be easy to use, it will be perceived as useful. This further validates the robustness of our data. Perceived ease of use was found by Karahoca et al., (2018) to have a significant effect on intention to adopt HR-IoTS.

A possible interpretation of our data could be as follows: when general public look at HR-IoTs they find it useful and easy to use but the attributes may prevent them from using it. The attributes make it difficult for individuals to use it. Despite the fact that our data is suggestive of the fact that attributes of usability may prevent members of the public from using HR-IoTS, Porter and Donthu, (2006) suggested that perceived ease of use and perceived usefulness were more strongly correlated to the usage of new technology than other components. One could infer that the data on perceived ease of use and perceived usefulness may provide a better indication as whether the general public would adopt HR-IoTS in real life. Abu-Dalbouh, (2013) did note that the attributes of usability could be changed to facilitate better ease of use.

4.6. Strengths and Limitations of Study

This is the first study based on a South African context looking at intention to use HR-IoTS. Furthermore, it is also the first study looking at healthcare practitioner's intention to use and recommend HR-IoTS to their patients. The modified TAM was confirmed to be valid in determining intention to use as well as reliable. The model fits well with the data, however, it is limited in that it did not look at other components which affect intention to use such as trust, security, social influence, and enjoyment.

This study did look into intention to use, however, it did not look at actual usage and furthermore, this was not included in the proposed model. Although the intention to use was analysed, an in-depth understanding about the motivation to use was not discussed. There could be other variables affecting intention to use which were not explored such as trust, security, and privacy. Furthermore, the entire population within South Africa was not included which affected the ability for this research to be generalised across the entire South African population. Not enough responses were gained in various age groups i.e. 50 – 59 and 60 – 69. This would allow for better representation and analysis within the sample.

Despite the fact that the survey was opened for a period of a month and a large number of healthcare professionals were invited to participate in the study through professional networks, there was insufficient power in this sample to obtain a meaningful structural equation that could pass a goodness of fit test. With this in mind the results from that SEM that predict intention to use must be interpret with caution and should be the subject of another study that is sufficiently powered. Quantitative research uses numbers to measure and analyse the relationship between variables in order to make a determination on how many respondents behave in a certain manner, however neglects to answer why these respondents behave that way (Abu-Dalbouh, 2013).

Unlike the study by Karahoca et al., (2018), we did not have as inclusion criteria owning an IoT device. This may have limited our results and could account for the negative association in attributes of usability.

4.7. Future Studies

Focus groups to understand what specific attributes pertaining to a HR-IoTS reduce the intent to use the service. In the future, a qualitative study to better understand intent to use IoT technologies by future potential consumers. Otherwise, a mixed methods study will be interesting in determining why It would also be nice to look at individual’s awareness of the IoT and whether usage has a positive impact on their intention to use IoT services. In order to validate the study, it would be nice to establish studies in similar markets such as BRICS (Brazil, Russia, India, and China) to see what results can be found. Following adequate engagement of consumers with HR-IoTS, it would be beneficial to look into other factors that influence intent to use such as trust, enjoyment, social influence, and privacy through a well-tested model i.e. UTAUAT2. Additionally, a larger respondent base including greater respondents in all age groups will be beneficial in verifying any differences in age and intention to use. An e-survey designed for specifically for healthcare practitioners only that would achieve sufficient power to build a best fit model for the data should be considered as a future study as this will provide greater and more precise information with regards to the intent to use a HR-IoTS by healthcare practitioners.

CHAPTER 5: Conclusion

It has been suggested by Davis, (1989), that the reason behind individual's adoption of new technology is as a result of the offered functionality as opposed to its ease of use (Porter and Donthu, 2006). The reason is seen as a result of the individual's motivation being the inherent benefits offered from the use of the new technology making them more willing to overcome the challenges associated to learning how to use the new technology (Porter and Donthu, 2006). Lu et al, (2006) confirms the future motivation demonstrated by older people to learn the new technology. Therefore, even though research has found that younger consumers are more willing to use new technology, it must be noted that there are plenty of benefits that could be afforded from older people using new technology, especially in healthcare (Porter and Donthu, 2006; Fox, 2004). This is because older consumers are more likely to search online for health related products and services and have greater spending power compared to younger consumers (Porter and Donthu, 2006; Moschis et al, 2004).

The SEM that we generated for the general public to determine the intention to use HR-IoTS was tested and it was found to have convergent validity, discriminant validity and reliability. The results from the descriptive statistics within the general public and healthcare practitioners indicate no statistically significant difference between gender and intention to use HR-IoTS with $p>0.05$. In the general public, there was a statistically significant difference between various age groups, however, the older age groups were not well represented and thus this result must be interpreted with some caution. In the healthcare group, no statistically significant difference was identified in the various age groups compared to their intention to use and confidence in recommending HR-IoTS, however, the older age groups were not well represented. The structural equation developed for the general public indicated that the there was a positive association between the intention to use a HR-IoTS and perceived ease of use and perceived usefulness. Both results were statistically significant However, there was negative association between intention to use HR-IoTS and the attributes of an IoT device and this result was also statistically significant. The method of data collection precluded the ability to determine why this was this was the case. Within the healthcare group, it was found that there was a statistically significant difference between prior knowledge of IoT services and confidence in recommending HR-IoTS. There was a statistically significant difference in perceived ease of use in the healthcare practitioners group, however, the model used in this group did not present goodness of fit and was therefore unable to be verified as being valid or reliable.

Among members of the general public it was clear that there was a positive association between perceived ease of use and perceived usefulness of HR-IoTS and the intention to use such a service. This did not hold true for attributes of IoT for which there was a negative association with intention to use. It can thus be concluded that the attributes of HR-IoTS may preclude members of the public from using it. With regards to healthcare professionals only perceived ease of use was positively associated with intention to use HR-IoTS. Taking into account that the structural equation developed for healthcare professionals did not pass the goodness of fit test, this result must be interpreted with caution.

Since this was the first study of its kind in South Africa to examine the intention to use HR-IoTS, we did not include a qualitative research component such as focus group. Future studies should involve determining the potential attributes of HR-IoTS which have dissuaded members of the public from engaging with this service. A future study should also focus only on healthcare professional by themselves so that the number of respondents to the survey can achieve sufficient power to ensure that a meaningful structural equation can be built. The results of our description statistics on healthcare professionals indicated to us that they would be willing to recommend an IoT service to monitor their patients' healthcare only if they had prior knowledge of the IoT. For this reason more must be done to increase the knowledge of healthcare professionals with regards to the IoT.

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SUPPLEMENTARY APPENDICIES

A1. Figure of Structural Equation Modelling using Confirmatory Factor Analysis.

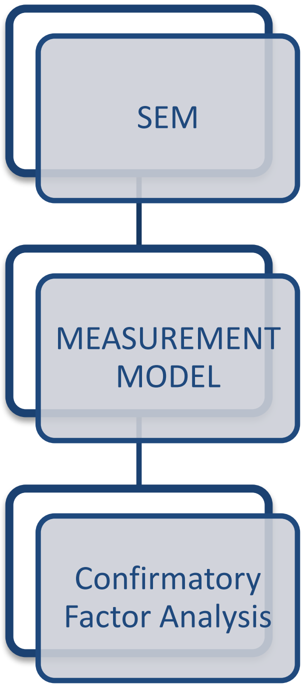

Figure 8: Structural Equation Modelling using Confirmatory Factor Analysis

A.2 Explanation of Build of Structural Equation Model

The squares represent the different indicators (questions) i.e. the endogenous variables. The circles represent the latent variables (constructs) i.e. the exogenous variables. The curved arrows are used to determine the covariance between the various constructs i.e. the exogenous variables. The lower the covariance represents that the questions differ and thereby need to be placed under different constructs.

A3. Reliability: Alpha Table

Item	Obs Sign	Correlation	Correlation	Covariance	Alpha
Q39	144 +	0.7768	0.7073	0.4252246	0.8669
Q40	144 +	0.7515	0.6867	0.4375687	0.8687
Q42	144 +	0.7474	0.6809	0.4433912	0.8700
Q43	144 +	0.6417	0.5456	0.4515365	0.8760
Q44	144 +	0.7512	0.6636	0.4196262	0.8695
Q45	144 +	0.7984	0.7353	0.4209722	0.8656
Q47	144 +	0.7283	0.6337	0.414219	0.8710
Q35	144 +	0.3743	0.3270	0.5230921	0.8879
Q36	57 +	0.6090	0.4967	0.4648383	0.8817
Q37	57 +	0.7297	0.6369	0.4553606	0.8790
Q38	57 +	0.7250	0.6721	0.4681719	0.8790
U	57 +	0.4391	0.3344	0.4782376	0.8838
V	144 +	0.6421	0.5293	0.435709	0.8816

Test Scale				0.44966	0.8816

A4. Key for Structural Equation Model for General Public

Table 14: Key for Structural Equation Model for General Public

Key:
Perceived Usefulness
Q39 – The use of a healthcare related IoT device will enable my healthcare practitioner to monitor me remotely. Q40 – The use of a healthcare related IoT device will allow my healthcare practitioner to follow up with me from outside the hospital. Q42 – The use of a healthcare related IoT device will allow for rapid retrieval of information of my healthcare information for my healthcare practitioner. Q43 – Using a healthcare related IoT service will allow my healthcare practitioner to easily monitor my chronic condition control.
Perceived Ease of Use
Q44 – Learning to use a healthcare related IoT device will be easy for me. Q45 – My interaction with a healthcare related IoT service will be clear and understandable. Q47 – It would be easy for me to become skilful at using a healthcare related IoT service.
User Satisfaction
Q35 – I own a smartwatch. Q36 – If yes, I am completely satisfied with my smartwatch’s ability to track my health progress. Q37 – I feel confident in using a smartwatch as a method to monitor my health

progress.
Attributes of Usability
Q38 – It is easy to interact with a smartwatch. Q39 – I found the various functions between the health related app and smartwatch tend to easily integrate.
Outcome
V – Intention to use.

A5. Key for Structural Equation Model for Healthcare Practitioners

Table 15 Key for Structural Equation Model for Healthcare Practitioners

Key:
Perceived Usefulness
Q13 – The use of a healthcare related IoT device will enable me to monitor my patient. Q14 – The use of a healthcare related IoT device will allow me to follow up with my patient from a remote location. Q15 – The use of a healthcare related IoT device will allow me to rapidly retrieve information of patients' healthcare information. Q16 – Using a healthcare related IoT device will allow me to easily monitor my patient's chronic condition control.
Perceived Ease of Use
Q17 – Learning to use a healthcare related IoT service will be easy for me. O – Learning to use a healthcare related IoT service will be easy for my patients. Q18 – Using a healthcare related IoT service to track my patient would afford me flexibility in treating them. Q 19 – My interaction with a healthcare related IoT service will be clear and understandable.

User Satisfaction
Q20 – I own a smartwatch. Q21 – If yes, I am completely satisfied with my smartwatch’s ability to track my health progress. Q22 – I feel confident in recommending healthcare related IoT devices as a method to track my patients’ health progress. Q23 – I feel confident in using a smartwatch as a method to my health progress. Q24 – I believe that from using a healthcare related IoT device, I can track a patient’s progress and this will increase the quality of care in the healthcare industry.
Attributes of Usability
Q25 – It is easy to interact with a smartwatch. Q26 – I found various functions between the health related app and smartwatch tend to easily integrate and serve the functions that I require out of it.
Outcome
Q27 – Intent to use.

A6. E-Survey

Demographic Data:

Generic Questions
1. Gender: ○ Male ○ Female ○ I do not wish to disclose
2. Age: ○ 20 – 29 ○ 30 – 39 ○ 40 – 49 ○ 50 – 59 ○ 60 – 69
3. Province: ○ Gauteng ○ Limpopo ○ North West ○ Northern ○ KwaZulu Natal ○ Western Cape ○ Free State ○ Eastern Cape ○ Mpumalanga If the person is not a resident of Gauteng, no further questions were asked.
4. Are you one of the following health care practitioners ○ Doctor ○ Nurse

- Pharmacist
- Occupational therapist
- Physiotherapist
- Physician assistant
- Biokineticist
- I am none of the above

5. If yes, I have been practising for?

- 0 – 5
- 6 – 10
- 11 – 15
- 16 – 20
- >20

6. Home Language:

- Northern Sotho
- Sotho
- Zulu
- Tsonga
- Afrikaans
- Venda
- Xhosa
- Ndebele
- Swazi
- Tswana
- English

7. Prior to reading the information sheet, I was aware of the internet of things (IoT):

- Strongly Agree
- Somewhat Agree
- Agree
- Neutral

○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
8. I am aware of the IoT and its application in healthcare following review of the information letter: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
11. I have access to a smartphone or internet enabled device: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree

Healthcare Practitioners Version

Perceived Usefulness
1. The use of a healthcare related IoT device will enable me to monitor my patient: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree

○ Somewhat Disagree ○ Strongly Disagree
2. The use of a healthcare related IoT device will allow me to follow up with my patient from outside of the hospital: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
3. The use of a healthcare related IoT device will allow me to rapidly retrieve information of patients healthcare data/information: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
4. Using a healthcare related IoT device will allow me to easily monitor my patient’s chronic condition control: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
Perceived Ease of Use
5. Learning to use a healthcare related IoT service will be easy for me: ○ Strongly Agree ○ Somewhat Agree ○ Agree

○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
6. Learning to use a healthcare related IoT service will be easy for my patients: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
7. Using a healthcare related IoT service to track my patient would afford me flexibility in treating them: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
8. My interaction with a healthcare related IoT service will be clear and understandable: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
User Satisfaction
9. I own a smartwatch: ○ Strongly Agree ○ Somewhat Agree

○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
10. If yes, I am completely satisfied with my smartwatch or fitbit's ability to track my health progress: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
11. I feel confident in recommending healthcare related IoT devices as a method to track my patient's health progress: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
12. I feel confident using a smart watch or fit as a method to my health progress: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
13. I believe that from using a healthcare related IoT device, I can track a patient's progress and this will increase the quality of care in the healthcare

industry:

- Strongly Agree
- Somewhat Agree
- Agree
- Neutral
- Disagree
- Somewhat Disagree
- Strongly Disagree

Attributes of Usability

14. It is easy to interact with a smartwatch or fitbit:

- Strongly Agree
- Somewhat Agree
- Agree
- Neutral
- Disagree
- Somewhat Disagree
- Strongly Disagree

15. I found various functions between the health related app and smartwatch/fitbit tend to easily integrate and serve the functions that I require out of it:

- Strongly Agree
- Somewhat Agree
- Agree
- Neutral
- Disagree
- Somewhat Disagree
- Strongly Disagree

16. I think I would like to use a healthcare related IoT service:

- Strongly Agree
- Somewhat Agree
- Agree
- Neutral
- Disagree
- Somewhat Disagree

○ Strongly Disagree

Non-healthcare Practitioners Version:

Perceived Usefulness
1. The use of a healthcare related IoT device will enable my doctor/healthcare practitioner to monitor me remotely: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
2. The use of a healthcare related IoT device will allow my doctor/healthcare practitioner to follow up with me from outside the hospital: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
3. The use of a healthcare related IoT device will allow for rapid retrieval of information of my healthcare data/information for my healthcare practitioner: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
4. Using a healthcare related IoT service will allow my doctor/healthcare

practitioner to easily monitor my chronic condition control:

- Strongly Agree
- Somewhat Agree
- Agree
- Neutral
- Disagree
- Somewhat Disagree
- Strongly Disagree

Perceived Ease of Use

5. Learning to use a healthcare related IoT device will be easy for me:

- Strongly Agree
- Somewhat Agree
- Agree
- Neutral
- Disagree
- Somewhat Disagree
- Strongly Disagree

6. My interaction with a healthcare related IoT service will be clear and understandable:

- Strongly Agree
- Somewhat Agree
- Agree
- Neutral
- Disagree
- Somewhat Disagree
- Strongly Disagree

7. It would be easy for me to become skilful on a healthcare related IoT service:

- Strongly Agree
- Somewhat Agree
- Agree
- Neutral
- Disagree
- Somewhat Disagree
- Strongly Disagree

User Satisfaction
8. I own a smartwatch or fitbit: ○ Yes ○ No
9. If yes, I am completely satisfied with my smartwatch or fitbit's ability to track my health progress: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
10. I feel confident in using a smart watch or fitbit as a method to monitor my health progress: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
Attributes of Usability
11. It is easy to interact with a smartwatch or fitbit: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
12. I found the various functions between the health related app and smartwatch/fitbit tend to easily integrate: ○ Strongly Agree

○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree
13. I think I would like to use a healthcare related IoT service: ○ Strongly Agree ○ Somewhat Agree ○ Agree ○ Neutral ○ Disagree ○ Somewhat Disagree ○ Strongly Disagree